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Yan Chang

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The thesis of Yan Chang was reviewed and approved* by the following:

Abdullah Yavas
Elliott Professor of Business Administration
Thesis Advisor
Chair of Committee

Austin J. Jaffe
Philip H. Sieg Professor of Business Administration
Head of the Department of Insurance and Real Estate

Kenneth M. Lusht
Professor of Business Administration
Interim Dean of the Smeal College of Business

N. Edward Coulson
Professor of Economics

*Signatures are on file in the Graduate School

ABSTRACT

The purpose of this dissertation is to investigate mortgage refinancing in the following three categories: refinancing and rate-and-point choice, refinancing and borrowers' mortgage instrument choice, and estimating the market refinancing share of total mortgage origination volume. The choice of rate-and-point combination is driven by a comparison between the borrower's own estimation of his holding period of the mortgage and the implied duration priced into each selection by the lender reflecting estimations of the lender. Questions tested in this setting are: whether the borrower correctly predicts his own holding period of the mortgage and chooses the right rate-and-point combination on his fixed-rate mortgage, and once chosen, whether he treats the upfront points paid as sunk costs and refinances optimally should such opportunity arise. Comparatively, choosing a loan product is a more complex issue than the choice of rate-and-point combination, affected by borrower characteristics including expected income, wealth, housing consumption, and life cycle. Examining borrowers' product choice in a refinance situation provides an in-depth look at their decision-making process, where a comparison can be made concerning changes in borrower characteristics and changes in loan instrument choices between the original loan and the refinance loan. The effects of various factors are tested in turn. Shifting focus from understanding borrower behavior on an individual basis to the macro level, the refinancing share of the total loan originations is also studied. Information from various sources on the refi-share is compared and examined in detail to reconcile the differences among previous estimates

of refinancing activity in the market and suggestions are made regarding the correct refinance share estimations.

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PREFACE

Two chapters in this thesis involve co-authored work. Chapter 2 (Do borrowers make rational choices in points and refinancing?) is co-authored with professor Abdullah Yavas of Penn State University, and Chapter 4 (De-mystifying the refi-share mystery) is co-authored with Frank E. Nothaft of Freddie Mac. In both cases I am the first author of the papers. In Chapter 2, I assembled the data used, performed the research and analysis needed, compiled the tables and graphs, and wrote the preliminary version of the full text. In Chapter 4, I provided the solution to the question proposed in the paper, performed the research and analysis needed, compiled the tables and graphs, and wrote the full text.

Chapter 1

Introduction

For most households, their house represents their largest investment and consumption choice. In most cases, the purchase is financed by a mortgage placed on the house. To individual borrowers, the mortgage contract is a collection of choices. Follain [1990] summarizes that there are in general three types of choices faced by a homeowner: choosing a loan-to-value ratio, prepayment (including refinancing and sale of the house) and default decisions, and the choice of mortgage instrument (including the product type of the mortgage and the rate-and-point choice in the case of a fixed-rate mortgage).

The refinancing activity has important implications on the financial wellbeing of households and the general economy. Refinance stimulates family consumption and investment in two ways. First, by refinancing into a mortgage with lower rate, families benefit from savings in reduced interest payments, which amount to about $10 billion a year on the aggregate level. Second, by taking out home equities through cash-out refinancing, families receive a cash infusion into their balance sheets. Based on calculations made by Freddie Mac, during 2002 and 2003 families converted more than $250 billion of home equity into cash when they refinanced their conventional mortgages. In 2005 alone the amount cashed out was more than $240 billion.[1] Freddie Mac also reports that the average amount cashed out comprised about 8 percent of the

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[1]. During the refinance boom of 2002 to 2003, the average family reduced its mortgage rate by one and one-eighth (1.125) percentage points. Based on the average loan size purchased by Freddie Mac in

total refinance volume originated in 2002-2003 period. This statistics increased to about 13 percent in 2004, and jumped to around 21 percent in 2005. Canner et al. [2002] find that two major uses of the proceeds obtained in refinancing are home improvements and retirement of other debts, accounting for 61 percent of the total monies obtained in 2001 and early 2002; other uses of the funds include consumer expenditures and various financial or business investments.

Refinancing not only helps families smooth and stabilize household consumptions, but together with other forms of home equity extraction, it injected monetary stimulants into the economy during its recent downturn. Zandi [2002] estimates that housing and mortgage activity accounted for nearly one-third of US economic growth between 2000 and 2002. In 2003, refinancing loan volume exceeded 2.6 trillion dollars and made up 73.3% of the single-family conventional loan market. To put this in perspective, the total single-family mortgage debt outstanding as of the fourth quarter of 2003 is 7.0 trillion dollars, or 37% of all mortgages outstanding at the end of 2003 were originated in that single year as refinancing mortgages. The volume and impact of the refinance activity call for better understanding of the issue, yet many questions are still unanswered and disputes unresolved in this topic both at the macro and micro levels.

In academic studies, the prepayment and default decisions are commonly viewed as call and put options written on the mortgage or the underlying property. To default a mortgage is to exercise a put option on the property with the strike price equaling the existing mortgage obligation; and to prepay a mortgage is to exercise a call option on the

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2002 (about $130,000 to $140,000), the average family shaved $100 per month off their mortgage payment, or an estimated $10 billion a year across all families in the United States.

mortgage with the strike price equaling the unpaid balance of the mortgage. The timing of refinancing, or exercising that option, is financially driven, and should be solely dependent on whether the option is 'in the money'. But studies also find that the observed borrower behavior is at often times sub-optimal: they refinance 'too early' or 'too late', which shows the complexity of the issue that might involve other incentives or hidden hindrances, and even the rationality of borrowers may be called into question. The essays in this dissertation investigate the connection between borrower refinancing behavior and two other important mortgage choices: the rate-and-point choice and mortgage instrument choice, where borrower characteristics and financial incentives are examined in detail to further the understanding of borrower behavior.

In choosing a mortgage loan, borrowers face a trade-off between paying more points and a lower interest rate. The theoretical prediction is that borrowers with a shorter expected holding period (higher probability of prepayment) would opt for a loan with fewer points and higher interest rate. A related theoretical prediction is that once incurred, points become sunk costs, hence should not affect borrowers' refinancing decisions in the future. In the second chapter of this dissertation these two predictions are tested. Utilizing individual mortgage loan data, observable borrower characteristics as well as macroeconomic variables are controlled for. The results indicate that borrowers overestimate their holding periods and pay too many points and that borrowers fail to treat points as sunk costs. Borrowers with points are less likely to refinance, and when they do, they refinance "too late."

Previous studies in the adjustable-rate mortgage (ARM) versus fixed-rate mortgage (FRM) choice have produced rich predictions and empirical evidences.

However, conflicts exist in theories and findings about the effect of certain factors on the borrower product choice. Some of these predictions are tested in the third chapter using a larger, more recent and geographically representative dataset. Different from previous studies, one innovation of this chapter is that it uses longitudinal data that correlate mortgage product choices when borrowers refinance with changes in household characteristics as well as the interest rate and macroeconomic environment between the time borrowers took out the original loan and the time they refinanced. Of special interest are the groups that decided to switch between products. Further distinction is made between balloon mortgages, 15-year FRMs and 30-year FRMs. Categorical values are used for independent variables instead of continuous values. Both approaches allow flexibility in model specification and the effect of variables and help reconcile the conflicting results of some of the earlier studies. Comparing dynamic product switching with static product choice offers insights into borrower responsiveness to changes in their socioeconomic characteristics. While borrowers respond to recent shocks by switching to different products that address the immediate concerns such as keeping the ability to make payments and expected tenure changes, they gradually make adjustments to their mortgage choices that fit their long term goals of utility maximization, such as matching their expected income stream with payments and equity protection. These findings enrich the mortgage product selection literature as well as help our understanding of borrower behavior in making refinance decisions.

In the last chapter, attention is shifted from the borrower's angle to take on a broader view of the market and the lending institutions. Since the discontinuation of the Survey of Mortgage Lending Activity (SMLA) by the Department of Housing and Urban

Development (HUD), there has been no systematic estimation of components of the flow of mortgage funding in the market. The Federal Reserve's most recent working paper on this subject, by Greenspan and Kennedy [2005], provides an overview of the subject and proposes a methodology of disintegrating the mortgage flow. This chapter is devoted to the correct estimation of one component of the mortgage flow, the refinancing originations. It investigates the difference in the quarterly refinance percentages reported by separate sources including Home Mortgage Disclosure Act (HMDA), Mortgage Bankers Association (MBA), Freddie Mac's Primary Mortgage Market Survey (PMMS), and National Mortgage News (NMN). For quarters between 1990 and 2004, the difference between the measures runs from 2 to 22 percentage points. Potential contributing factors include differences among different series in data coverage, nature of the series, and computation methods. It is found that the combination of lender size and computation method explains away most of the discrepancies between the reported refinance shares.

The hypothesized link between a lender's size and the refinance share in that lender's originations is tested using HMDA data for selected years, among them 2000 and 2003, where the year 2000 is associated with very low refinance originations while 2003 had a record level of refinancing activity. Using refinance share in originations as dependent variable, it is found that lender size, as proxied by annual origination volume, is positively related to refinance share. The result is statistically significant on both lender and lender-state levels. Other variables considered include lender's institution type, cultural affinity, and dummy variables for the state location in the case of lender-state combination. Furthermore, the size of the lender's mortgage holding portfolio or

mortgage servicing portfolio is found to have a positive correlation with the lender's refinance share. Finally, it is demonstrated that by employing different methods of calculating the overall refinance share, the same sample data will yield separate results that can vary by up to 15 percent, as is the case with the observed difference among the various refinance measures.

