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Did Prepayments Sustain the Subprime Market?*

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Abstract

This paper demonstrates that the reason for widespread default of mortgages in the subprime market was a sudden reversal in the house price appreciation of the early 2000's. Using loan-level data on subprime mortgages, we observe that the majority of subprime loans were hybrid adjustable rate mortgages, designed to impose substantial financial burden on reset to the fully indexed rate. In a regime of rising house prices, a financially distressed borrower could avoid default by prepaying the loan and our results indicate that subprime mortgages originated between 1998 and 2005 had extremely high prepayment rates. However, a sudden reversal in house price appreciation increased default in this market because it made this prepayment exit option cost-prohibitive.

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1 Introduction

The recent crisis in the subprime mortgage market is arguably one of the landmark events in recent financial history. The extraordinary growth of the subprime mortgage market in the first part of this decade and its subsequent demise in 2006-2007 is of interest to both academics and policymakers. However, much of the workings of this market are not fully understood. It is even less clear as to what caused this market to collapse from its peak in the second quarter of 2005.

This paper seeks to understand what went wrong in this market. Our aim is to provide a rationale behind the sharp rise in borrower defaults on subprime mortgages during 2006 and 2007. To determine the causes of the subprime crisis, we use a large, unique loan level database on subprime mortgages. The database records lender, borrower and mortgage characteristics as well as repayment behavior (prepayments, delinquencies and foreclosures) on individual mortgages.

Our results show that subprime mortgages originated between 1998 and 2006 had very high prepayment rates and prepayment speeds (see Table 1). For all subprime originations and across all product types, at least half of all loans were prepaid within the first five years after origination.[1] Aside from being current on their mortgage payments, financially distressed borrowers can avoid default and foreclosure by prepaying their loans (either through a refinance or a property sale). Clearly, prepayments are crucial to understanding the subprime crisis. This begs the obvious questions: Why were prepayments so high in the subprime market? What sustained such high prepayment rates?

There are several reasons behind the high prepayment rates in the subprime mortgage market. To begin with, we find that initial mortgage rates in the subprime market were significantly higher than prime mortgage rates. While this is true for interest rates on

[1] This is despite the fact that around 60-75 percent of FRMs and around 70-85 percent of ARMs include prepayment penalties. For more details on prepayment penalties, see discussion in Section 4.

fixed-rate mortgages (FRMs), it is also true, contrary to popular belief, on teaser rates of hybrid adjustable rate mortgages (hybrid ARMs). Consequently, there is a higher probability that subprime borrowers face financial distress, increasing their propensity to refinance.

However, lower interest rates have not always been the motivation behind prepayments (refinances) in the subprime market. The case in point being mortgage originations of 2003, which have the highest prepayment rate for hybrid-ARM products. As much as 83 percent of hybrid-ARM products (about 64 percent of total) that were originated in 2003, were prepaid by the end of 2006. This seems to suggest that the "low-interest-rate environment" around 2003-2004 did not play a large role in the prepayment behavior of subprime mortgages.

Nevertheless, our results support the hypothesis that subprime mortgages were unique in that prepayments were integral part of the mortgage design (Gorton, 2008). This is particularly true in the case of hybrid-ARMs which comprise the majority of subprime mortgages of recent vintages. Gorton (2008) argues that lenders avoided exposing themselves to long-term contracts (like thirty year mortgages) with high-risk subprime borrowers by placing terms and conditions on the loan that would ideally "force" the borrower to "return" to the lender at shorter intervals. Essentially, the claim is that the fully-indexed rate upon reset from the teaser rate was designed to be prohibitively high so that the borrower had little choice but to return to the lender and refinance the loan. This study of repayment behavior on individual subprime loans finds strong support in favor of this claim.

What sustained high prepayment rates on subprime mortgages? We use a competing-risk hazard model to demonstrate how the evolution of house prices helped in sustaining the boom and subsequently led to the downturn in the subprime mortgage market. As is well known, there was a strong and persistent appreciation in house prices in almost all

US metropolitan areas from 1995 to 2006, followed by a sharp downturn (see Figure 1).[2] We estimate that an increase in house prices has a positive effect on the likelihood of prepayment for first-lien subprime mortgages. At the same time, this increase in house prices also reduces the likelihood that the borrower defaults on the loan. In a regime of rising house prices, borrowers can avoid default by prepaying their loans (either through a refinance or a property sale). Moreover, if the house price appreciation is sufficiently large, a borrower can recover the costs of refinancing and even choose to extract equity. However, this option is no longer available when prices do not appreciate. Consequently, borrower defaults began to increase in 2006, when house prices ceased to appreciate.

The subject of mortgage termination through prepayment (refinance) and its relation to house price appreciation has been discussed before in different contexts. Increased financial awareness, in addition to lender competition, financial innovations and structural changes in the mortgage market have significantly increased a household's ability to refinance a mortgage at very low costs (Bennett, Peach and Persitiani, 2001). Using PSID household survey data between 1991 and 1996, Hurst and Stafford (2003) show that families experiencing a negative income shock or those that are severely liquidity constrained, are 25 percent more likely to refinance than otherwise similar households. Moreover, there is increasing evidence that some households refinance even in times of rising interest rates, primarily with the motive of consumption-smoothing (Stanton, 1995; Agarwal, Driscoll and Laibson, 2002). Finally, a decrease in property values makes it difficult for households to refinance mortgages and take advantage of declining interest rates (Caplin, Freeman and Tracy, 1997).

Putting the pieces together, we sketch the intuition behind our results as follows. Rising house prices and declining refinancing costs over the last two decades have facilitated a household's propensity to refinance a mortgage. This propensity has been shown to be

[2]The date for the peak on housing prices and the extent of the fall in home prices varies depending on the home-price index used. See Aubuchon and Wheelock (2008) for a discussion on the differences between the indices.

higher for borrowers that are financially distressed due to a job loss or medical expenses. Moreover, this consumption smoothing motivation can be sufficiently strong so that borrowers are known to refinance even in periods of rising interest rates, merely to extract equity from their homes (which might explain the high prepayment rates on subprime originations of 2003). It is fair to claim that while motivations for a cash-out refinance exist for a typical prime borrower, these incentives are likely to be much stronger for subprime borrowers. Evidently, refinancing mortgages during a period of declining interest rates and rising house prices can be easier than doing the same when the opposite is true.

The dominant explanation for the subprime crisis is that a severe weakening in underwriting standards occurred over the last few of years, which eventually caused a downturn in this market. In a companion paper, we examine underwriting standards (Bhardwaj and Sengupta, 2008), showing that lending standards did not deteriorate within the subprime market. However, the growth of the subprime segment obviously implies a weakening of borrower quality in the overall mortgage market. Our explanation for the subprime crisis is best summarized in Shiller (2008, p.50):

> Adjustable-rate mortgages were common because those who had been influenced by bubble thinking and wanted to get into real estate investments as heavily as possible were demanding them. The mere fact that interest payments would be going up soon did not deter them. They expected to be compensated by rapidly increasing home prices, and they believed that those higher prices would permit them to refinance at a lower rate.

Section 2 reviews the literature while Section 3 provides the summary statistics on default and prepayments in the mortgage market. In Section 4, we discuss how subprime mortgage contracts were unique in their design in that they relied heavily on prepayments. Section 5 provides estimation results and Section 6 concludes.

2 The Economics of Subprime Prepayments

Mortgage prepayment can occur by refinancing or a property sale. Because the considerations for property sale under financial distress are better understood, we will focus our attention on mortgage refinance. Mortgage refinancing refers to the prepayment of an existing mortgage by replacing it with another mortgage, typically under more favorable terms. Refinancing can be undertaken to reduce the interest burden (monthly payments) on the mortgage (either by refinancing to a lower interest rate or by switching to a longer-term loan), to switch from one product type to another (like switching from an ARM to FRM), and to extract homeowner's equity (also known as cash out refinancing).

The literature on mortgage refinancing has highlighted two principal reasons why households choose to refinance.[3] The first occurs when a household refinances by taking advantage of declining interest rates, and is often referred to as a *rate refinance*. The borrower refinances into a stream of lower mortgage payments by paying off the existing higher interest mortgage and replacing it with one at the current (lower) interest rate. In addition, a household may also refinance so as to extract accumulated equity in their home, also known as a *cash-out refinance*. This second motivation is typically consumption-smoothing and is particularly relevant during a period of house price appreciation.

Evidently, the two motives for refinancing are not mutually exclusive and, as Bennett, Peach and Persitiani (2001) observe, refinancing in the prime housing market in the US has occurred in waves during periods of declining long-term interest rates and rising house prices. On the other hand, there is evidence of households refinancing even when the current market rate is higher than the existing contract rate (Stanton, 1995; Agarwal, Driscoll and Laibson, 2002). The consumption smoothing motivation that drives

[3] Using PSID Survey data, Hurst and Stafford (2003) find that those who refinance tend to have lower age, higher education, more income, and are more likely to be married.

this anomalous behavior is particularly strong for households that experience a negative income shock (Hurst and Stafford, 2003). This study also finds that liquidity-constrained households exhibit a higher propensity to convert home equity into current consumption than non-liquidity-constrained refinancers. In summary, not all refinancing behavior in the current housing market can be explained by current and expected future interest rate movements.

Evidently, not all households that are liquidity constrained and have an incentive to refinance their existing mortgages are able to do so. Refinancing involves transactions costs that are reflected in points and fees, legal expenses, mortgage insurance premiums and additional out-of-pocket expenses. Additionally, each of these items varies with property, loan and borrower characteristics. For example, in regions suffering from adverse economic conditions, mortgage refinancing is constrained not only by depressed incomes and damaged credit profiles of borrowers but also by declining property values (Caplin, Freeman and Tracy, 1997).

Finally, mortgage underwriting in the United States has undergone a fundamental change over the last three decades and is now more closely integrated with the capital market. Financial innovations, technological advances, along with increased lender competition during this period have greatly reduced the transactions cost associated with mortgage refinancing (Bennett, Peach and Persitiani, 2001). Figure 2 illustrates the decline in one component of transactions cost, namely points and fees levied as a proportion of the conventional loan amount.[4] These costs declined from 2.5 percent in 1983 to roughly 0.4 percent in 2006. Bennett, Peach and Persitiani (2001) argue that such changes have resulted in a secular increase in prepayment speeds of all mortgage products in recent years. As a result, lenders now try to avoid prepayment risk by including a prepayment penalty. Borrowers typically are offered a lower interest rate in exchange for

[4]We use fees and points from the Freddie Mac PMM Survey, the most commonly available series for prime borrowers. To the best of our knowledge, we are yet to come across a data series on fees and points in the subprime mortgage market.

accepting a prepayment penalty.

The literature on mortgage refinance has mostly concentrated on the prime market. This is important because the 2001 Residential Finance Survey, the latest conducted by the Census Bureau, suggests differences in the motivation to refinance between borrowers in prime and subprime markets. Among prime refinances, 66 percent were rate refinances while only 26 percent extracted equity. On the other hand, 40 percent of subprime refinances included a lower rate but almost half of the sample extracted equity. Chomsisengphet and Pennington-Cross (2006) confirm that a higher proportion of subprime refinances take cash out than prime refinances. While they examined refinancing in the early years of the subprime market, little work has been done for the years 2002-2006 when the subprime activity was at its peak.