Given its size and impact in the economy, refinancing activity is a critical component of the financial wellbeing of households, banking industry and the general economy. As a result, a small improvement in understanding the refinancing behavior of households can have significant financial implications. The objective of this dissertation is to make a contribution towards improving our understanding of borrowers' refinancing behavior.

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Chapter 2

Do Borrowers Make Rational Choices on Points and Refinancing?

2.1 Introduction

With some fixed-rate mortgages (FRMs), borrowers can choose to pay an upfront fee, or points, in exchange for a more favorable mortgage rate. The purpose of this study is to empirically test two theoretical predictions regarding borrowers' point choice and their refinancing decisions. One prediction is that borrowers with a shorter expected holding period (higher probability of prepayment) would opt for a loan with fewer points and higher interest rate. The other prediction is that once incurred, points become sunk costs, hence should not affect borrowers' refinancing decisions in the future. That is, once the difference between the contract rate and the market rate becomes large enough to make it optimal to refinance, the borrower should disregard the points paid at origination. With our data set of 3,899 individual loans between 1996 and 2003, we are able to track a loan from origination till termination and control for observable borrower characteristics as well as macroeconomic variables.

To our knowledge, this is the first empirical test of the rationality of the choices made by borrowers with respect to the points they pay and whether or not these points play a role in their future refinancing decisions. Refinancing loan volume exceeded 2.6 trillion dollars and made up 73.27% of the single-family conventional loan market in 2003. The average points and origination costs for that year was 0.6%, totaling 15.6

billion dollars. According to the 2001 Residential Finance Survey, 27% of all the single-family outstanding first mortgages have positive number of points.[2] Clearly, understanding the rationality of borrowers' behavior will have significant implications for policy makers as well as pricing of mortgages by financial institutions.

Theoretical models in the literature offer different explanations for the borrower's choice among various rates and points combinations. According to these models, points serve as: a tax shield for borrowers, a way for lenders to charge for the prepayment risk, and, in the case of information asymmetry, a screening instrument to separate borrowers of different prepayment risk.

Kau and Keenan [1987] use tax benefits to explain the existence of points. They show that if the marginal tax rate of the lender is less than that of the borrower, points can serve as a means for the lender to increase his after-tax yield without increasing the after-tax cost paid by the borrower. Their model suggests that there should be a positive relationship between points and income, since individuals in higher tax brackets have greater desire to deduct points up front. There should also be observed difference between purchase loans and refinance loans because points on purchase loans are tax-deductible in the year they are incurred while points on refinance loans are amortized over the life of the loan[3].

A number of papers utilize the option theory to study borrowers' points choices and refinancing decisions. The mortgage can be viewed as a callable coupon bond issued

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[2] http://www.freddiemac.com. It is also worth noting that points and origination costs were at their lowest in 2003 since 1972. They were as high as 2.5% in early 80s.

by the homeowner. When the borrower sells the house or refinances, she is exercising the option accompanying the bond and calling it at face value. For this option, the borrower pays a price above that of a non-callable bond. Chen and Ling [1989] and Follain et al. [1992] suggest that a form through which such prepayment options are changed is upfront points. Dunn and Spatt [1988] suggest an alternative view of the typical fixed-rate loan as an adjustable-rate loan with a protective option to continue the loan at the same rate. Borrowers who are less likely to prepay the loan for nonfinancial reasons will find this option to continue the loan at a low coupon rate more valuable and will self-select toward loans with high points and low rates. A similar conclusion is reached in Chen and Ling [1989] and Follain et al [1992] who compare the borrower's expected holding period to the lender's assumption about the borrowers' holding period and show that borrowers who expect a shorter duration on their mortgage than the duration assumed by the lender should choose loans with fewer points.

When borrowers have private information concerning the length of their holding period of the loan, the problem of asymmetric information arises. In this case, lenders can offer a list of contracts to screen high risk and low risk borrowers. Points and rates combination on an FRM is argued to be such a screening instrument in many studies. Chari and Jagannathan [1989], for instance, expand the argument behind prepayment penalty in Dunn and Spatt [1985] and show that the up-front points function as an insurance device against future income fluctuations in the event of a move. Their critical assumption is that mobile borrowers have a riskier income stream than stationary

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[3] Points applicable to the portion of a refinance loan that is used for home improvement can be deducted in the same year as incurred.

borrowers, and borrowers move when their future income realization is favorable. The likelihood of a move, or the riskiness of the borrower's income, is private to the borrower, and the resulting separating equilibrium involves borrowers with a higher probability of a future move choosing loans with more points. However, their results contradict the results of a series of other studies such as Brueckner [1994], Yang [1992] and Stanton and Wallace [1998].

Brueckner [1994] develops a two-period model in which borrowers self-select into loans of different point and rate features according to their mobility, with more mobile borrowers choosing loans with lower points and a higher coupon. Unlike Chari and Jagannathan [1989], the only distinguishing characteristics between the borrowers are the probability of moving and prepaying the loan, and income uncertainty is no longer a differentiating factor. Yang [1992] considers the case of a market with multiple classes of borrowers distinguished by their expected tenure, and shows that it is possible to achieve a separating equilibrium where borrowers who expect a longer residence in their houses choose a high point and low rate mortgage while those with shorter expected tenures choose a low point and high rate mortgage. LeRoy [1996] extends the asymmetric information model to include the cases of both mobility and refinancing choice. When voluntary prepayments are allowed, the points/coupon choice can only achieve a semi-pooling equilibrium, where a menu of nonnegative points and nonpositive points (but not both zero) are served. The stationary borrowers are identified through self-selection, as the mobile borrowers choose loans with nonpositive points while the stationary borrowers are indifferent between the two choices. Stanton and Wallace [1998] also distinguish borrowers with respect to the probability of moving. They show that in the

presence of refinancing costs payable by borrowers but not received by the lender, the value of the loan is always higher to the borrower than to the lender. When both asymmetric information and refinancing costs are present, it is possible to construct a separating equilibrium where borrowers are separated by type into different contracts with the stationary borrowers selecting higher points and lower coupon rates. In the absence of such costs, no such equilibrium is possible.

Empirical studies linking points selection and prepayment probability are sparse and the data typically lack either points information or termination status. For instance, the dataset in Brueckner [1994] involves points, but not the loan termination information. The sample includes 418 conventional 30-year mortgages from the National Association of Realtors Home Financing Transaction Database from 1988 to 1991. He utilizes the American Housing Survey panel data to control for a series of geographical, household and property characteristics. He then examines the relationship between the points choice and mobility and concludes that mobile borrowers choose low points. The datasets in Hayre and Rajan [1999], Pavlov [2001] and Clapp et al. [2001], on the other hand, involve prepayment information but not points. Focusing on the prepayment speed of GNMA mortgage backed securities, Hayre and Rajan [1999] simulate the points paid on a pool of mortgages by comparing the weighted average coupon rate to the prevailing rate at the time of the mortgage originations. They find that the pools with average coupons higher than prevailing rates, signaling no points or low points, prepay faster than those with lower coupons. Both Pavlov [2001] and Clapp et al. [2001] assumes that loans with rates lower than the prevailing market rates must have points and borrowers expecting higher transaction costs choose loans with points to avoid future refinance. Pavlov [2001]

finds that lower transaction costs are associated with higher refinance probability, but the significance disappears when prepayment is due to a move and default. Clapp et al. [2001] incorporate borrower characteristics into their analysis, such as age, income, credit score and minority status, and report that points have significant deterring effect on the probability of moving, but no effect on the probability of refinancing or default.

We use a dataset that contains both the points information and the loan termination information as well as various borrower characteristics, mortgage characteristics, transaction costs and macroeconomic factors. The richness of our dataset enables us to investigate the borrower's choice of points and her decision to terminate the loan in relation to points. In particular, we address two questions. First, we examine the termination pattern of mortgages with and without points and explore if borrowers had formed accurate expectations about their holding period at the time of origination and made rational decisions in the amount of points they chose to pay. Second, we examine the refinance behavior of the borrowers and see if those who chose points in the beginning waited longer time, i.e., required larger rate reduction, before refinancing. Given the trade off between points and interest rates, the borrowers who paid points will clearly have less incentive to refinance. However, once we control for the difference between the coupon rate and the market rate, the points paid at origination should be irrelevant for the refinancing decisions. We also test to see how such factors as tax incentives and transaction costs impact the borrower's choice decisions.

Our results show that most of the borrowers end up taking too many points by over-estimating their holding period of the mortgages. Furthermore, we borrowers fail to treat points as sunk costs; borrowers with points are less likely to refinance, and when

they do, they refinance "too late." When we examine the relationship between points and the other two forms of prepayment, move and default, we find that points do not impact the likelihood or the timing of borrowers' moving or default decisions. We also investigate the relationship between borrower characteristics and refinancing probability and find that older borrowers, minorities, borrowers with lower credit scores, less educated borrowers and lower income borrowers are less likely to refinance. If borrowers expect rates to increase in the future, this increases their propensity to refinance.

Although the economic theory states it very clearly that only marginal cost and benefits are relevant and previously incurred sunk costs should be irrelevant, our results indicate that sunk costs do matter in refinancing decisions of borrowers. One explanation for this behavior is that borrowers dislike admitting that they have been better off had they made different points choices. Instead of simply regretting the past, they may be delaying their refinancing decisions to make their point choices look better. In fact, there is evidence that it is very common for sunk costs to play a role in decision making. Govindarajan and Anthony [1995] and Shim and Sudit [1995], for instance, report that most firms in their surveys take into account fixed and sunk costs in pricing their products. Our results complement the existing empirical literature on the relevance of sunk costs. There is also experimental evidence that sunk costs are relevant in pricing decisions (e.g., Offerman and Potters, 2005; Dick and Lord, 1998; and Bazerman et al, 1982). Recent theoretical papers by Al-Najjar, Baliga and Besanko [2005] and Eyster [2002] offer models of behavior that provide an explanation for why sunk costs matter.[4]

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[4] Al-Najjar, Baliga and Besanko (2005) and Eyster (2002) also offer a nice review of the literature on sunk costs.

The rest of the paper is organized as follows. We discuss the data set in the next section. In Section 3, we study the determinants of borrowers' point choices and whether or not borrowers pay too many or too few points. In Section 4, we investigate whether or not borrowers refinance too early or too late, and examine whether or not borrowers treat point payments as sunk costs and not let their point payments influence their refinancing strategies. We offer some concluding remarks in Section 5.

2.2 Data

We use mortgage data provided by Freddie Mac, which include 3,899 observations of individual mortgages originated between January 1996 and December 2003. This dataset contains information on itemized transaction costs including various origination costs, yield spread premiums and discount points. As part of the practice of a control process, this dataset over-samples in loans that ended in default. Because of the fundamental differences in payment structure, valuation, and prepayment behavior between fixed-rate and adjustable-rate mortgages, adjustable-rate mortgages are excluded from our sample, resulting in 3,785 observations. The detailed breakdown by loan product can be found in Table 2.1. About two-thirds of the sample are refinance purpose mortgages, and the others are purchase mortgages. A little over one-eighth of the sample took out points at origination. The distribution of points as a percentage of the loan amount can also be found in Table 2.1. For those with points, the median number of points is 1, or 1 percent of the mortgage origination amount, and the mean is 1.2 points. If we consider mortgages with 0 to 0.25 points as being zero-point mortgages as well, the median number of points for the rest is 1 and the mean is 1.34.

To investigate the prepayment behavior of loans with and without points, we need to consider the three sources of prepayment separately; default, move, and refinance. One reason for doing so is that while default and move decisions are largely determined by exogenous factors that are often outside the control of the borrower, refinance decision is taken strategically by the borrower. Since the driving factors behind cash-out refinance are slightly different from those of regular rate-and-term refinance, we also pay separate attention to this type of refinancing as well.[5] Our general prepayment information comes directly from individual loan records, which show whether a loan is terminated, and if so, the date of termination, and the reason of termination, whether as a result of prepayment or REO (Real Estate Owned sale, the last stage of foreclosure where the property is taken over and put on the market for sale by creditors). From our sample, a total of 2,652 loans were terminated as of June 30th 2005.

To further categorize the terminations into move or refinance, we resort to Freddie Mac's Conventional Mortgage Home Price Index database, where each month, loans from Freddie Mac and Fannie Mae's purchases are pooled and matched by property address, so that consecutive transactions on the same property, including both purchase and refinance, are recorded and paired, and house price appreciation between the two transactions can be measured. Currently there are more than 29 million such pairs in this dataset. We use this "repeat transaction" dataset to match our dataset against the first loan of the pair to further distinguish whether the loan in our dataset ended in a refinance, cash-out refinance, or termination with the sale of the house. This results in 1,370 loans

[5] The cash-out refinance has gained popularity with the recent acceleration of house price growth and accumulation of home equity.

that are identifiable for the four categories, move, refinance, cash-out refinance, or REO sale. The other 1,282 that are shown as prepaid are undistinguishable between the subcategories and are treated as censored observations. Almost half of the identifiable termination resulted from refinances, with an additional twenty percent from cash-out refinance. Moving sale takes up about ten percent, with the rest 18 percent from REO sales. This particularly large sample of default cases allows us to look at the cases of move and default separately, rather than having them pooled together. From the repeat transaction dataset, we can also observe the actual rate reduction the borrower achieved through refinance.

2.3 Analysis – Ex Ante

2.3.1 Is there a tradeoff between points and rates?

Before we carry out any of the analysis, we first test the validity of the assumption that there is a tradeoff between points and rates. Traditional belief puts the tradeoff at a reduction of 0.25 percent on the fixed mortgage rate for each point.

Brueckner [1994] uses a regression model with the mortgage rate as the dependent variable, and origination time, origination region and the number of points as independent variables, and finds a reduction of 0.076 percent with 1 point. Nothaft and Perry [2002], using Federal Housing Finance Board's Mortgage Interest Rate Survey (MIRS) for 1992-1995 origination years, which contains information on loan rates and points, also found a smaller rate reduction of one point equaling 0.078 to 0.095

percentage points reduction in rates. Our approach is similar to that of Brueckner's, except that we are able to control for borrower and loan characteristics as well as the origination time and place. For borrower characteristics, we include borrower's FICO score for credit worthiness. Higher FICO scores are believed to be associated with more favorable mortgage rates. We also wish to capture the borrower's financial savvy through education level, which is not directly available in our loan information. Instead, we merge census area population percentage that have a college degree or higher by zip code. We hypothesis that this variable has a negative relationship with the loan rate as the borrowers are more likely to engage in more searching efforts among lenders to find the best deal, or have more accurate expectations about the market mortgage rate movement to achieve a better timing of financing. Two variables are included to indicate borrower affordability and financial constraint: monthly debt-to-income ratio, and loan-to-value ratio at origination. Lenders may charge a premium on the mortgage rates if these ratios are high enough that the threat to the borrower's continued ability to make payments is raised. We identify whether the borrower is a first-time homebuyer to take into consideration lender programs that provide them with favorable rates to help them qualify. In addition to mortgage product dummies, we indicate whether the loan in question is for house-purchase or refinance, in case these two groups are offered separate menus of mortgage choices. We also take into consideration the effect of yield spread premiums.[6] Other transaction costs as a percent of loan amount are included as well. As

[6] It is a general practice for borrowers to reduce transaction costs at the point of origination by agreeing to pay a slightly higher rate on their mortgage. Part of this spread on the higher mortgage rate is paid to the mortgage broker in the form of yield spread premium, for reducing the transaction costs, such as providing broker credit to help with some of the closing costs, or providing no-cost refinances. We use the ratio of the

Stanton and Wallace [1998] suggest, these should constitute positive social costs and are not translated into reduced loan rates.

We use four alternative specifications of points to catch their sensitivity to interest rates: 1) a dummy variable indicating if the loan has points above 0.25 percent of the loan amount; 2) values of the points as a percent of loan amount if the number of points is above 0.25; 3) a dummy variable indicating if the loan has points above 1 percent of the loan amount; 4) values of the points as a percent of loan amount if the number of points is above 1.

The regression results can be found in table 2.2. Points are associated with reduction in mortgage rates. Our results are close to those of Brueckner [1994] and Nothaft and Perry [2002]. Using the four alternative specifications of points given above, we find the corresponding reduction in the interest rate of 0.036, 0.078, 0.096 and 0.034, respectively, and they are all statistically significant. The results confirm that points taken out are associated with rate reduction. The smaller magnitude of the reduction implied by the regression coefficients from our study and previous studies, compared to the conventional wisdom, could be due to the fact that the timing of origination rather than the timing of lock-in was controlled for in the regressions, and therefore the results are not a direct comparison to the menu offered by a lender on a given day, on which the traditional belief of the tradeoff is based. The reduction also does not seem to be proportional to the increase of points.[7]

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dollar amount of the yield spread premium to the loan origination amount to capture any increase in loan rates as a result of using this mechanism.

[7] As a robustness test, we have also calculated the mean effective rates from the Mortgage Interest Rate Survey (MIRS) by origination month, region, and loan product. The MIRS is a purchase mortgage

Other factors largely bear the sign and significance as expected. Balloons, 15-year, and 20-year fixed-rate mortgages bear lower interests than 30-year fixed-rates. The borrower's FICO score has a negative and significant impact on mortgage rates. Our proxy for borrower education, or financial savvy, is shown to have a lowering effect on mortgage rates as well. Higher loan-to-value ratio is shown to incur higher rates. Yield spread premium is positively related to mortgage rates as expected. The coefficients on other transaction costs are also positive.

2.3.2 Did the borrowers make rational decisions regarding points?

Having established the tradeoff between points and rates, we then turn to examine the number of points the borrowers choose to pay when taking out the mortgage. If the justification of the choice of points lies in the mortgage payment savings from the corresponding rate reduction, the observed number of points should reflect the expected length of the holding period of the mortgage by the borrower. In order to study this question, we define the "minimum payback period" as the number of periods needed for the nominal monthly savings to add up to the dollar value of the points paid. This definition of the minimum holding period is based on the assumptions that the borrower's

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only dataset that reports in detail nominal mortgage rates, discount points, and effective rates. We match our data with MIRS data by all three criteria: origination month, region, and loan product. For each loan in our sample, we then find the rate reduction over corresponding mean rates from the MIRS data and regress it over the borrower and mortgage characteristic variables. The points are again shown to have significant, but less than the conventional wisdom, rate reduction effects. The reduction goes from 0.043 to 0.119 under our alternative points specifications.

discount rate is zero and that each point reduces the interest rate by 0.25 percent.[8] Clearly, borrowers have positive discount rates and, as our results in Table 2.1 indicate, the reduction in the interest rate is likely to be smaller than 0.25 percent per point. Thus, these assumptions allow the largest amount of benefits to be reaped from points and therefore favor the selection of points. The actual minimum holding period would be larger than our definition here.