Cutts and Van Order (2005) find that while prepayment speeds for the subprime market are higher on average than those for the prime market, they are relatively less sensitive to cyclical movements in the interest rate. They document that unlike the prime market, borrowers in the subprime market have a strong incentive to refinance when their credit scores improve. This distinction often prompts lenders to safeguard against prepayment risk in the subprime market. Consequently subprime loans are more than three times as likely to have prepayment penalty terms, with lockouts usually in effect for two to five years.

3 Data and Summary Statistics

Our data source is the ABS (Alt-A & Nonprime) Database from First American Loan Performance (hereafter, FALP).[5] For the purposes of this study, we restrict our analysis

[5] Details on this database, its evolution and coverage are available in Chomsisengphet and Pennington-Cross (2006) and Mayer and Pence (2008).

to first-lien, subprime mortgages.[6] Not only does this database report borrower and loan characteristics at the time of origination, but it also provides updates on the current status of the mortgage. Our data is current up to June, 2008. However, an important limitation of this database is that while it records that a mortgage has been paid off; it does not report if this payment was through a refinance of the mortgage or if the property was sold. For the purposes of this paper, we define default and prepayment as follows. A mortgage is in default if it were delinquent for 90 days, or in foreclosure, or real-estate owned. Finally, all mortgages that were paid off before they ever registered a 90-day delinquency are defined to be prepaid.

Table 1 summarizes prepayment behavior in the subprime mortgage market. The numbers denote the fractions of total loans by product type, that were prepaid within a given calendar year from the year of origination.[7] We consider three major product types on subprime loans, namely, FRM, ARM2 and ARM3.[8] The period of study in each case is from the time of origination to the end of a calendar year.[9] Thus, for example, 38 percent of all FRM loans originated in 1998 were prepaid by the end of 2001. Three trends are immediately obvious from the data. First, the prepayment rates for ARMs are higher than those for FRMs of the same vintage. Second, for mortgages originated between 1998 and 2003, the prepayment rates continue to increase progressively over time. This is true across all product types. Third, for mortgages originated after 2003,

[6] We classify a loan as a subprime loan if it belongs to a subprime pool in the FALP database. Loosely speaking, subprime pools include loans to borrowers with incomplete or impaired credit histories while Alt-A pools include loans to borrowers who generally have high credit scores but who are unable or unwilling to document a stable income history or are buying second home or investment properties (Fabozzi 2000, p.9).

[7] For a distribution of subprime mortgages by product types and year of origination, see Table 1 in Bhardwaj and Sengupta (2008).

[8] For Adjustable Rate Mortgages (ARMs), the majority of loans are hybrid-ARM, where the initial teaser rate is often fixed for periods of 2, 3 and even 5 years. To simplify classification over a very broad range of product types in the market, we define these products as ARM2, ARM3 and ARM5 respectively. Thus, ARM2 includes the hybrid 2/28 while ARM3 includes the hybrid 3/27 mortgage. However, not all ARM2 and ARM3 are 30-year mortgages.

[9] Our choice of calendar year over the more conventional method of presenting the distribution by loan age is motivated by much of the commentary on this market arguing that things started worsening after a calendar date.

there has been a decline in the prepayment rates, and this has been particularly severe for the years 2006 and 2007.

To provide a more detailed picture of these trends, we examine the following loan status variables over time: delinquency, prepayment and foreclosure. For each vintage (year of origination), we record loans that experience either a 30-day or a 60-day delinquency (as a fraction of total originations) separately. Among these delinquent loans, we tabulate those that were prepaid and those that went into foreclosure. We do this separately for loans that experience a 30-day and a 60-day delinquency. The summary statistics are reported in Tables 2-5 for different classifications like occupancy, product type and purpose of loan.

Table 2 provides the details in trends for delinquency, prepayment and foreclosure on owner-occupied households. Each panel presents the cumulative percentages for the loans from the year of origination up to the end of the second, third and fourth calendar year after the year of origination. For example, 31 percent of owner-occupied originations in 2003 were 30-day delinquent at least once by the end of 2006. Among those experiencing a 30-day delinquency, 53 percent had been prepaid and 15 percent foreclosed by the end of 2006.

Tables 3-5 present summary data from the year of origination up to the end of two calendar years.[10] The following patterns emerge from a cursory inspection of the summary data.

1. Loans that register a 30-day delinquency are more likely to prepay than loans that record a 60-day delinquency in the same period.

2. Both 30-day and 60-day delinquencies are significantly higher for loans originated

[10] This allows us to compare across loans of all vintages, especially those originated in 2004-2006. The numbers for 2007, although stated, are not comparable since there is one and a half calendar years of data available since origination.

after 2004.

3. Finally, and perhaps most importantly, there is sharp decline in prepayment rates for loans originated after 2004.

Most important, Tables 3-5 show that these findings are robust across variations in ownership patterns (occupancy), product type and loan purpose. It is important to clarify some doubts that may arise. Since our data is current up to June 2008, the data on originations of 2007 are not strictly comparable with the rest of the vintages. However, even with one and a half years of data, the prepayment numbers do seem low when compared to those of earlier vintages. Also, for mortgages that included prepayment penalties, these penalties were in effect for originations of *all vintages* (not just 2006 and 2007 vintages) because we consider data for the first two calendar years from the year of origination. Therefore, the anomalous prepayment behavior for originations of 2006 and 2007 vintages is indeed striking.

In summary, this section has demonstrated the importance of prepayments in subprime mortgages. Of course, this raises the obvious questions stated previously. First, why were prepayment rates so high for subprime mortgages? Second, what sustained such high prepayment rates in the subprime market? The following sections answer these questions.

4 The Uniqueness of Subprime Mortgage Design

Why were repayment rates so high for subprime mortgages? Our answer builds on Gorton's (2008) hypothesis that the high prepayment rates were largely due to the unique way in which subprime mortgages were designed. Gorton argues that lenders avoided exposing themselves to long-term contracts (like thirty year mortgages) because of the

high risk profile of subprime borrowers. They did this by placing terms and conditions on the loan that would ideally "force" the borrower to "return" to the lender at shorter intervals. This is best illustrated in terms of the hybrid-ARMs, the most common product type in subprime markets. In a nutshell, the theory claims that the fully-indexed rate that the borrower was required to pay upon reset from the teaser rate was designed to be prohibitively high so that the borrower had little choice but to return to the lender and refinance the loan. This gives the lender the desired option to refinance or to foreclose on the property at the shorter length.

Of course, this theory raises serious questions as to the viability of such mortgage design, not to mention the short-sightedness of a borrower to enter into such a contract. However, given the evidence on subprime contracts, this is the most plausible explanation available to us. One explanation here is that these products were orginally intended as "bridge-financing" for financially distressed borrowers:

> These products originally were extended to customers primarily as a temporary credit accommodation in anticipation of early sale of the property or in expectation of future earnings growth. However, these loans have more recently been offered to subprime borrowers as "credit repair" or "affordability" products. The Agencies are concerned that many subprime borrowers may not have sufficient financial capacity to service a higher debt load, especially if they were qualified based on a low introductory payment.[11]

Importantly, subsequent legislation has made it mandatory that the borrower's repayment ability should be judged by his ability to pay the fully indexed rate and not the teaser:

> For all nontraditional mortgage loan products, an institution's analysis of a

[11] Board of Governors of the Federal Reserve System (2007).

> borrower's repayment capacity should include an evaluation of their ability to repay the debt by final maturity at the fully indexed rate, assuming a fully amortizing repayment.[12]

In this section we provide some empirical evidence in support of this theory. Table 6 shows the terms on the interest rates on subprime mortgage contracts at the time of loan origination. The first and second columns give us the unconditional means of the closing rate on ARM and FRM products respectively. Note that the closing rate on the ARM is typically the *teaser rate* in the case of the hybrid-ARM. This teaser rate resets into the *fully-indexed rate* which is the sum of the *index* (typically a *market-traded rate* like the LIBOR) and the *margin*. The third column gives us the mean on margins for loans of a given vintage, which on average has been a little more than six percent for such loans. The fourth and fifth columns give us the means of the minimum and the maximum interest rates that could be charged on subprime mortgages over the lifetime of these contracts. The last column indicates that for an overwhelming majority of subprime loans, the closing teaser rate was the lifetime minimum that would be charged on such mortgages.

Table 6 shows the essentials behind the design on subprime mortgages. First, the popular notion that teaser rates were very low is largely untrue. Second, the sum of the margin and the lifetime minimum is on average not much lower than lifetime maximum on the loan. Clearly, the interest rates were anticipated to be extremely high on reset. Gorton (2008) argues that such high rates were designed to "force" the subprime borrower to prepay the loan.[13] If the contract terms were settled at origination, why did the borrower not refinance the loan before the reset date? Gorton argues that subprime lenders prevented this eventuality by the inclusion of prepayment penalties in the con-

[12] Board of Governors of the Federal Reserve System (2006).

[13] It is not altogether clear if the borrowers were short-sighted or they were misled into such contracts. While it is not possible to rule this out, it is important to note that millions of such mortgages were originated in the subprime market.

tract. Several studies have noted that a higher proportion of subprime loans included prepayment penalties when compared with prime loans (Cutts and van Order, 2005, Gorton, 2008).

Table 7 provides the timeline on prepayment dates and rate resets. Column (2) shows that roughly 70-80 percent of hybrid ARMs had prepayment penalties. Fortunately, our data provide information on the penalty term (the number of months after which the borrower could prepay the mortgage without incurring the penalty). If Gorton's hypothesis of prepayment penalties on hybrid-ARMs is true, then for a majority of these loans the prepayment term should not expire before the rest date. Indeed, that is exactly what we find for over 90 percent of such loans (Columns (5)-(6)). Interestingly, the prepayment term ends at the reset date for a majority of loans and this proportion seems to be increasing over the years (Column 5). For loans in which the prepayment term expires before the reset date, the length of the term (in months) is on average half of duration for which the teaser rate is in effect (Column 4). Conversely, for loans in which the prepayment term is longer, it is on an average at least 1.5 times lengthier (Column 7).

The results in Tables 6 and 7 demonstrate the uniqueness of subprime mortgages. In summary, they support the hypothesis that is formalized in Gorton (2008). The majority of subprime mortgage contracts were hybrid-ARMs, featuring teaser rates, margins, reset dates and prepayment penalties. The overwhelming majority of these contracts rest into prohibitively high rates leaving the borrower little option but to prepay either by selling or by refinancing. While these data explain why prepayments were so high in the subprime market, it also leads us to our next question: What sustained such high prepayment rates?

5 Results

In this section, we attempt to answer as to what sustained high prepayment rates. Our question could be stated differently: why didn't these mortgages go into default or foreclosure? To help answer this question we model how mortgage repayment behavior switches between prepayment and default. As explained previously, prepayments and defaults are in the set of alternatives available to the borrower in repaying the loan and therefore we need to look at them in tandem. There is however a third alternative: stay current (or maintain the current delinquency status) by paying the monthly installment on the loan.

Since prepayment and default are substitutes, we jointly model the competing risks of default and prepayment. To this end, we estimate a competing risk hazard model for the events of prepayment and default. A loan is considered *prepaid* if it was paid off before the borrower recorded a 90-day delinquency. On the other hand, a mortgage is considered to be in *default* if the loan records a 90-day delinquency or foreclosure. We look at what considerations prompted a borrower to prepay or default.