Comparing the minimum payback period to the actual length of time the borrower holds the mortgage, we find that the borrowers in general over-estimate the length of the holding period, and end up paying too many points up front. Table 2.3 shows how much shorter, in months, the actual holding period was vis-à-vis the minimum payback period. To make a clear distinction, we excluded all the loans with points less than 0.25. The median length of time the mortgage was prepaid before the minimum payback period is 39.3 months, or nearly 3 years and four months, and the mean is 37.2 months, close to 3 years and two months. Including the 57 observations where points are less than 0.25, 44 of which resulted in terminations, does not change the basic results. The median number of months short of the minimum holding period is 39.5 and the mean is now 37.5. Only about 1.4 percent of the borrowers held their mortgages longer than the minimum payback period.

While the results point to a failure by borrowers to have correct expectations regarding their holding period of the loan, we need to notice that the period we studied covers a stretch of time marked by low mortgage rates unseen in thirty years, even

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[8] We use 0.25 percent reduction in the annual rate to find out what the monthly payment would be had no points been taken out. The monthly savings in payments are then calculated comparing the actual payments

defying the forecast of economists, which triggered record high refinance volumes. It should not be surprising that a number of borrowers refinanced under unexpected circumstances. The implication for the probability of moving is that mostly likely moving results from unforeseen events rather than endogenous decisions.

Turning to the borrowers that did not take out points at origination, we test whether they would have benefited from taking out points by assigning points at 0.25 percentage points intervals from 0.25 to 4 percentage points and comparing the amount of points with the payment savings given their actual duration. We find that only about 1.5 percent of the population without points would have been better off with points and the percentage declines from 1.6 to 1.4 as the points we assign increase from 0.25 to 4 percent of the original loan amount.

In large, for the loans that are terminated before the cutoff date of our data set, 65% of loans without points and 62% of loans with points, the majority of the borrowers made the correct decision of not taking out points for the period studied, yet the majority of the borrowers that took out points over-estimated the expected length of stay and assumed more points than can be justified by the savings associated. For the loans that have not been terminated by the cutoff date, 11% of loans without points would have benefited from points between 0.25 and 4 percent, and 16% of loans with points have been active long enough that the payment savings would have exceeded the upfront points paid. Relaxing our assumptions regarding the rate-point tradeoff, the borrower's tax bracket, and the borrower's discount rate yields even less favorable results concerning positive points selection. For example, assuming that one point equals 0.125 percentage

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made with the reduced rates and those hypothesized without the point-rate tradeoff.

points reduction, as we observed in our sample, would result that none of the borrowers with positive points, including those who have not terminated the loan by the cutoff date yet, would have enough savings by the cutoff date to justify their points selection. In addition, assuming a 10% annual required rate of return shows that only 0.1 percent of those without points that terminated before the cutoff date would have benefited from paying points and only 5.7% of the active loans without points would have benefited from some points. Adding the tax concern makes the savings in interest payments smaller because interest payments are tax deductible, and points paid on refinance loans unchanged because they are not deductible in the year incurred. Therefore, the refinance mortgages with points will have even longer theoretical payback periods.

2.3.3 Who took out points?

We further study whether any group of borrowers with specific socioeconomic traits are more inclined to take out positive points. We regress the number of points as a percentage of loan amount against a series of borrower characteristics. We focus on the variables that are indicators of borrower mobility, such as income and minority status, and indicators of strong tax incentives, such as income and the purpose of the mortgage. Earlier results by Brueckner [1994] suggest that lower income borrowers, minorities and older borrowers are less likely to move, hence more likely to pay more points.

To control for other financial characteristics that may affect the points choice, we include the monthly housing payments to income ratio. This ratio may be positively correlated with points selection because those borrowers with higher payment-to-income

ratios may have more incentive to reduce this ratio by taking advantage of the rate reduction with points. Furthermore, we include an indicator of whether at the time of origination the loan-to-value ratio is above 90 percent, as those with high LTV's may be restrained in their ability to take out additional points even though they may wish to.

We also include variables indicating the location of the residence, including whether or not the house is located inside an MSA or not, and the regional dummies for Northeast, South, and Midwest, leaving West as the default.

Lastly, we consider the probability of future refinances and the associated costs. We include transaction costs as a percentage of the loan amount, as borrowers with higher transaction costs are considered to have more incentive to avoid future transactions and therefore, more incentive to take out higher points to reduce the current coupon. We also include the credit score of the borrower and whether there are multiple borrowers on the loan as a proxy for the relative difficulty of future financing. If a borrower perceives a higher hurdle of refinancing in the future, conceivably she would take out more points with the current loan to maximize the benefit.

Our results, as shown in table 2.4, indicate that the mobility indicator, i.e., the age of the borrower, has the expected sign and is significant. Older borrowers are more likely to take out points. Income does not make a significant difference, which does not support the tax incentive argument. The other variable we check, whether the loan was for a purchase or not, is not significant either, further showing that tax consideration may not be the major reason for choosing points. Transaction costs are positively correlated with points selection, while the effect of the credit score is significantly negative, both

suggesting that avoiding future costly transactions is an important incentive for taking out points.

2.4 Analysis – Ex Post

2.4.1 Do points make a difference in the likelihood of loan terminations?

We use the Cox proportional hazard model to model the survival function for mortgages. The model does not require a specification of the underlying baseline hazard function. This is distinctive from studies such as Schwartz and Torous [1989], where the baseline functions are specified as one of several possible distributions, including, but not limited to, the log normal, log logistic, and Weibull distributions.

We study four types of termination risks: moving, refinance, cash-out refinance, and default. These four types of terminations are mutually exclusive, which means that loan termination as a result of one type prevents the other types of terminations from happening. As a result, when studying the possibility of one type of termination, those loans that were terminated for other reasons are treated as censored observations. All the observations that were not terminated by our cutoff date, June 2005, are also treated as censored observations.

The hazard function corresponding to the competing risks of mortgage termination is

$$\pi_j(t;\nu,\theta) = \lim_{\Delta t \to 0} \frac{P\left(t \le T < t + \Delta t, J = j \middle| T \ge t\right)}{\Delta t},$$

where *j* denotes one of the four competing risks in this study, moving, refinance, cash-out, or default. Assuming there are no simultaneous causes for terminations, the overall termination probability is

$$\pi(t;\nu,\theta)=\sum_{j=1}^{4}\pi_j(t;\nu_j,\theta),$$

where υ_j is the vector of variables contributing to the termination risk *j*, and θ is the vector of coefficients.

The survivorship function for the mortgage is

$$F(t;\nu,\theta)=\exp\left[-\int_0^t \pi(u;\nu,\theta)\right].$$

The termination time density function for termination of type *j*, given θ is

$$f_j(t;\nu,\theta)=\lim_{\Delta t\to 0}\frac{P(t\le T<t+\Delta t, J=j)}{\Delta t}=\pi_j(t;\nu,\theta)F(t;\nu,\theta).$$

The likelihood function is proportional to

$$\prod_{i=1}^{n}\left(\left[\pi_{ji}(t_i;\nu_i,\theta_i)\right]^{\delta_i}F(t_i;\nu_i,\theta_i)\right)=\prod_{i=1}^{n}\left(\left[\pi_{ji}(t_i;\nu_i,\theta_i)\right]^{\delta_i}\prod_{j=1}^{4}\exp\left[-\int_0^{t_i}\pi_j(u;\nu_i,\theta_i)du\right]\right)$$

where t_i is the observed survival time for the i^{th} mortgage and δ_i indicates if the i^{th} mortgage was terminated during the observation period. If a mortgage is terminated for a particular cause in the observation period, it will be treated as censored observation in the study of other causes.

We use a proportional-hazard function to model the probability of termination due to cause *j* as given in the following equation:

$$\pi_j(t;\nu,\theta)=\pi_{j0}(t)\exp(\nu_j\theta),$$

where $\pi_{j0}(t)$ is the baseline hazard function, and $\exp(\nu_j\theta)$ shows the effect of explanatory variables. As in Cox [1975], Green and Shoven [1986] and Pavlov [2001], we do not specify the functional form of the baseline function. Instead, the conditional probability of mortgage *i* being prepaid at time t_i while the collection $R(t_i)$ are at risk is

$$\frac{\pi(t_i;\nu_i,\theta)}{\sum_{l\in R(t_i)}\pi(t_l;\nu_l,\theta)}=\frac{\exp(\nu_i\theta)}{\sum_{l\in R(t_i)}\exp(\nu_l\theta)}.$$

The partial likelihood is the product over all termination cases t_i

$$L(\theta)=\prod_i\frac{\exp(\nu_i\theta)}{\sum_{l\in R(t_i)}\exp(\nu_l\theta)},$$

and the value of θ is estimated with the maximum likelihood function *L*.

Studies of mortgage terminations usually take the contingent claims approach, as illustrated in Hendershott and Van Order [1987], that the option to refinance the mortgage can be valued as a call option on the mortgage and the option to default a put option on the underlying property. In this framework, deterministic factors that influence the borrower's decision to exercise these options are face value of the mortgage, market value of the mortgage, and price of the house. The observed patterns of loan terminations often defy these option value-based predictions. Many studies in the literature have turned to other factors that may explain the observed loan terminations. Especially the focus of attention has been transaction costs, borrower characteristics, and economic environment. Among the works are Peristiani et al [1997], Archer et al [1996, 1997], Caplin et al [1997], and Green and LaCour-Little [1999]. These studies identify declines in collateral value, credit status and other macroeconomic factors, such as unemployment,

as significant factors inhibiting prepayment, and borrower characteristics such as borrower age playing an important role in predicting mobility. In our study, we control for various borrower characteristics, macroeconomic and rates environment, transaction costs, and other mortgage-related characteristics to isolate the effect of points on termination risks. The details of our results can be found in Table 2.5.

Our primary result is that points as a percentage of original loan amount has a significant negative effect on refinance and cash-out decisions, which means that the higher the points a borrower chose, the less likely she will terminate the loan due to refinance or cash-out. Points are not a significant factor in default or moving, meaning that the events of default and moving are most likely caused by exogenous factors. This last result is contrary to the theoretical predictions that the offering of points induces self-selection among borrowers with different mobile rates.

The prepayment patterns of loans with and without points are displayed in Figure 2.1, which shows that overall loans with points have lower prepayment rates at shorter periods after origination. Figure 2.2 shows that a similar pattern is repeated in the refinance and cash-out refinance types of terminations. However, as shown in Figure 2.3, when we include only loans that were terminated due to moving or default, then loans with and without points do not show much difference.

Transaction costs are shown to be an influential factor in refinancing decisions in previous studies. Generally higher transaction costs are associated with an increase in the required rate reduction in a refinance decision. Transaction costs are also considered to be partially responsible for the observed ‘woodhead’ behavior of the borrowers, referring to the observation that borrowers choose not to refinance even when the call option is deep

in the money. We use the transactions costs associated with the origination of the current loan, excluding points, as a percentage of the original loan balance, to proxy for the expected transaction costs in the case of origination of a new loan. We find that transaction costs reduce the likelihood of refinance and cash-out refinance, but they are not a factor in moving. We also find that the probability of default increases with transaction costs, which could mean that high transaction costs impede borrowers from taking advantage of refinancing into lower monthly payments and therefore increase their chance of default.

We also consider the difference between transaction costs across different geographical areas. According to the Lehman Brothers fixed income research [2005], the states of New York, Florida, New Jersey and Texas have highest refinancing costs as a percentage of loan amount for a $200,000 loan. We include a dummy variable that takes the value of one if loans are originated in these states and found that it has a significant negative impact on both the probability of refinance and cash-out refinance.

In addition, we consider the difference in default costs across states. Six states (CA, MN, MS, MT, WV, ND) do not allow the lender to go after the borrower's other personal possessions once the loan is in default.[9] This reduces the default cost for the borrowers in those states and may make them more likely to choose to default. This prediction is born out by our result that the dummies for the six states have a positive sign, meaning that the borrowers in these states are more likely to default. We also find a slightly increased risk of cash-out refinance in those states, indicating the possibility that

the borrowers in these states choose to increase their loan-to-value ratios at higher rates since the consequences of a default in those states are less severe.

We expect the borrower's age to be negatively associated with move probability, as reported in Archer et al [1997] and Clapp et al [2001]. The evidence on the relationship between the borrower's age and refinance probability, however, is mixed. While LaCour-Little [1999] and Clapp et al [2001] find no significant impact for the borrower's age, Nothaft and Chang [2005] show that older borrowers are less likely to engage in refinance or cash-out refinance. Our results show that the older the primary borrower at time of origination, the less likely she will move or refinance or cash-out later on. We find no significant impact for the borrower's age on the default probability.

We expect borrower credit score to have a positive effect on the refinance or move possibilities, as their good credit standing makes it easier for them to get qualified for a new loan, while poor credit history restricts the borrower's ability to refinance or move. Good credit scores should also indicate a reduced possibility of default. But the caveat is that we only have credit information at origination, while throughout the life of the mortgage the borrower's credit could evolve in either direction. We find that the higher the combined credit score of the borrower, the more likely she will refi or cash-out, consistent with the findings of Peristiani et al [1997] and Clapp et al [2001]. Higher credit scores are also associated with increased move probability. We do not find a significant relationship between default rate and credit score, as opposed to Clapp et al

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[9] Cutts and Green [2005] offer a detailed review on the differences in state foreclosure legislatures. Clauretie and Herzog [1989] find significant relationship between differences in three major aspects in state foreclosure laws and aggregate loss severities in different states.

[2001] who report a significant relationship between low credit score and increased default probability.

We include an indicator for whether or not one or more of the borrowers are minorities and find that minorities are less likely to refinance or cash-out, corroborating earlier results of Kelly [1995], Clapp et al [2001] and Nothaft and Chang [2005]. A study by Anderson and VanderHoff [1999] also reports a higher default rate among black households. Their explanation is that black households have lower home equity accumulation (due to lower house price growth in areas where minorities are more likely to live) and lower default costs (due to their lower income levels). Our results indicate no significant relationship between minority status and mobility or default probability.

We also include an indicator of whether there are multiple borrowers present at loan origination. The combined income may facilitate qualifying for a refinance or cash-out refinance. It may also reduce the probability of default. South and Crowder [1998] show that being married and having children are associated with decreased mobility. Our results indicate that the presence of multiple borrowers at origination results in a higher probability that the loan will get refinanced, either regular or cash-out, but a lower probability of default or move.

We proxy for the borrower's education level and financial savvyness by the percentage of population that are high school graduates at zip level where the property is located. The assumption here is that a borrower's education level is likely to be positively correlated with the education level of the other residents in that zip code area. We find that the education level has a positive impact on the probability of refinance, negative

impact on the probability of default, and no distinctive effect on cash-out refinance or moving.

We use the natural logarithm of the borrower's reported monthly gross income to study the relationship between income and prepayment probability. Consistent with Brueckner [1994], Archer et al [1997], and Clapp et al [2001], we find an increased probability of moving as the borrower's income increases. While Clapp et al [2001] report a negative relationship between the income level and refinance probability, and speculate that it is due to the higher opportunity costs of refinancing for higher income borrowers, we find that this result holds for the case of cash-out refinance but not for the case of regular refinance.[10]

We view borrowers with high LTV loans as constrained against moving or refinance. They are also hypothesized to have higher default rate. Our results show that high LTVs do not have significant effect on the moving or refinance probabilities. But the higher initial LTV does deter cash-out refinance subsequently. A higher initial LTV is also associated with higher probability of default. Peristiani et al [1997] report that high current LTV reduces the probability of refinance. Clapp et al [2001] find a strong negative correlation for the current LTV with moving and refinance, and a positive correlation with default, consistent with Archer et al [1997] and Caplin et al [1997].

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[10] To address the possibility that borrowers reported just enough income to qualify for the loan, i.e., in case the borrower's reported income is less than her actual income, we merged the median family income by census tracts with our data and used the area median income as a proxy for our borrower income. The results do not differ substantially from what we reported here.

We also include the dollar amount of loan balance to capture the increased incentive to refinance, move or default. A larger loan is likely to create bigger savings from refinancing or default and is likely to be associated with higher moving costs. We find an accelerated rate of refinance, cash-out refinance, and moving with larger loan amounts, but the impact on default is negligible.

We use a dummy variable of investor properties to indicate if the residence underlying the mortgage is a second home or investment property. We suspect that these properties may have a higher turnover rate than owner-occupied properties, yet we do not find a positive relationship between this variable and the possibility of moving. Instead, we obtain a decreased probability of both refinance and cash-out refinance associated with investor properties. We also include an indicator of the purpose of the loan, which takes the value of one if the current loan is a refinance loan of a previous mortgage, and zero if the current loan is for a home purchase. Our results show that whether the loan is refinance or not has no effect on the probability of moving or refinancing. However, if the current loan is a refinance, then the borrower is likely to engage in cash-out refinance later.

Among the mortgage types we control for, we find that balloons, 15-year and 20-year FRMs all have higher refinance and cash-out refinance risks than the 30-year FRMs, while 15-year FRMs have smaller risk of default than the 30-year FRMs. We also control for whether the current loan is applied through special reduced documentation process, and find it to be linked to higher moving and default probabilities.

To capture the impact of changes in economic conditions, we use the change in employment rate. We take the difference between the state unemployment rate and that of

the nation, and calculate the change in this indicator for period *t* by comparing the employment rate in period *t* to the employment rate at the time of loan origination. Worsening employment situation could prompt households to move to other locations where better prospects may be found. Yet, a general economic downturn could prolong the time on the market for the house in the case of move, and frustrate the borrower in getting a refinance loan (Green and LaCour-Little 1999). It could also contribute to higher default probability. We show that if the employment situation worsens in the state relative to the country, it reduces the likelihood of refinancing but has no impact on other forms of termination.

To measure the value of the call option as an incentive to refinance, we follow Deng et al [2000] and use the ratio of the market value of the mortgage to the unpaid principal balance at time *t*. We calculate the difference between the value of the unpaid mortgage discounted at current interest rate and the value of the unpaid mortgage discounted at its coupon rate, or the book value of the mortgage, and divide it by the book value of the mortgage. The larger this ratio, the more the option to prepay is in the money, and therefore one should observe a positive relationship between this ratio and the refinancing probability. Our results support this hypothesis with a positive relationship between this ratio and both the refinancing and cash-out refinancing probabilities. We also find that a higher ratio is related to a lowered default probability, which means that if the interest environment is favorable, the chance of default should decrease as terminations due to refinancing will extinguish the probability of default. Moving seems to be an exogenous decision unaffected by the interest rate environment.

In our sample, for the loans that are terminated for identifiable reasons, we have house values at both loan origination and the point where the house is sold or the loan is refinanced. For other loans, we merge the median house prices by state from the monthly Mortgage Interest Rate Survey and assume that the houses underlying the loans in our sample follow the same growth rates as the median price in that state. We measure the cumulative house price increase by the annualized growth rate, which is the ratio of the house price at time t to the house price at origination. We find that higher cumulative house price growth accelerates cash-out refinance while reducing the likelihood of regular refinance, as cash-outs are more motivated by the accumulation of home equity. We also find that higher house price growth deters default, as the put option on the house is more out of money.