Figures 3 and 4 plot the Kaplan-Meier default and prepayment probabilities. The two plots are not mirror images of each other because, as mentioned before, there is a third option for the borrowers to stay current (or delinquent). As seen in Figure 3, with the exception of originations in 2003, default probabilities increased progressively for each year in the sample period. However, the default probabilities rise sharply for originations of 2004-2007. Much of the commentary on the subprime crisis has sought to explain this trend. What has been omitted from these commentaries is that, during the same period (2004-2007), every vintage shows a progressively lower prepayment probability rate than earlier vintages for the same age on the loan (Figure 4). Stated differently, prepayment probabilities fall sharply for originations of 2004-2007. After two calendar years, the prepayment probabilities were 0.44, 0.46 and 0.45 for mortgage originations of 2002, 2003 and 2004 vintages. However, the prepayment probability on originations

of 2005 and 2006 vintages are 0.36 and 0.23 respectively (note that this includes their performance during the calendar years 2006 and 2007). Furthermore, mortgages of 2003 and 2004 vintages have very similar prepayment probabilities, though for the first 24 months the prepayment probability for 2003 vintages is slightly lower then that of 2004, which could be attributed to historically low interest rates during 2003.

To formalize our argument, we split borrower repayment behavior into three possible outcomes: (1) the borrower defaults on the loan, (2) borrower prepays and (3) the loan is current or even 30-day or 60-day delinquent. We denote the exit routes by event j, where the three events are given by subscript $j = 1, 2, 3$. Let T_{ij} be the age (in months) at which borrower i chooses event j. Therefore, the loan performance of borrower i is observed for $min_j\,(T_{ij})$. The hazard function $h_{ij}(t)$ specifies the instantaneous probability of occurrence of event $j\,(1, 2)$ for mortgage i, and is given by

$$h_{ij}(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T_{ij} < t + \Delta t | T_{ij} \geq t)}{\Delta t} \tag{1}$$

Then, following Cox (1972) the semi parametric representation that we estimate takes the form

$$h_{ij}(t) = h_{0j}(t) \exp(X_i \beta_j) \tag{2}$$

where $h_{0j}(t)$ is the cumulative baseline hazard rate for event $j\,(1, 2)$ and X_i is the vector of covariates on mortgage i.

For estimating both equations we control for characteristics of the borrower, lender, property as well as some loan characteristics. The borrower characteristics that we control for include credit score[14] and occupancy (dummies for owner-occupied, investor-owned or second home), while lender characteristics include the type of lender or loan source (like retail, broker, realtor, etc.). Property characteristics include the number of units,

[14]The credit score is normalized by dividing borrower's FICO score by 100.

property type (condo, townhouse etc.), location (dummy for each state in which the property is located), and home value quartile to which the property belongs. Finally, loan characteristics include loan type (conventional, VA, FHA, government, etc.), loan purpose (purchase, cash-out refinance, no cash-out refinance etc.), loan documentation (high doc or low-doc), prepayment penalty and term of prepayment. In addition, we also include two dummies. The first takes the value one if the term (in months) of the prepayment penalty is greater than the term of reset for ARMs and zero otherwise. The second takes the value one if the date on the event (prepayment or default) is greater than the term of reset for ARMs.

In addition, we include several variables that control for market conditions between the time of orgination and at the time of prepayment or default. *Fees and Points* are the fees and discount points charged by the lender at settlement. As is common in this literature, we use the Principal/Value (PV) variable as measure of the incentive to undertake a rate refinance (Richard and Roll, 1989). PV_t measures the ratio of the present value of the payments on mortgage principal outstanding at time t using the existing mortgage rate to that using the current rate available on refinance:

$$PV_t = \frac{r_t}{r_0}\left[\frac{1-(1+r_0)^{t-M}}{1-(1+r_t)^{t-M}}\right]$$

where r_t and r_0 are the current and existing rates on the mortgage and M is the maturity period in number of months (360 months for a 30-year mortgage). Note that if $r_t = r_0$, $PV_t = 1$. There is an incentive to refinance if $r_t < r_0$, that is if $PV_t < 1$. Defining r_t and r_0 to be the 6-month LIBOR at the time of the event and the time of origination, we create the variable PV *Annualized rate*.

Kau et al (1993) suggest that interest rate volatility reduces the probability of prepayment. Following Ambrose and Sanders (2003), we define the variable as the standard deviation of the six-month LIBOR for the previous 24 months. Furthermore, as argued

above, house price appreciation is critical for the decision to refinance. We tabulate *House Price Growth* as the appreciation of the repeat-sales OFHEO house price index at the MSA level. Finally, to control for negative income shocks we use *Unemployment Rate* which is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics.

A question of added interest here is: What determines the age at which loans are prepaid? To answer this question we use a two-step Heckman correction regression where the selection equation (decision to prepay) is a probit. The regression results are provided in Tables 8-16. Tables 8-13 provide the results of the competing risk hazard models of prepayment and default for each product type: FRM, ARM2 and ARM3. In Tables 14-16, we provide the results for the treatment equation in the Heckman two-step regression on determinants of loan age at prepayment for each of the three product types.

Tables 8-9 reports the hazard ratios for the competing-risk hazard rate regressions for FRMs. The regressions are conducted for all loans originated in a given calendar year.[15] A hazard rate that is greater than unity implies an increase in the probability of the event and vice-versa. The results seem to confirm our somewhat ad hoc beliefs about how borrower characteristics determine repayment behavior. For example, a hundred-point increase in FICO scores on mortgage originations of 2002, increases the prepayment probability by 15.64 percent but reduces the default probability by 46.58 percent. Likewise, full documentation (as opposed to low or no documentation) on an origination of 2002 increases the probability of prepayment by 3.3 percent but reduces the probability of default by 17.94 percent.

Our main result comes from the hazard ratios on the *House Price Growth* variable. For the FRMs originated in 2004, the hazard rate on the *House Price Growth* variable is 1.16 for prepayment but 0.76 for default. This implies that, for mortgages of 2004

[15] We omit loans originated in 2007 because we have just over a year and a half of payment data for loans of this vintage

vintage, a one percent per annum increase in house prices increases the probability of prepayment by 16 percent but reduces the probability of default by 24 percent. This result is extremely robust. Moreover, this ratio is economically and statistically significant for both the prepayment and default regression. Furthermore, the result holds true for all vintages and across each of the three product types.

Next, we expect *Fees and Points* and *Prepayment Penalties* to reduce the probability of prepayment and thereby increase the probability of default. For *Fees and Points*, we find that it marginally increases the probability of both prepayment and default. Our results reveal that the use of fees and points from the Freddie Mac PMM Survey (figure 2) on prime mortgages might be an imperfect proxy for the fees and points on the subprime market. For our data on *Prepayment Penalties*, the results are just as we would expect: the inclusion of such penalties reduces the likelihood of prepayment and increases the likelihood of default.

As for macroeconomic variables, the *Interest Volatility* and *PV Annualized Rate* variables have a significant and positive effect on the likelihood of default and prepayment. The result is not in line with our expectations. Ideally, *Interest Volatility* should reduce the likelihood of prepayment but our results show the opposite. However, the magnitude of the hazard ratio is not economically significant. As mentioned earlier, an increase in the *PV Annualized Rate* should reduce the incentive to refinance. Again, we find the opposite in our results, but the magnitude of this variable's effect on the hazard ratio appears not to be significant for most vintages. From our results, we get that *Unemployment Rate* increases the probability of prepayment (as homeowners cash-out the benefit from the appreciation in home prices) and default (only for later vintages) as one would expect.

Before concluding this section, we discuss the results on the determinants of loan age on refinance. Again the results are given by loan vintage. The coefficients on the

second stage treatment equation for each product type are reported in Tables 14-16. For mortgages of the given vintage, a negative coefficient implies that borrowers are more likely to prepay sooner than later. For *House Price Growth*, this coefficient is positive for mortgages of earlier vintage but turns negative for mortgages of later vintages. This points to an interesting phenomenon witnessed in these markets. A house price appreciation on earlier mortgages delayed prepayment whereas the similar appreciation on mortgages of later vintages rushed prepayment. It somewhat embellishes the earlier result and our hypothesis regarding the downturn in this market: borrowers on more recent mortgages are keener to prepay on house price appreciation than those who took out subprime loans earlier.

In summary, the results underlie the importance of house prices in this market. First, a rise in house price increased the probability of prepayment while reducing the probability of default. Second, a house price appreciation on mortgages of earlier vintage delayed prepayment whereas the similar appreciation on mortgages of later vintages increased prepayment speeds. Taken together, the robustness of these results point to the fact that the boom in house prices for the most part of the sample period was largely responsible for sustaining the subprime mortgage market by allowing distressed borrowers to prepay mortgages.

6 Conclusion

We conclude that the story of the subprime mortgage crisis is a story of mortgage prepayments. The highest prepayment rate is for adjustable rate mortgages originated in 2003. This is surprising given that interest rates were considerably low in 2003. Consequently, it is difficult to argue that borrowers in mortgages of this vintage were able refinance at lower rates in subsequent years. And yet, as much as 83 percent of loans in this category

were prepaid by the end of 2007. Therefore, it is likely that most prepayments on these loans would include cash-out refinances or property sales.

Against this background are the steep rise in house prices over the same period in some US metropolitan areas (see Figure 1). In this period, house price indices increased more then ten percent per year in several states, mostly in the coastal states of California, Florida, Nevada, Maryland and Rhode Island. However, the rise in house prices has been very uneven across the nation, with some states, like Texas and Ohio, growing barely above two percent per year. The increase in house prices is substantial even if one looks at the average state-level price, which smoothens out differences across local markets within each state. As Case and Shiller (2003) note, US house prices have been rising faster than incomes and faster than other prices in virtually every metropolitan area. Contrary to most theoretical predictions, the house prices did not turn down and the housing boom continued unabated despite the recession in 2001 (Mayer and Quigley, 2003).

At this point it is important to note that our explanation treats the widespread appreciation of home prices in the US as exogenous. In this regard, we are motivated largely by Shiller (2008), who argues that the "most important single element" in the house price boom is, as he puts it, "the social contagion of boom thinking." He argues (p.48):

> Other factors are widely cited as the cause of the housing boom.... to a large extent, these other factors are themselves substantially a *product* of the bubble, and not exogenous factors that caused the bubble.

Our results show that this sharp and persistent increase in house prices in almost all metropolitan areas since 1995 is critical. We estimate that an increase in house prices has a positive effect on the likelihood of prepayment for first-lien subprime mortgages. Concomitantly, this increase in house prices also reduces the likelihood that the borrower

defaults on the loan. In a regime of rising house prices, a financially distressed borrower can avoid default by prepaying the loan (either through a refinance or a property sale). Moreover, if the house price appreciation is sufficiently large, the borrower can recover the costs of refinancing and even choose to extract equity. However, this option is no longer available when prices cease to appreciate. Consequently, borrower defaults began to increase once house prices failed to appreciate in 2006.

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Figure 1: Evolution of House Prices 1992-2007
(year on year change)

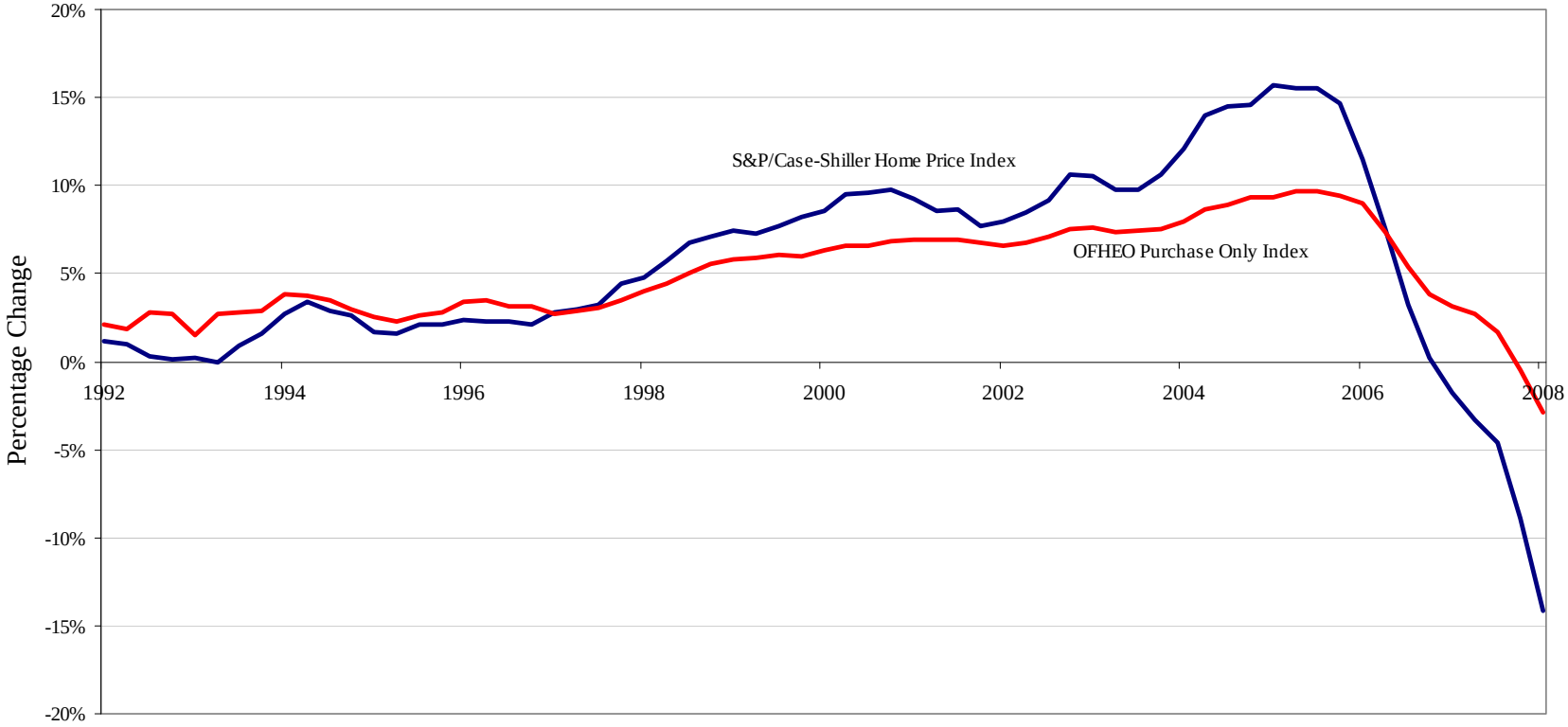

Figure 2: Fees and Points on 30-yr Fixed Rate Mortgages
Source: FHLMC PMMS Survey