We capture the expectations about future rate movements through the yield curve, the difference between the current long-term yields and short-term yields. In our sample we use the difference between the 10-year constant maturity Treasury (CMT) rate and the 3-month CMT rate. If borrowers expect rates to increase in the future, they are more likely to refinance or cash-out now. Expected future rate increases also decrease the default risk. The reason, as Cappoza et al [1998] argue, is that an expected increase in the interest rate causes the borrower to value the current low-cost mortgage more and to be unwilling to surrender it. The only prepayment decision not affected by rate movements is moving, further showing that moving is less of a borrower's decision than a decision triggered by exogenous events.

We use the number of months of forgone refinance opportunity to capture other constraints a borrower may face to obtain a new loan. We measure the months of

foregone refinance opportunity as follows. We first identify the month in which the savings from the difference between the coupon rate and the market rate exceed the refinancing costs. We then count the number of months it takes the borrower to refinance. Our results indicate that this burnout measure is negatively related to refinance or cash-out refinance, and positively related to move or default. This suggests that borrowers who forgone numerous refinancing opportunities have done so in anticipation of a move or default.

2.4.2 Do Borrowers Refinance Optimally?

In the previous section, our results showed that points have a negative effect on the borrower's refinancing probability, even after controlling for financial incentives and the possible deterring factors such as transaction costs. The delayed refinance decision could be the result of three factors: 1) since loans with points have lower coupon rates, it might be more difficult to hit upon lower rates needed to make refinancing of these loans profitable, even though the rate reduction required is the same as that for loans without points; 2) the borrower procrastinates on refinancing for non-financial reasons; 3) the borrower waits for deeper rate reduction, possibly to compensate for the points paid previously that had not reaped its full return through the duration of the loan. As pointed out earlier in the introduction, there is evidence in economics literature that economic agents dislike regretting their decisions and admitting their mistakes. Instead of simply regretting the past and treating the point payments as a sunk cost, they may be delaying their refinancing decisions to make their point choices look better.

If the first two factors are the case, then we shouldn't observe a higher rate reduction in refinancing cases for borrowers with points, but if the third factor is the case, then we should consistently observe higher rate reductions when borrowers with points refinance. Therefore, it is worth examining our data further for the observations that ended in refinance. We have the interest rate information on 408 of such loans in our data set, which are the loans that were purchased by Freddie Mac. Table 2.6 compares the rate reduction and time passage associated with the loans with and without points in three groups: the combined cases of refinance and cash-out refinance, all refinance cases without cash-out, and only those who refinanced to the same product as they had before, i.e. a new 30-year FRM in place of the old 30-year FRM, or a new 7-year balloon in place of the old 7-year balloon. We consider those refinance into different mortgage products having other incentives than purely rate-reduction driven, and those cash-out having even more non-rate-related incentives. Loans with points show a longer time passage from the origination of the loan in question to the issuance of their refinance loan, and also a slightly higher rate reduction. Those who refinanced within the same product group show the most significant difference: loans with points on average refinance at 0.2 percentage points higher rate differential while experiencing a 3-month delay compared to those without points. The results are significant at 5% and 10% level respectively. Figure 2.4 shows the cumulative prepayment rate by rate reduction and those with points are shown to prepay at a slightly slower rate than those without points when the rate reduction is small.

Since each loan is different in characteristics and the optimal rate required for refinancing is different for each loan, we need to look at individual decisions. We first

calculate the range of optimal interest rate drops needed for refinancing by utilizing the option pricing technique. We then compare to see if the actual rate reduction at the time of refinancing falls within this range we calculated. Across the sample we can then compare the percentage that refinanced too early or too late for loans with points versus those without points.

In modeling the optimal refinancing strategy, we assume a binomial interest rate environment where the interest rate either rises or falls from time *t* to *t+1*. Let *U* describe the increase in the interest rate in the up state and let *D* describe the decrease in the interest rate in the down state. As in Rendleman and Bartter [1980], Hall [1985], Chen and Ling [1989] and Follain et al [1992], we assume the logarithm of the ratio of short-term interest rates at time *t+1* to time t follows a binomial distribution, where the mean μ and variance σ^2 are given by:

$$\mu = N\left[\pi \ln(U) + (1-\pi)\ln(D)\right]$$

$$\sigma^2 = N\left[\ln(U) - \pi(1-\pi)\ln(D)\right]$$

where π is the probability that the interest rate rises in the next period, and *N* is the number of payments per year, which will be equal to 12 in our calculations. The values of *U* and *D* that describe the interest rate movement over time can be expressed as functions of μ, σ^2, π and *N*.

$$U = \exp\left[\mu/N + \left(\sigma/\sqrt{N}\right)\sqrt{N(1-\pi)/\pi}\right]$$

$$D = \exp\left[\mu/N - \left(\sigma/\sqrt{N}\right)\sqrt{N\pi/(1-\pi)}\right]$$

The value of the borrower's callable mortgage liability at time *t* is

$$M_t(r,T,c_0) = M_t^{nc}(r,T,c_0) - V_t(r,T,c_0),$$

where *r* is the one-period risk-free interest rate at time *t*, *T* is the term to maturity, c_0 is the coupon rate on the mortgage, $M_t^{nc}(r,T,c_0)$ is the value of a non-callable mortgage that is identical to the mortgage in every other feature, and $V_t(r,T,c_0)$ is the value of the refinancing option.

The present value at time *t* for the borrower to hold on to the mortgage, or delay exercising the refinancing option, for another period is:

$$W_t(r,T,c_0) = \frac{E[V_{t+1}(r,T,c_0)]}{1+r}.$$

The value realized from exercising the refinancing option at time *t* is the difference between the value of the mortgage at existing coupon rate and the unpaid balance of the mortgage, net of refinancing costs:

$$G_t(r,T,c_0) = M_t(r,T,c_0) - B_t(B_0,T,c_0) - \alpha B_t(B_0,T,c_0),$$

Where $B_t(B_0,T,c_0)$ is the unpaid balance of the mortgage at time *t* and the refinancing costs are assumed to be proportional to the book value of the mortgage by a factor of α. The value of the refinancing option is therefore is the greater of the exercising value and holding value of the option:

$$V_t(r,T,c_0) = \max[G_t(r,T,c_0), W_t(r,T,c_0)].$$

The borrow will refinance if and only if the value of exercising the option exceeds that of holding the option. By substituting the actual loan amount, coupon rate and

transaction costs to the equation, and assuming alternative values of 0.05 and 0.15 for the standard deviation and alternative values of 0.02 and -0.02 for the mean in the rates model, we arrive at a range of optimal rate reductions needed for refinancing for each loan. Comparing this range with the actual rate reduction, we calculate the percentage of borrowers who refinanced too early or too late in different categories distinguished by points. Table 2.7 summarizes the percentage of 'too early' and 'too late' refinancers among borrowers with and without points. We find that on average more borrowers with points refinance too late, i.e., wait beyond the interest rate at which refinancing becomes optimal, and fewer borrowers with points refinance too early.

One could argue that one possible explanation for the above result is that borrowers who paid points on the original loan are more likely to refinance into a loan with points, hence enjoy lower interest rates with the refinancing loan. This would make these borrowers appear to be waiting for a larger than optimal rate drop to refinance. However, this does not explain why we see time delay till refinance for these borrowers (as displayed in Table 2.6 and Figure 2.2). In addition, we also compared the coupon rates on borrowers' new loans with contemporary average rates on loans matched by the same geographical region. Controlling for other factors, we find that whether a borrower gets a better discount on the rate at the time of refinancing is not related to whether or not her original loan had points or not. The regression results are summarized in Table 2.8.

2.5 Conclusion and Future Directions

Through a unique dataset that has complete information on transaction costs, points paid, and the subsequent prepayment status of the mortgages, we are able to study the rationality of borrowers' points selection and their refinancing strategies. We find that borrowers who are less likely to move or refinance take out mortgage loans with more points. However, borrowers generally over-estimate their length of holding the mortgage, and end up paying too many points.

Contrary to prior theoretical predictions, we do not find a significant relationship between points and borrower mobility. That is, point selection by a borrower does not serve as a signal of that borrower's mobility type. This result indicates that the decision to move arises from exogenous events and a borrower's mobility type cannot be inferred from the number of points paid by that borrower. Similarly, tax-related incentives do not appear to play a significant role in points selection.

Instead, we find that upfront points are related to the endogenous decisions of refinancing and cash-out refinancing. Borrowers with points are less likely to refinance, and when they do, they refinance "too late." In other words, borrowers fail to treat points as sunk costs and allow points influence their refinancing decisions.