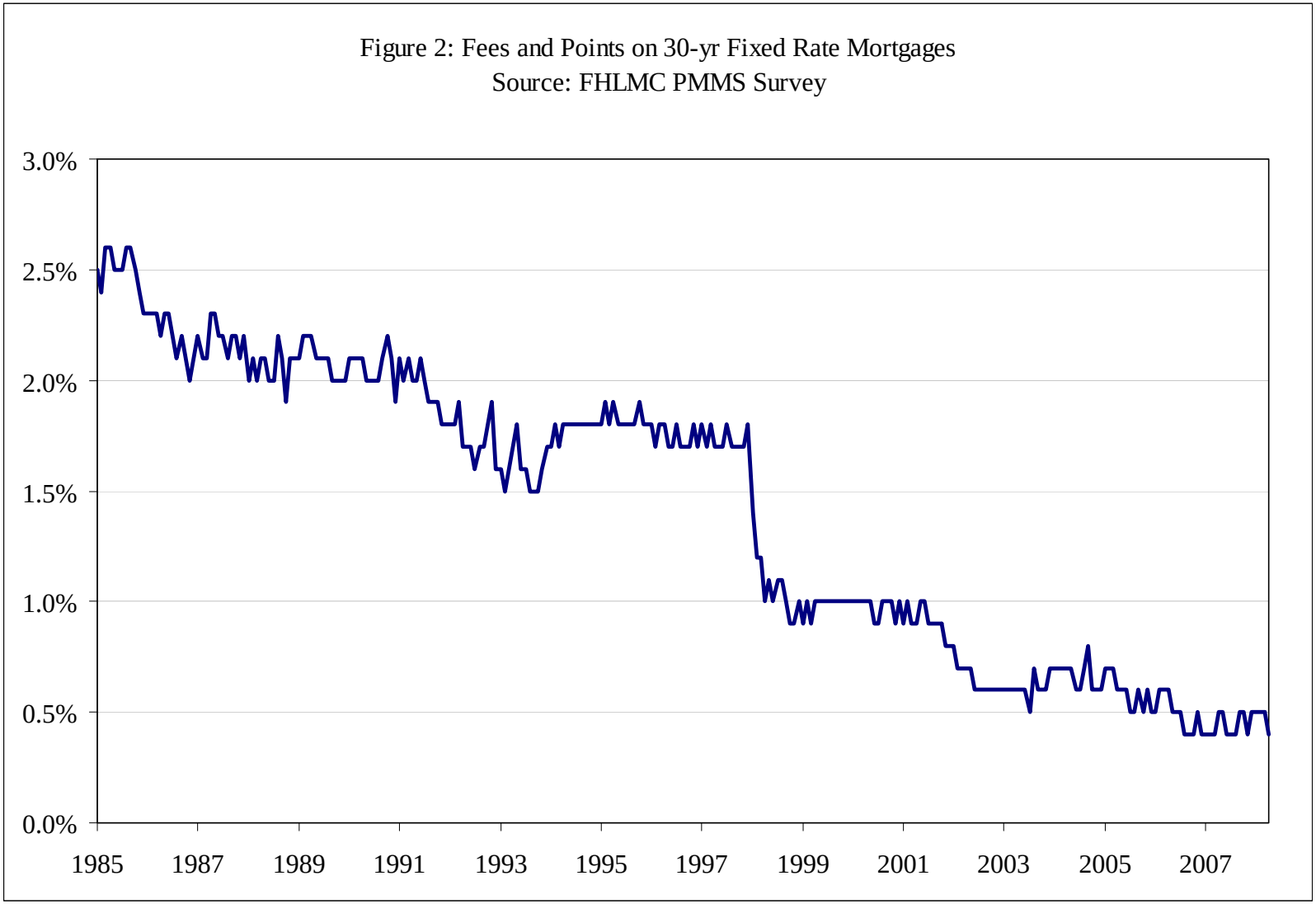

Figure 3: Kaplan Meier Default Probabilities

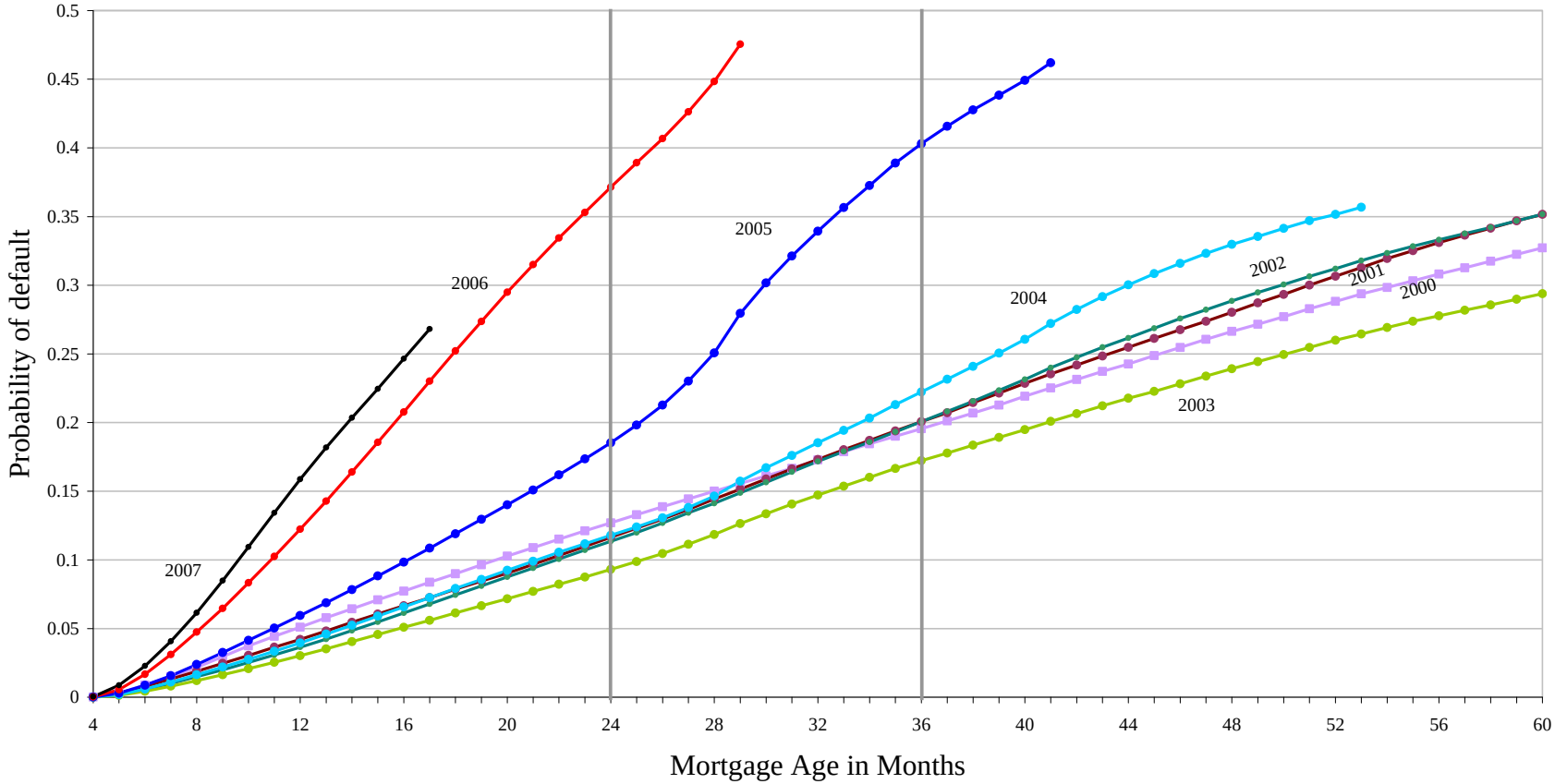

Figure 4: Kaplan Meier Prepayment Probabilities

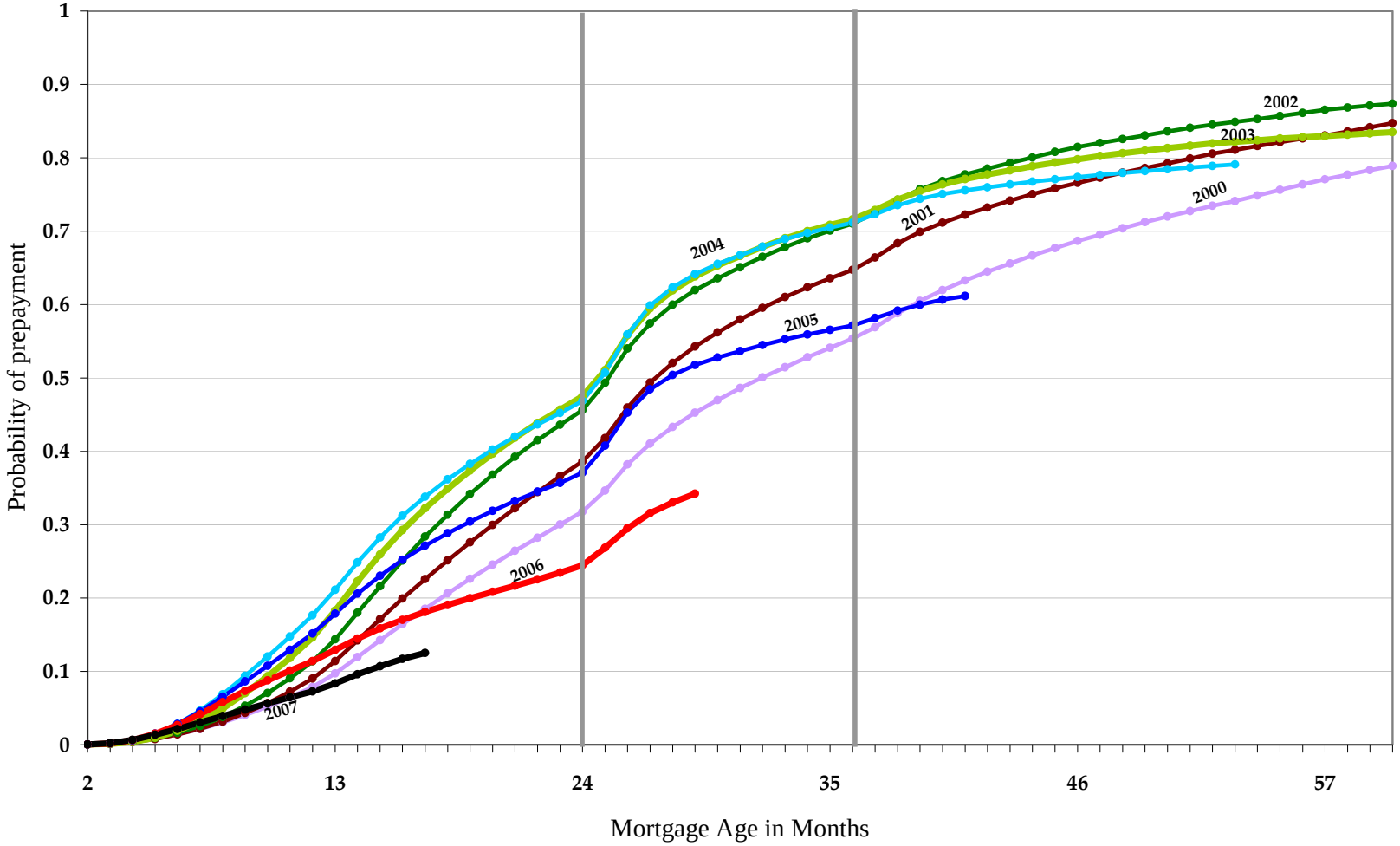

Table 1. Prepayment Rates by Mortgage Product Type

The numbers in the table denote the fraction of total loans by product type that were paid off before they become seriously delinquent. The loans are organized by year of origination and the period of study for each loan extends to the end of the calendar year. The data is available till June 2008.

Year of mortgage origination	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Fixed										
Up to 1 calendar year	0.03	0.04	0.05	0.06	0.08	0.09	0.09	0.08	0.07	0.06
Up to 2 calendar years	0.14	0.14	0.24	0.31	0.39	0.36	0.32	0.24	0.16	
Up to 3 calendar years	0.23	0.28	0.40	0.50	0.55	0.51	0.42	0.30		
Up to 4 calendar years	0.38	0.44	0.52	0.61	0.65	0.59	0.48			
Up to 5 calendar years	0.50	0.55	0.60	0.68	0.70	0.63				
ARM2										
Up to 1 calendar year	0.04	0.05	0.07	0.08	0.10	0.14	0.17	0.14	0.11	0.07
Up to 2 calendar years	0.23	0.23	0.31	0.37	0.43	0.49	0.47	0.36	0.21	
Up to 3 calendar years	0.58	0.51	0.57	0.64	0.71	0.77	0.75	0.56		
Up to 4 calendar years	0.68	0.63	0.67	0.73	0.78	0.82	0.78			
Up to 5 calendar years	0.72	0.70	0.72	0.76	0.80	0.83				
ARM3										
Up to 1 calendar year	0.05	0.05	0.06	0.06	0.08	0.12	0.16	0.14	0.10	0.07
Up to 2 calendar years	0.18	0.23	0.29	0.34	0.41	0.46	0.47	0.36	0.21	
Up to 3 calendar years	0.33	0.41	0.47	0.54	0.58	0.62	0.61	0.45		
Up to 4 calendar years	0.51	0.57	0.63	0.70	0.75	0.79	0.74			
Up to 5 calendar years	0.59	0.64	0.69	0.74	0.79	0.82				

Source: FALP

Table 2. Repayment Behavior of Owner Occupied Households (up to four years after origination).

Delinquency rates is based on percentage of total loans in the sample. We consider both loans that are both 30-day and 60-day delinquent. Among the loans that are delinquent, we consider those that were prepaid and those that went into foreclosure. We do this separately for loans that were 30-day and 60-day delinquent. The second panel is prepayment rate, the number of loans prepaid expressed as percentage of loans that are delinquent in each category. The third panel is the foreclosure rate, the number of loans foreclosed expressed as percentage of loans that are delinquent in each category.

Panel A. Delinquency Rate
(% of total loans)

	30-day delinquency			60-day delinquency		
Vintage	After 2 years	After 3 years	After 4 years	After 2 years	After 3 years	After 4 years
1998	21%	28%	32%	8%	12%	14%
1999	26%	33%	37%	10%	14%	17%
2000	31%	37%	40%	13%	17%	20%
2001	33%	39%	41%	13%	18%	20%
2002	33%	37%	39%	13%	17%	19%
2003	27%	31%	32%	11%	14%	15%
2004	29%	33%	35%	13%	17%	19%
2005	34%	42%		19%	28%	
2006	46%			34%		
2007*	40%			30%		

Panel B. Prepayment Rate for delinquent loans
(% of delinquent loans)

	30-day delinquency			60-day delinquency		
Vintage	After 2 years	After 3 years	After 4 years	After 2 years	After 3 years	After 4 years
1998	22%	36%	45%	13%	21%	26%
1999	22%	36%	46%	13%	20%	26%
2000	24%	39%	49%	13%	20%	26%
2001	26%	44%	54%	15%	24%	30%
2002	32%	51%	60%	18%	28%	35%
2003	35%	53%	60%	20%	30%	35%
2004	33%	49%	52%	19%	26%	27%
2005	22%	27%		10%	11%	
2006	9%			3%		
2007*	4%			1%		

Panel C. Foreclosure Rate for delinquent loans
(% of delinquent loans)

	30-day delinquency			60-day delinquency		
Vintage	After 2 years	After 3 years	After 4 years	After 2 years	After 3 years	After 4 years
1998	11%	15%	19%	29%	36%	42%
1999	11%	16%	19%	29%	39%	42%
2000	14%	19%	22%	35%	40%	44%
2001	12%	17%	20%	29%	37%	41%
2002	11%	16%	19%	29%	36%	39%
2003	11%	15%	17%	27%	33%	37%
2004	11%	17%	20%	26%	34%	38%
2005	17%	28%		30%	42%	
2006	27%			36%		
2007*	19%			25%		

* For 2007 vintage, the data is available for only one calendar year and five months. Source: FALP

Table 3. Repayment Behavior by Occupancy: Status for two calendar years after year of origination.

Delinquency rates is based on percentage of total loans in the sample. We consider both loans that are both 30-day and 60-day delinquent. Among the loans that are delinquent, we consider those that were prepaid and those that went into foreclosure. We do this separately for loans that were 30-day and 60-day delinquent. The second panel is prepayment rate, the number of loans prepaid expressed as percentage of loans that are delinquent in each category. The third panel is the foreclosure rate, the number of loans foreclosed expressed as percentage of loans that are delinquent in each category.

Panel A. Delinquency Rate
(% of total loans)

	30-day delinquency			60-day delinquency		
Vintage	Owner Occupied	Second Home	Investor Occupied	Owner Occupied	Second Home	Investor Occupied
1998	21%	7%	22%	8%	3%	10%
1999	26%	11%	26%	10%	3%	11%
2000	31%	21%	30%	13%	7%	13%
2001	33%	24%	32%	13%	8%	13%
2002	33%	26%	30%	13%	8%	12%
2003	27%	21%	23%	11%	7%	10%
2004	29%	23%	26%	13%	9%	13%
2005	34%	28%	33%	19%	15%	20%
2006	46%	43%	45%	34%	32%	34%
2007*	40%	39%	38%	30%	29%	30%

Panel B. Prepayment Rate for delinquent loans
(% of delinquent loans)

	30-day delinquency			60-day delinquency		
Vintage	Owner Occupied	Second Home	Investor Occupied	Owner Occupied	Second Home	Investor Occupied
1998	22%	23%	17%	13%	18%	10%
1999	22%	23%	18%	13%	15%	10%
2000	24%	23%	21%	13%	15%	11%
2001	26%	28%	23%	15%	20%	14%
2002	32%	32%	25%	18%	23%	13%
2003	35%	33%	28%	20%	21%	15%
2004	33%	32%	28%	19%	19%	14%
2005	22%	19%	20%	10%	9%	9%
2006	9%	7%	9%	3%	3%	4%
2007*	4%	4%	4%	1%	1%	2%

Panel C. Foreclosure Rate for delinquent loans
(% of delinquent loans)

	30-day delinquency			60-day delinquency		
Vintage	Owner Occupied	Second Home	Investor Occupied	Owner Occupied	Second Home	Investor Occupied
1998	11%	11%	21%	29%	28%	45%
1999	11%	9%	18%	29%	28%	41%
2000	14%	10%	18%	35%	32%	40%
2001	12%	8%	16%	29%	22%	39%
2002	11%	8%	17%	29%	26%	42%
2003	11%	9%	17%	27%	24%	42%
2004	11%	10%	19%	26%	25%	40%
2005	17%	19%	28%	30%	35%	46%
2006	27%	32%	37%	36%	44%	49%
2007*	19%	26%	28%	25%	35%	37%

* For 2007 vintage, the data is available for only one calendar year and five months. Source: FALP

Table 4. Repayment Behavior by Product Type: Status for two calendar years after origination.

Delinquency rates is based on percentage of total loans in the sample. We consider both loans that are both 30-day and 60-day delinquent. Among the loans that are delinquent, we consider those that were prepaid and those that went into foreclosure. We do this separately for loans that were 30-day and 60-day delinquent. The second panel is prepayment rate, the number of loans prepaid expressed as percentage of loans that are delinquent in each category. The third panel is the foreclosure rate, the number of loans foreclosed expressed as percentage of loans that are delinquent in each category.

Panel A. Delinquency Rate
(% of total loans)

	30-day delinquency			60-day delinquency		
Vintage	FRM	ARM2	ARM3	FRM	ARM2	ARM3
1998	18%	24%	22%	7%	9%	10%
1999	22%	30%	32%	8%	11%	13%
2000	27%	34%	33%	11%	14%	14%
2001	27%	37%	38%	10%	15%	15%
2002	25%	36%	38%	9%	14%	15%
2003	21%	30%	28%	8%	12%	12%
2004	22%	32%	26%	10%	14%	13%
2005	27%	37%	31%	14%	21%	19%
2006	37%	51%	45%	24%	39%	33%
2007*	34%	44%	39%	24%	35%	29%

Panel B. Prepayment Rate for delinquent loans
(% of delinquent loans)

	30-day delinquency			60-day delinquency		
Vintage	FRM	ARM2	ARM3	FRM	ARM2	ARM3
1998	19%	24%	21%	12%	14%	10%
1999	19%	23%	23%	12%	14%	14%
2000	22%	25%	25%	12%	14%	13%
2001	23%	28%	25%	12%	17%	14%
2002	29%	33%	30%	15%	19%	16%
2003	29%	37%	33%	16%	21%	19%
2004	25%	35%	33%	13%	20%	19%
2005	17%	23%	21%	8%	11%	10%
2006	8%	9%	9%	3%	4%	3%
2007*	4%	4%	4%	1%	1%	1%

Panel C. Foreclosure Rate for delinquent loans
(% of delinquent loans)

	30-day delinquency			60-day delinquency		
Vintage	FRM	ARM2	ARM3	FRM	ARM2	ARM3
1998	11%	10%	12%	29%	28%	28%
1999	11%	11%	12%	29%	29%	30%
2000	12%	16%	16%	30%	37%	36%
2001	11%	12%	13%	29%	30%	32%
2002	10%	12%	13%	26%	31%	32%
2003	9%	12%	12%	23%	30%	28%
2004	8%	13%	13%	18%	29%	25%
2005	10%	20%	17%	19%	35%	29%
2006	15%	31%	25%	22%	41%	35%
2007*	12%	24%	18%	17%	30%	24%

* For 2007 vintage, the data is available for only one calendar year and five months. Source: FALP

Table 5. Repayment Behavior by Loan Purpose: Status for two calendar years after year of origination.

Delinquency rates is based on percentage of total loans in the sample. We consider both loans that are both 30-day and 60-day delinquent. Among the loans that are delinquent, we consider those that were prepaid and those that went into foreclosure. We do this separately for loans that were 30-day and 60-day delinquent. The second panel is prepayment rate, the number of loans prepaid expressed as percentage of loans that are delinquent in each category. The third panel is the foreclosure rate, the number of loans foreclosed expressed as percentage of loans that are delinquent in each category.

Panel A. Delinquency Rate
(% of total loans)

	30-day delinquency			60-day delinquency		
Vintage	Purchase	Refinance (Cash Out)	Refinance (No Cash Out)	Purchase	Refinance (Cash Out)	Refinance (No Cash Out)
1998	21%	21%	23%	8%	8%	9%
1999	23%	26%	32%	9%	10%	12%
2000	29%	31%	37%	12%	13%	16%
2001	33%	33%	37%	14%	13%	16%
2002	32%	33%	33%	13%	13%	13%
2003	26%	27%	26%	11%	10%	11%
2004	28%	29%	29%	13%	12%	13%
2005	34%	33%	34%	21%	17%	18%
2006	49%	44%	42%	39%	31%	29%
2007*	41%	39%	37%	33%	29%	27%

Panel B. Prepayment Rate for delinquent loans
(% of delinquent loans)

	30-day delinquency			60-day delinquency		
Vintage	Purchase	Refinance (Cash Out)	Refinance (No Cash Out)	Purchase	Refinance (Cash Out)	Refinance (No Cash Out)
1998	20%	21%	25%	11%	13%	16%
1999	19%	22%	22%	11%	14%	13%
2000	23%	25%	23%	12%	14%	12%
2001	22%	28%	26%	12%	16%	15%
2002	28%	34%	31%	15%	19%	17%
2003	30%	37%	31%	16%	22%	17%
2004	28%	36%	28%	15%	21%	15%
2005	16%	27%	20%	7%	13%	9%
2006	6%	12%	9%	3%	4%	4%
2007*	3%	4%	4%	1%	1%	1%

Panel C. Foreclosure Rate for delinquent loans
(% of delinquent loans)

	30-day delinquency			60-day delinquency		
Vintage	Purchase	Refinance (Cash Out)	Refinance (No Cash Out)	Purchase	Refinance (Cash Out)	Refinance (No Cash Out)
1998	13%	13%	10%	32%	32%	26%
1999	12%	11%	12%	31%	29%	32%
2000	15%	14%	17%	37%	33%	38%
2001	14%	11%	13%	33%	28%	29%
2002	14%	11%	13%	34%	28%	31%
2003	15%	9%	11%	34%	25%	28%
2004	16%	10%	11%	33%	23%	24%
2005	24%	13%	14%	38%	26%	27%
2006	35%	21%	21%	45%	30%	30%
2007*	28%	16%	15%	34%	22%	21%

* For 2007 vintage, the data is available for only one calendar year and five months. Source: FALP

Table 6. Interest Rates on Subprime Loans

The first column gives the mean of the closing interest rate for the mortgage. For hybrid-ARMs this is the teaser rate. The mean (and standard deviations in parentheses) of margin on reset, the lifetime maximum and minimum interest rates for ARMs are given in columns 3-5 respectively. The last column gives the percent of ARMs for which the closing interest rate is equal to the lifetime minimum interest rate on the loan.

	Close Interest Rate		Margin	Life Time Max	Life Time Min	Closing rate= Min
Vintage	Avg. (s.d.)		Avg. (s.d.)	Avg. (s.d.)	Avg. (s.d.)	Percent of ARM
	FRM			ARM		
1998	9.92	9.92	6.16	16.44	9.65	89.1%
	(1.6)	(1.22)	(0.88)	(1.33)	(1.5)	
1999	10.15	10.08	6.29	16.46	9.95	94.2%
	(1.57)	(1.2)	(0.83)	(1.37)	(1.37)	
2000	10.98	10.6	6.2	17.04	10.43	94.7%
	(1.55)	(1.28)	(0.92)	(1.5)	(1.63)	
2001	9.71	9.68	6.36	16.1	9.5	91.9%
	(1.65)	(1.36)	(1.18)	(1.46)	(1.59)	
2002	8.52	8.73	6.63	15.07	8.64	95.5%
	(1.44)	(1.32)	(1.32)	(1.42)	(1.42)	
2003	7.49	7.74	6.29	14.07	7.68	96.0%
	(1.21)	(1.22)	(1.34)	(1.4)	(1.25)	
2004	7.23	7.3	6.1	13.69	7.24	95.7%
	(1.15)	(1.16)	(1.11)	(1.23)	(1.19)	
2005	7.43	7.54	5.96	13.86	7.42	93.2%
	(1.17)	(1.15)	(1.04)	(1.24)	(1.25)	
2006	8.34	8.49	6.09	14.82	8.25	91.1%
	(1.3)	(1.15)	(0.91)	(1.26)	(1.41)	
2007	8.65	8.6	6	14.94	7.93	
	(1.46)	(1.26)	(0.79)	(1.37)	(1.56)	76.8%

Table 7. Prepayment Term and Date of First Reset

The prepayment term is the duration (in months) for which the prepayment penalty is in effect. The First Reset date is the date at which the hybrid-ARM resets from the closing (teaser) interest rate to the fully-indexed interest rate. Columns (1) and (2) give the percent of mortgages by vintage that include a prepayment penalty in their contract. Column (3) is the percent of loans with the penalty for which we have data on the prepayment term.

	Percent with Prepayment Penalty		Prepayment term available in data	Prepayment Term ends before First Reset Date		Prepayment Term ends at First Reset Date	Prepayment Term ends after First Reset Date	
Vintage			Percent of all loans with prepayment terms	Percent of ARM loans with prepayment terms	Difference in duration[1]	Percent of ARM loans with prepayment terms	Percent of ARM loans with prepayment terms	Difference in duration[1]
	FRM	ARM						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1998	53%	71%	66%	8%	0.49	57%	35%	1.82
1999	60%	80%	79%	4%	0.47	54%	42%	1.78
2000	61%	85%	81%	4%	0.49	64%	32%	1.89
2001	68%	86%	85%	4%	0.49	69%	27%	1.66
2002	69%	85%	83%	4%	0.48	76%	21%	1.62
2003	72%	79%	78%	5%	0.47	81%	14%	1.56
2004	75%	74%	74%	6%	0.47	83%	11%	1.55
2005	74%	72%	72%	7%	0.49	85%	8%	1.52
2006	72%	71%	71%	7%	0.50	88%	5%	1.52
2007	69%	69%	69%	8%	0.50	89%	3%	1.51

1. Expressed as a proportion of the number of months before the first reset date.

Table 8. Estimated Cox proportional hazard rate regression: Prepayment Hazard Ratios for FRMs

FICO score is normalized or divided by 100. *Fees and Points* are the fees and discount points charged by the lender at settlement on a 30-yr FRM prime mortgage, taken from the Freddie Mac PMMS Survey. *House Price Growth* is the appreciation of the repeat-sales OFHEO house price index at the MSA level. *Interest Volatility* is the standard deviation of the six-month LIBOR for the previous 24 months. *PV Annualized Rate* measures the ratio of the present value of the payments on mortgage principal outstanding using the existing mortgage rate to that using the current rate available on refinance. *Unemployment Rate* is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics at the time of prepayment/default. *Home Value n*th *Quartile* is a dummy that equals one if the value of the property lies in the *n*-th quartile of all property values in the data and zero otherwise.

Variable	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
FICO (normalized)	1.2616***	1.2847***	1.4113***	1.2486***	1.1564***	1.12***	1.0863***	1.1092***	1.0842***
Fees and Points	1.0679***	1.0636***	1.0406***	1.0306***	1.0178***	1.0314***	1.0486***	1.0021***	0.976***
Prepayment Penalty	1.0300	1.089***	0.9458***	0.9185***	1.0662***	0.8535***	0.8313***	0.7967***	0.7273***
Full-Doc	1.0676***	1.0666***	1.0477***	1.0334***	1.033***	1.0518***	1.0247***	1.0703***	1.0591
House Price Growth	1.1881***	1.2307***	1.0005***	1.0515***	1.0843***	1.162***	1.1614***	1.141***	1.1001***
Interest Volatility	1.0055***	1.0078***	1.0075***	1.0101***	1.0038***	0.9959***	1.0038***	1.0238***	1.0242***
PV Annualized Rate	1.0018***	1.0026***	1.0017***	1.0027***	1.0158***	1.0333***	1.0674***	1.0768***	1.0473***
Unemployment Rate	1.0317***	1.0033	0.9706***	1.1036***	1.0816***	1.0558***	0.9912**	1.0208***	1.0217**
Home Value First Quartile	0.839***	0.9151***	0.6676***	0.6925***	0.6716***	0.7206***	0.7912***	0.7879	0.7965***
Home Value Second Quartile	0.9096***	0.9462***	0.8012***	0.8411***	0.8152***	0.8304***	0.8574***	0.9127**	0.9294***
Home Value Third Quartile	0.9814	0.9884	0.8947***	0.916***	0.9081***	0.8804***	0.9148***	0.9854	0.9963
LR	53930.73	61289.10	33171.88	42962.99	76076.95	220403.07	206758.05	94163.76	13845.02
p-value (H_0: $\beta = 0$)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

The symbols ***, ** and * denote statistical significance at 1-percent, 5-percent and 10-percent levels respectively.