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Table 2.1 Sample Description

1. Termination Type

Reason for Termination	Frequency	Percent
Move	146	10.7
Refinance	677	49.4
Cashout Refi	299	21.8
REO Sale	248	18.1
Other/Active thru 12/2004	2415	NA

2. Mortgage Product Type

Loan Product	Frequency	Percent
5-Year Balloon	107	2.8
7-Year Balloon	80	2.1
15-Year Fixed Rate	986	26.1
20-Year Fixed Rate	229	6.1
30-Year Fixed Rate	2383	63.0

3. Points Selection

Number of Points	Number of Observations	Percent of Population
0	3265	86.3
>0 and <=0.25	74	2.0
> 0.25 and <= 0.5	84	2.2
> 0.5 and <= 1	149	3.9
> 1 and <= 1.5	74	2.0
>1.5 and <=2	76	2.0
>2 and <= 2.5	17	0.4
>2.5 and <= 3	21	0.6
> 3	25	0.7

Table 2.1 Sample Description – Continued

4. Statistics on Selected Variables

Variable	**Mean**	**Minimum**	**Maximum**
Gross annual income	$68,191	$20,304	$268,608
House price	$167,545	$38,000	$584,000
Prime borrower age	43	22	88
Credit score	693	533	804
Loan-to-value at origination	74%	24%	95%
Mortgage rate	7.00	4.75	9.00
Original loan amount	$115,282	$25,700	$300,000
Transaction costs (excluding points) as a percentage of loan amount	1.9	0.0	5.0

5. Distribution of Selected Variables

Variable	**Percentage of sample**
First-time homebuyer	11.2%
Multiple borrower	62.4%
Minority borrower	17.6%
Investor property	7.3%
Inside MSAs	68.6%

Table 2.2 Tradeoff between Points and Coupon Rates

Dependent variable: coupon rates on the mortgage in sample

Variable	**Points as a % of Loan Amount**	**Points as a % of Loan Amount (if >=1)**	**Points=1 if >=0.25**	**Points=1 if >=1**
Points as a % of Loan Amount	**-0.0383**	**-0.0359**	**-0.0836**	**-0.0100**
Origination month dummy	Collectively Significant	Collectively Significant	Collectively Significant	Collectively Significant
Region=Northeast	**0.0441**	**0.0443**	**0.0431**	**0.0445**
Region=South	0.0162	0.0163	0.0145	0.0152
Region=Midwest	**0.0509**	**0.0515**	**0.0485**	**0.0500**
Balloon?	**-0.9412**	**-0.9407**	**-0.9420**	**-0.9402**
15-year FRM?	**-0.5667**	**-0.5662**	**-0.5667**	**-0.5644**
20-year FRM?	**-0.1864**	**-0.1855**	**-0.1887**	**-0.1859**
All Borrower FICO	**-0.0005**	**-0.0005**	**-0.0005**	**-0.0005**
Percent of College Graduates	**-0.0016**	**-0.0016**	**-0.0016**	**-0.0016**
Debt Expense as a % of Income	-0.0439	-0.0451	-0.0416	-0.0435
LTV at Origination	**0.1448**	**0.1439**	**0.1488**	**0.1464**
First Time Home Buyer	-0.0346	-0.0340	-0.0348	-0.0330
Refinance Loan	-0.0170	-0.0173	-0.0157	-0.0171
Other Transaction Costs as a % of Loan Amount	**0.0502**	**0.0500**	**0.0511**	**0.0506**
Yield Spread Premium as a % of Loan Amount	**0.0906**	**0.0909**	**0.0898**	**0.0910**
R-Square	0.87	0.87	0.87	0.87

Note: Highlighted coefficients significant at 10% level.

Table 2.3 The Benefit of Points for Borrowers

1. Comparison of Actual Duration and Minimum Payback Period on Loans with Points

	If points ≥ 0.25		If points ≥ 0	
Time difference between actual loan duration and the payback period for points	Number of Observations	Percentage of Population	Number of Observations	Percentage of Population
Longer than payback period	4	1.3	5	1.4
≤ 1 year	16	5.3	17	4.9
> 1 year and ≤ 2 years	30	9.9	34	9.8
> 2 years and ≤ 3 years	76	25.0	87	25.0
> 3 years and ≤ 4 years	113	37.2	127	36.5
> 4 years and ≤ 5 years	55	18.1	65	18.7
> 5 years and ≤ 6 years	10	3.3	13	3.7

2. Number of Loans without Points That Would Have Benefited from Choosing Positive Points

Number of Points	**Number of Observations**	**Percent of Population**
0.25-1.25	36	1.6
1.5-2	35	1.5
2.25	34	1.5
2.5-3	33	1.4
3.25-4	32	1.4

Note: The calculations in Table 2.3 assumes zero discount rate and one point equaling a reduction of 0.25 percentage points in coupon rates.

Table 2.4 Points Choice and Explanatory Factors

	Regression with percentage points as dependent variable	Logistic regression with whether points are chosen or not (Yes=1) as dependent variable
Intercept	**0.3965**	-0.8611
Tax Incentives		
Income	-0.0175	-0.0468
Is the loan refi (1=Yes)	0.0016	0.1523
Mobility		
Prime Borrower Age	**0.0017**	**0.0072**
Minority (1=Yes)	0.0816	0.3784
Transaction Costs		
All Borrower FICO Score	**-0.0002**	**-0.0016**
Transaction Costs as a Percentage of Loan Amount	**0.0225**	**0.1612**
Other		
Multiple Borrower (1=Yes)	-0.0166	-0.0021
House Expense as a Percentage of Income	-0.0491	0.4466
LTV at origination >= 90%? (1=Yes)	-0.0112	-0.0478
Inside MSA? (1=Yes)	-0.0041	-0.0573
Region=Northeast	0.0222	-0.1037
Region=South	-0.003	-0.1668
Region=Midwest	-0.0368	**-0.5610**

Note: Highlighted coefficients significant at 10% level.

Table 2.5 Points Choice and Termination Risks

	All		Move		Refi		Cash-Out Refi		Default	
	Estimate	**Percent Change in Hazard Rate**	**Estimate**	**Percent Change in Hazard Rate**	**Estimate**	**Percent Change in Hazard Rate**	**Estimate**	**Percent Change in Hazard Rate**	**Estimate**	**Percent Change in Hazard Rate**
Points	**-0.243**	**0.784**	-0.212	0.809	**-0.354**	**0.702**	**-0.603**	**0.547**	-0.133	0.875
Percentage other transaction costs	**-0.164**	**0.849**	-0.006	0.994	**-0.288**	**0.750**	**-0.251**	**0.778**	**0.083**	**1.087**
Age of prime borrower	**-0.019**	**0.981**	**-0.017**	**0.983**	**-0.029**	**0.972**	**-0.033**	**0.967**	-0.004	0.996
FICO Score	**0.004**	**1.004**	**0.003**	**1.003**	**0.008**	**1.008**	**0.003**	**1.003**	-0.002	0.998
Minority Indicator	**-0.192**	**0.825**	-0.306	0.737	**-0.434**	**0.648**	**-0.474**	**0.622**	0.218	1.489
Multiple Borrower?	**0.137**	**1.147**	**-0.501**	**0.606**	**0.506**	**1.658**	**0.337**	**1.400**	**-0.638**	**0.529**
Percent of High School Graduates in the Area	0.002	1.002	0.003	1.003	**0.006**	**1.006**	0.000	1.000	**-0.014**	**0.986**
Borrower income	-0.023	0.977	**0.352**	**1.422**	-0.043	0.958	**-0.156**	**0.856**	-0.048	0.953
Total LTV	0.001	1.001	0.007	1.007	0.003	1.003	**-0.019**	**0.981**	**0.059**	**1.061**
If the house is investor property	**-0.877**	**0.416**	-0.281	0.755	**-1.465**	**0.231**	**-0.807**	**0.446**	0.577	1.781
If the loan itself is a refi	0.030	1.031	0.131	1.139	-0.129	0.879	**0.311**	**1.364**	0.042	1.043
Reduced Documentation?	0.044	1.045	**0.536**	**1.710**	-0.071	0.932	-0.238	0.788	**0.629**	**1.876**
State Unemployment Rate Change	**-1.193**	**0.303**	-0.821	0.440	**-1.510**	**0.221**	-1.053	0.349	0.615	1.850

Table 2.5 Points Choice and Termination Risks - Continued

	All		Move		Refi		Cash-Out Refi		Default	
	Estimate	**Percent Change in Hazard Rate**	**Estimate**	**Percent Change in Hazard Rate**	**Estimate**	**Percent Change in Hazard Rate**	**Estimate**	**Percent Change in Hazard Rate**	**Estimate**	**Percent Change in Hazard Rate**
How profitable it is to refi in the current month	**0.013**	**1.013**	-0.014	0.986	**0.049**	**1.050**	**0.035**	**1.036**	**-0.055**	**0.946**
Cumulative price growth since loan origination	**0.109**	**1.115**	-0.199	0.820	**-0.140**	**0.870**	**0.802**	**2.231**	**-0.694**	**0.500**
Yield Curve	**0.065**	**1.067**	0.073	1.076	**0.143**	**1.153**	**0.154**	**1.166**	**-0.576**	**0.562**
Number of months since first profitable refinance opportunity is missed	**0.003**	**1.003**	**0.008**	**1.008**	**-0.005**	**0.995**	**-0.007**	**0.993**	**0.025**	**1.025**
15-year mortgage	0.087	1.091	-0.250	0.779	**0.519**	**1.680**	**0.676**	**1.965**	**-1.589**	**0.204**
20-year mortgage	**0.610**	**1.840**	0.483	1.620	**0.714**	**2.043**	**1.149**	**3.155**	-1.283	0.277
Balloon mortgage	**0.622**	**1.863**	0.613	1.846	**1.195**	**3.304**	**1.122**	**3.072**	-1.595	0.203
If state does not allow going after personal possessions	0.133	1.143	0.570	1.769	0.086	1.090	**0.371**	**1.449**	**0.697**	**2.007**

Note: Highlighted coefficients significant at 10% level. Coefficients for high refi-cost states and loan amount are suppressed for confidentiality reasons.

Table 2.6 Rate Reduction and Months till Refinance

	Refi into same product		All refi		All refi and cash-out refi	
	With Points	Without Points	With Points	Without Points	With Points	Without Points
Average rate reduction	1.53*	1.31*	1.50	1.47	1.49	1.47
Average months from origination to refinance	18.4**	15.6**	18.7	17.7	18.4	18.8

* The difference between means for mortgages with points and without points is significant at 5% level.
** The difference between means for mortgages with points and without points is significant at 10% level.