Table 9. Estimated Cox proportional hazard rate regression: Default Hazard Ratios for FRMs

FICO score is normalized or divided by 100. *Fees and Points* are the fees and discount points charged by the lender at settlement on a 30-yr FRM prime mortgage, taken from the Freddie Mac PMMS Survey. *House Price Growth* is the appreciation of the repeat-sales OFHEO house price index at the MSA level. *Interest Volatility* is the standard deviation of the six-month LIBOR for the previous 24 months. *PV Annualized Rate* measures the ratio of the present value of the payments on mortgage principal outstanding using the existing mortgage rate to that using the current rate available on refinance. *Unemployment Rate* is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics at the time of prepayment/default. *Home Value n*th *Quartile* is a dummy that equals one if the value of the property lies in the *n*-th quartile of all property values in the data and zero otherwise.

Variable	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
FICO (normalized)	0.5802***	0.6045***	0.5397***	0.5986***	0.5342***	0.5671***	0.5339***	0.6094***	0.5913***
Fees and Points	1.1179***	1.1409***	1.1577***	1.0949***	1.046***	1.0776***	1.1277***	1.0486***	0.9534***
Prepayment Penalty	1.1244	0.95***	1.043***	0.9655***	1.2844***	1.2388***	1.2768***	1.2975***	1.8092***
Full-Doc	0.9075***	0.9152***	0.852***	0.881***	0.8206***	0.7802***	0.7851***	0.7478***	0.6652
House Price Growth	0.5009***	0.5577***	0.8511***	0.5683***	0.6188***	0.7214***	0.7622***	0.8081***	0.7883***
Interest Volatility	1.0061***	1.013***	1.0184***	1.0215***	1.0143***	1.005***	1.0219***	1.1008***	1.0606***
PV Annualized Rate	1.0012***	1.0033***	1.0031***	1.0028***	1.019***	1.0368***	1.078***	1.1225***	1.0556***
Unemployment Rate	0.7756***	0.8105	0.936***	1.0473***	1.1156***	1.1148***	1.085**	1.1073***	0.8853**
Home Value First Quartile	0.8154***	0.8276***	1.0819***	0.9926***	0.9711***	0.9612***	1.0497***	1.1422	1.083***
Home Value Second Quartile	0.7309***	0.7221***	0.9464***	0.8879***	0.9556***	0.9394***	0.9194***	0.9264**	0.9437***
Home Value Third Quartile	0.7441	0.7761	0.9378***	0.971***	1.0382***	0.9826***	0.9643***	0.8792	0.9347
LR	46894.99	58229.52	33397.85	44585.62	43410.20	59609.75	50749.31	35996.27	10549.90
p-value (H_0: $\beta = 0$)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

The symbols ***, ** and * denote statistical significance at 1-percent, 5-percent and 10-percent levels respectively.

Table 10. Estimated Cox proportional hazard rate regression: Prepayment Hazard Ratios for ARM2

FICO score is normalized or divided by 100. *Fees and Points* are the fees and discount points charged by the lender at settlement on a 30-yr FRM prime mortgage, taken from the Freddie Mac PMMS Survey. *House Price Growth* is the appreciation of the repeat-sales OFHEO house price index at the MSA level. *Interest Volatility* is the standard deviation of the six-month LIBOR for the previous 24 months. *PV Annualized Rate* measures the ratio of the present value of the payments on mortgage principal outstanding using the existing mortgage rate to that using the current rate available on refinance. *Unemployment Rate* is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics at the time of prepayment/default. *Home Value n*th *Quartile* is a dummy that equals one if the value of the property lies in the *n*-th quartile of all property values in the data and zero otherwise.

Variable	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
FICO (normalized)	1.2199***	1.2217***	1.1682***	1.1702***	1.1567***	1.1692***	1.1069***	1.1126***	1.0224***
Fees and Points	1.05***	1.044***	1.0337***	1.036***	1.0128***	1.0063***	1.0177***	1.0128***	0.9844***
Prepayment Penalty	1.0088	1.0601***	1.054***	0.8299***	0.8369***	0.7696***	0.7352***	0.749***	0.719***
Full-Doc	1.0705***	1.0064***	1.0416***	1.0436***	1.0471***	1.0402***	1.0443***	1.0707***	1.0673
House Price Growth	1.121***	1.1526***	1.1953***	1.0966***	1.0538***	1.0931***	1.1156***	1.1165***	1.1375***
Interest Volatility	1.0015***	1.008***	1.0053***	1.0031***	1.005***	1.0034***	0.995***	1.008***	1.0175***
PV Annualized Rate	0.9997***	1.002***	1.0029***	1.0015***	1.0044***	1.0249***	1.0435***	1.0484***	1.0346***
Unemployment Rate	1.0447***	1.0501	0.9854***	1.0549***	1.0525***	1.0059***	0.9705**	1.0294***	1.0324**
Home Value First Quartile	0.7791***	0.9534***	0.8054***	0.7768***	0.7088***	0.7775***	0.8273***	0.8585	0.8893***
Home Value Second Quartile	0.8773***	0.9114***	0.8748***	0.83***	0.8167***	0.84***	0.8628***	0.9301**	0.9701***
Home Value Third Quartile	0.9435	0.9820	0.9168***	0.8899***	0.8918***	0.8891***	0.9111***	0.9881	1.0237
LR	68087.08	102021.92	159310.47	245907.63	423865.51	780354.18	1323138.13	1084162.71	111520.70
p-value (H_0: $\beta = 0$)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

The symbols ***, ** and * denote statistical significance at 1-percent, 5-percent and 10-percent levels respectively.

Table 11. Estimated Cox proportional hazard rate regression: Default Hazard Ratios for ARM2

FICO score is normalized or divided by 100. *Fees and Points* are the fees and discount points charged by the lender at settlement on a 30-yr FRM prime mortgage, taken from the Freddie Mac PMMS Survey. *House Price Growth* is the appreciation of the repeat-sales OFHEO house price index at the MSA level. *Interest Volatility* is the standard deviation of the six-month LIBOR for the previous 24 months. *PV Annualized Rate* measures the ratio of the present value of the payments on mortgage principal outstanding using the existing mortgage rate to that using the current rate available on refinance. *Unemployment Rate* is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics at the time of prepayment/default. *Home Value n*th *Quartile* is a dummy that equals one if the value of the property lies in the *n*-th quartile of all property values in the data and zero otherwise.

Variable	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
FICO (normalized)	0.6009***	0.6885***	0.7172***	0.5988***	0.61***	0.6109***	0.5595***	0.6934***	0.8554***
Fees and Points	1.0883***	1.1192***	1.1372***	1.0944***	1.0409***	1.0637***	1.1481***	1.0496***	0.9523***
Prepayment Penalty	1.1201	0.9065***	1.16***	1.0039***	1.202***	0.983***	1.0602***	1.0008***	0.7632***
Full-Doc	0.9352***	0.9023***	0.9262***	0.846***	0.8605***	0.788***	0.8301***	0.7574***	0.7382
House Price Growth	0.5117***	0.5344***	0.5378***	0.6518***	0.645***	0.7741***	0.8076***	0.8656***	0.8482***
Interest Volatility	0.999***	1.0098***	1.0144***	1.0243***	1.0179***	0.9893***	1.0195***	1.1151***	1.057***
PV Annualized Rate	0.9989***	1.0009***	1.001***	1.0006***	1.0199***	1.0333***	1.0969***	1.1444***	1.0711***
Unemployment Rate	0.7355***	0.7233	0.7917***	1.0282***	1.0724***	1.095***	1.1175**	1.0497***	0.8988**
Home Value First Quartile	0.877***	0.7519***	0.8688***	0.9669***	0.9695***	0.9958***	1.056***	0.9242	0.8078***
Home Value Second Quartile	0.7642***	0.7466***	0.8728***	0.965***	0.9596***	0.9892***	0.9657***	0.842**	0.7364***
Home Value Third Quartile	0.8282	0.8275	0.9204***	1.0313***	1.0587***	1.0466***	0.9862***	0.8763	0.8312
LR	23046.91	45846.20	82747.68	84653.84	123727.26	170563.12	275834.03	374067.92	82194.34
p-value (H_0: $\beta = 0$)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

The symbols ***, ** and * denote statistical significance at 1-percent, 5-percent and 10-percent levels respectively.

Table 12. Estimated Cox proportional hazard rate regression: Prepayment Hazard Ratios for ARM3

FICO score is normalized or divided by 100. *Fees and Points* are the fees and discount points charged by the lender at settlement on a 30-yr FRM prime mortgage, taken from the Freddie Mac PMMS Survey. *House Price Growth* is the appreciation of the repeat-sales OFHEO house price index at the MSA level. *Interest Volatility* is the standard deviation of the six-month LIBOR for the previous 24 months. *PV Annualized Rate* measures the ratio of the present value of the payments on mortgage principal outstanding using the existing mortgage rate to that using the current rate available on refinance. *Unemployment Rate* is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics at the time of prepayment/default. *Home Value n*th *Quartile* is a dummy that equals one if the value of the property lies in the *n*-th quartile of all property values in the data and zero otherwise.

Variable	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
FICO (normalized)	1.1304***	1.137***	1.1483***	1.2017***	1.1661***	1.1407***	1.0747***	1.1068***	1.069***
Fees and Points	1.0406***	1.028***	1.0488***	1.0146***	0.994***	1.0005***	1.0401***	1.0035***	0.9819***
Prepayment Penalty	1.0088	0.8749***	0.9456***	0.9503***	0.9855***	0.6838***	0.7334***	0.7859***	0.7425***
Full-Doc	1.0553***	1.024***	1.0209***	1.0461***	1.0409***	1.0336***	1.0225***	1.0803***	1.0511
House Price Growth	1.0866***	1.1432***	1.2348***	1.1137***	1.0798***	1.1115***	1.1383***	1.1507***	1.1505***
Interest Volatility	1.0061***	0.9965***	1.0008***	1.0091***	1.0116***	0.9878***	0.9978***	1.0202***	1.0194***
PV Annualized Rate	1.0025***	1.0027***	1.0017***	0.9992***	1.0104***	1.0205***	1.0552***	1.0694***	1.0414***
Unemployment Rate	1.0351***	1.0085	1.0224***	1.0455***	1.0224***	1.016***	1.0066**	1.0349***	1.0108**
Home Value First Quartile	0.693***	0.9002***	0.7964***	0.7641***	0.735***	0.7622***	0.8119***	0.8099	0.816***
Home Value Second Quartile	0.8695***	0.9868***	0.8739***	0.8385***	0.8474***	0.8438***	0.8409***	0.8949**	0.8528***
Home Value Third Quartile	0.9201	1.0084	0.9084***	0.9058***	0.9192***	0.9084***	0.8948***	0.9654	0.9616
LR	10829.47	72336.64	55620.67	55988.58	86896.08	149174.13	259137.95	104994.61	11739.56
p-value (H_0: $\beta = 0$)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

The symbols ***, ** and * denote statistical significance at 1-percent, 5-percent and 10-percent levels respectively.

Table 13. Estimated Cox proportional hazard rate regression: Default Hazard Ratios for ARM3

FICO score is normalized or divided by 100. *Fees and Points* are the fees and discount points charged by the lender at settlement on a 30-yr FRM prime mortgage, taken from the Freddie Mac PMMS Survey. *House Price Growth* is the appreciation of the repeat-sales OFHEO house price index at the MSA level. *Interest Volatility* is the standard deviation of the six-month LIBOR for the previous 24 months. *PV Annualized Rate* measures the ratio of the present value of the payments on mortgage principal outstanding using the existing mortgage rate to that using the current rate available on refinance. *Unemployment Rate* is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics at the time of prepayment/default. *Home Value n*th *Quartile* is a dummy that equals one if the value of the property lies in the *n*-th quartile of all property values in the data and zero otherwise.

Variable	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
FICO (normalized)	0.5845***	0.6647***	0.6778***	0.6599***	0.6433***	0.5875***	0.5685***	0.686***	0.7699***
Fees and Points	1.0978***	1.1219***	1.133***	1.0883***	1.0502***	1.0876***	1.1318***	1.056***	0.9509***
Prepayment Penalty	0.6226	1.1906***	1.1948***	0.7317***	1.2***	0.586***	0.817***	0.988***	1.076***
Full-Doc	1.0845***	0.8979***	0.9073***	0.8624***	0.8857***	0.7816***	0.7608***	0.7059***	0.6894
House Price Growth	0.5236***	0.5473***	0.4907***	0.6031***	0.6094***	0.7421***	0.7656***	0.7945***	0.8038***
Interest Volatility	1.0031***	1.0079***	1.0148***	1.0213***	1.0138***	1.0026***	1.0292***	1.0991***	1.0585***
PV Annualized Rate	0.9992***	1.0021***	1.0013***	1.0013***	1.0208***	1.0365***	1.0957***	1.1271***	1.0589***
Unemployment Rate	0.7027***	0.7471	0.7585***	1.0012***	1.0331***	1.1016***	1.0937**	1.083***	0.894**
Home Value First Quartile	0.8024***	0.7262***	0.9874***	0.9694***	1.0328***	0.9921***	1.1107***	1.0097	0.7852***
Home Value Second Quartile	0.7467***	0.7276***	0.9856***	0.9579***	1.0435***	1.011***	1.022***	0.8895**	0.8156***
Home Value Third Quartile	0.7492	0.7751	1.0476***	1.0705***	1.1136***	1.0555***	1.0201***	0.9279	0.8420
LR	4926.78	35987.02	29360.90	23228.41	29360.53	33643.98	51833.90	47008.79	10329.33
p-value (H_0: $\beta = 0$)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

The symbols ***, ** and * denote statistical significance at 1-percent, 5-percent and 10-percent levels respectively.

Table 14. Second Stage Loan Age Regression (OLS): **FRM**

FICO score is normalized or divided by 100. *Fees and Points* are the fees and discount points charged by the lender at settlement on a 30-yr FRM prime mortgage, taken from the Freddie Mac PMMS Survey. *House Price Growth* is the appreciation of the repeat-sales OFHEO house price index at the MSA level. *Interest Volatility* is the standard deviation of the six-month LIBOR for the previous 24 months. *PV Annualized Rate* measures the ratio of the present value of the payments on mortgage principal outstanding using the existing mortgage rate to that using the current rate available on refinance. *Unemployment Rate* is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics at the time of prepayment/default. *Home Value n*th *Quartile* is a dummy that equals one if the value of the property lies in the *n*-th quartile of all property values in the data and zero otherwise.

Variable	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
FICO (normalized)	-0.2984***	-0.5369***	-1.1883***	0.2245***	0.2047***	0.0514**	0.261***	-0.094***	0.0956***
Fees and Points	-1.3329***	-1.261***	-1.0492***	-0.7125***	-0.4481***	-0.4515***	-0.4228***	-0.0139***	0.1616***
Prepayment Penalty	0.6926***	-0.2134	0.4531***	0.5677***	-1.4945***	0.8284***	0.7063***	0.6484***	0.7209***
Full-Doc	-0.5892***	-0.7593***	-0.2519***	-0.0761	0.0165	-0.1514***	0.0582***	-0.0891***	0.1955***
House Price Growth	0.5475***	0.0062	0.1581***	0.4616***	-0.1936***	-0.72***	-0.5347***	-0.3199***	-0.0508***
Interest Volatility	-0.1008***	-0.1349***	-0.1581***	-0.1373***	-0.0456***	-0.01***	-0.0794***	-0.1578***	-0.1309***
PV Annualized Rate	-0.0339***	-0.0536***	-0.0508***	-0.0447***	-0.1723***	-0.246***	-0.3921***	-0.3497***	-0.1699***
Unemployment Rate	0.7058***	0.6053***	0.2675***	-2.2933***	-1.1688***	-0.5707***	-0.1745***	-0.0821***	0.0396**
Home Value First Quartile	1.8756***	0.9784***	2.6754***	2.9431***	2.8473***	1.5918***	0.3684***	0.5051***	0.6472***
Home Value Second Quartile	1.524***	0.9682***	1.3864***	1.7505***	1.5476***	1.1792***	0.5542***	0.3313***	0.1897***
Home Value Third Quartile	0.876***	0.6789***	0.7981***	0.6316***	0.6851***	0.8759***	0.3561***	0.1435***	0.0194
Adjusted R-Squared	0.8296	0.8537	0.8495	0.6311	0.6970	0.7484	0.8017	0.8346	0.4811

The symbols ***, ** and * denote statistical significance at 1-percent, 5-percent and 10-percent levels respectively.

Table 15. Second Stage Loan Age Regression (OLS): **ARM2**

FICO score is normalized or divided by 100. *Fees and Points* are the fees and discount points charged by the lender at settlement on a 30-yr FRM prime mortgage, taken from the Freddie Mac PMMS Survey. *House Price Growth* is the appreciation of the repeat-sales OFHEO house price index at the MSA level. *Interest Volatility* is the standard deviation of the six-month LIBOR for the previous 24 months. *PV Annualized Rate* measures the ratio of the present value of the payments on mortgage principal outstanding using the existing mortgage rate to that using the current rate available on refinance. *Unemployment Rate* is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics at the time of prepayment/default. *Home Value n*th *Quartile* is a dummy that equals one if the value of the property lies in the *n*-th quartile of all property values in the data and zero otherwise.

Variable	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
FICO (normalized)	-0.1606**	-0.1305**	0.3832***	0.8942***	0.1154***	0.1519***	0.1821***	-0.3484***	0.0565***
Fees and Points	-1.1017***	-0.9545***	-0.8891***	-0.5747***	-0.3314***	-0.1994***	-0.2431***	-0.0547***	0.1588***
Prepayment Penalty	-0.8212***	-0.5084***	0.1127	1.0271***	0.7261***	0.9116***	0.7852***	0.96***	2.2106***
Full-Doc	-0.4131***	0.0992	0.0502	0.2105***	-0.0629***	0.1104***	-0.007	-0.1949***	0.1179***
House Price Growth	0.2245***	0.0695***	0.1818***	0.4829***	0.1399***	-0.1469***	-0.2078***	-0.3062***	-0.1642***
Interest Volatility	-0.1033***	-0.1472***	-0.1253***	-0.0358***	-0.0359***	-0.0233***	-0.0167***	-0.0965***	-0.1148***
PV Annualized Rate	-0.0161***	-0.0553***	-0.0505***	-0.0282***	-0.0638***	-0.1609***	-0.2557***	-0.2431***	-0.1624***
Unemployment Rate	0.4268***	0.323***	0.4013***	-0.9466***	-0.7736***	-0.3248***	-0.1084***	-0.1152***	0.0381***
Home Value First Quartile	2.2825***	0.5711***	1.4839***	1.0023***	2.0166***	1.0688***	0.3412***	0.4233***	0.657***
Home Value Second Quartile	1.3895***	0.8311***	0.8601***	1.0965***	1.1932***	0.8143***	0.4087***	0.2273***	0.345***
Home Value Third Quartile	0.8249***	0.366***	0.4621***	0.3736***	0.5557***	0.516***	0.2584***	0.0806***	0.0619***
Adjusted R-Squared	0.8548	0.8792	0.8407	0.7525	0.7370	0.8209	0.8733	0.9188	0.5111

The symbols ***, ** and * denote statistical significance at 1-percent, 5-percent and 10-percent levels respectively.

Table 16. Second Stage Loan Age Regression (OLS): **ARM3**

FICO score is normalized or divided by 100. *Fees and Points* are the fees and discount points charged by the lender at settlement on a 30-yr FRM prime mortgage, taken from the Freddie Mac PMMS Survey. *House Price Growth* is the appreciation of the repeat-sales OFHEO house price index at the MSA level. *Interest Volatility* is the standard deviation of the six-month LIBOR for the previous 24 months. *PV Annualized Rate* measures the ratio of the present value of the payments on mortgage principal outstanding using the existing mortgage rate to that using the current rate available on refinance. *Unemployment Rate* is the monthly series for total non-farm unemployment rate at the MSA level from the Bureau of Labor Statistics at the time of prepayment/default. *Home Value n*th *Quartile* is a dummy that equals one if the value of the property lies in the *n*-th quartile of all property values in the data and zero otherwise.

Variable	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
FICO (normalized)	0.7706***	-0.2919***	0.5731***	0.1413**	0.2018***	-0.0494*	0.3186***	0.036**	0.0352
Fees and Points	-0.9447***	-0.8951***	-0.7873***	-0.4737***	-0.1655***	-0.1413***	-0.3667***	-0.0366***	0.1584***
Prepayment Penalty	0.29	1.7978***	-0.1044	1.2546***	-0.4604***	2.1453***	1.0761***	0.7181***	1.4591***
Full-Doc	-0.8236***	-0.2076*	0.106	0.004	0.1353***	-0.0199	0.1525***	0.0839***	0.2641***
House Price Growth	0.6298***	-0.1149***	0.2641***	0.2031***	0.115***	-0.2877***	-0.3569***	-0.2952***	-0.0735***
Interest Volatility	-0.1208***	-0.0658***	-0.0525***	-0.0879***	-0.1014***	0.054***	-0.0383***	-0.1597***	-0.1255***
PV Annualized Rate	-0.0484***	-0.055***	-0.0382***	0.0023***	-0.0943***	-0.1686***	-0.3166***	-0.3477***	-0.1579***
Unemployment Rate	0.7383***	0.7924***	0.226***	-0.7191***	-0.3652***	-0.2235***	-0.3499***	-0.2022***	0.0648***
Home Value First Quartile	3.7336***	1.7117***	1.0203***	1.507***	1.5006***	1.1627***	0.4057***	0.4783***	0.9881***
Home Value Second Quartile	1.3777***	0.7125***	0.6056***	1.1483***	0.7835***	0.7667***	0.5278***	0.41***	0.6334***
Home Value Third Quartile	0.5987**	0.3846***	0.2662***	0.4362***	0.2135***	0.4432***	0.3386***	0.1869***	0.1965***
Adjusted R-Squared	0.8583	0.8464	0.8940	0.8208	0.8378	0.8878	0.8782	0.8436	0.4959

The symbols ***, ** and * denote statistical significance at 1-percent, 5-percent and 10-percent levels respectively.