Table 2.7 Percentage of Borrowers Who Refinanced Outside Theoretical Range

	Refi into same product		All refi		All refi and cash-out refi	
	With Points	Without Points	With Points	Without Points	With Points	Without Points
Percent refinanced "too early"	33	46	37	45	39	45
Percent refinanced "too late"	20	17	26	24	26	24

Table 2.8 Rate Discount on the New Loan and Whether the Previous Loan Has Points

Dependent Variable: rate reduction achieved compared to MIRS average effective rates

Variable	**All Refinance**	**Refi into same product**
Intercept	**-1.256**	**-2.009**
Borrower FICO score	**0.0012**	**0.0012**
Borrower income	**0.075**	**0.141**
Debt expense ratio	0.239	0.213
LTV	**-0.284**	**-0.330**
If the original loan had points	0.049	0.072

*Highlighted coefficients significant at 10% level.

Figure 2.1 Cumulative Prepayment Rate – All Terminations

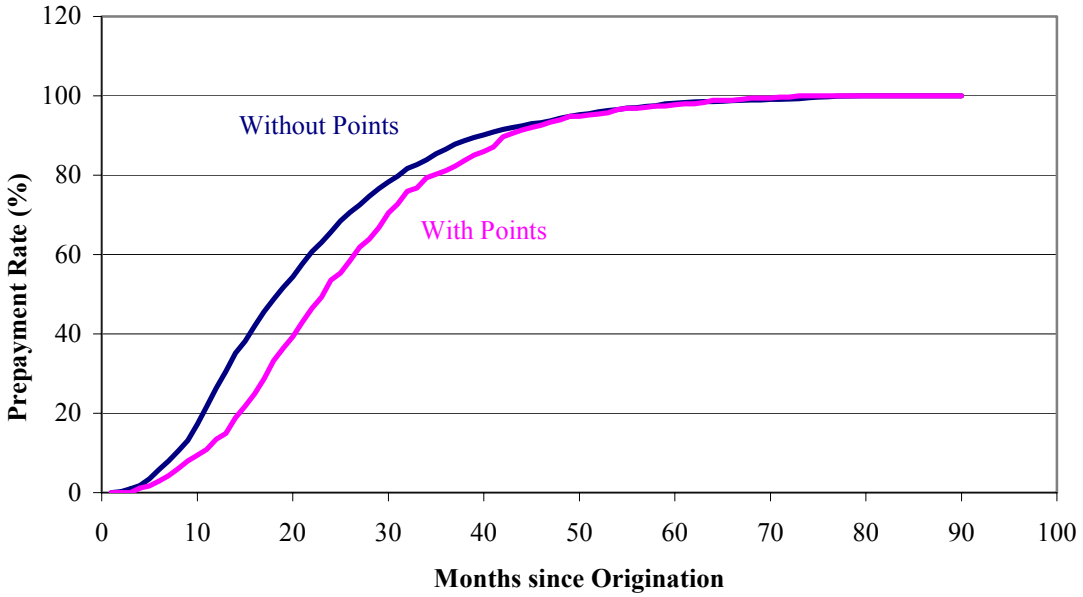


Figure 2.2 Cumulative Prepayment Rate – Refinance and Cash-Out

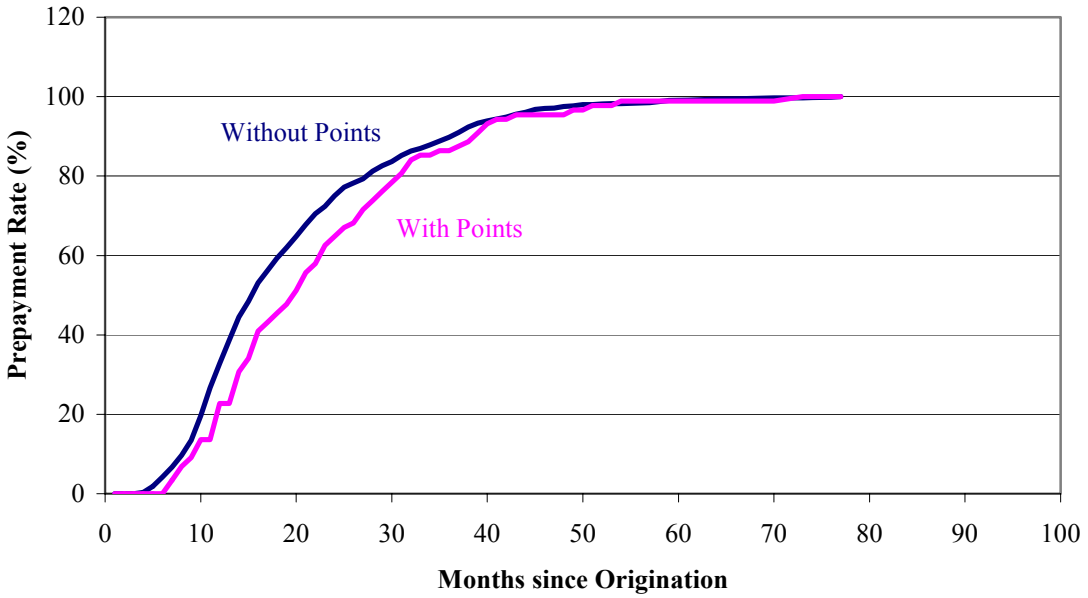


Figure 2.3 Cumulative Prepayment Rate – Move and Default

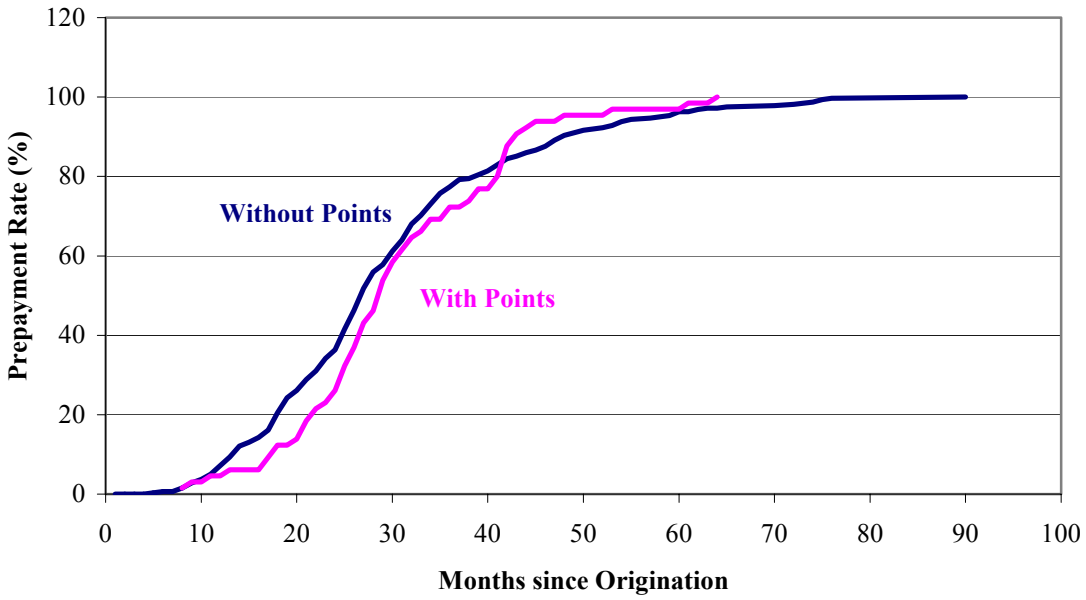
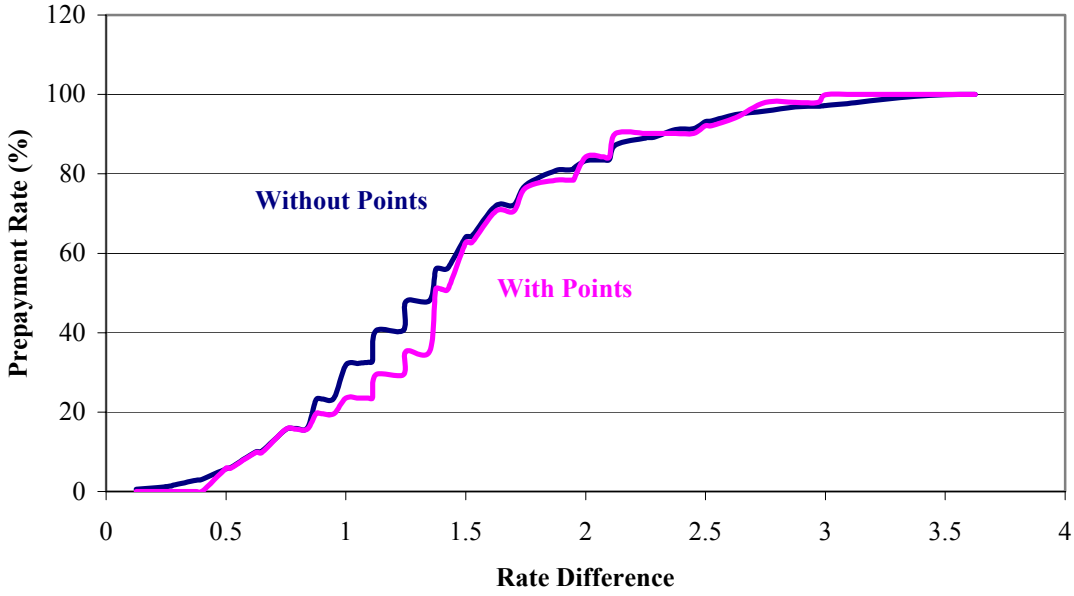


Figure 2.4 Prepayment Rate by Rate Reduction – Refinance and Cash-Out



Chapter 3

The Product Switch in Refis: Who, When and Why

3.1 Introduction

The difference between the features of adjustable-rate mortgages (ARMs) and fixed-rate mortgages (FRMs) has been well studied. Compared to fixed-rate mortgages, ARMs usually offer lower starting rates and allow borrowers to qualify for larger mortgages according to the lender's payment-to-income standard or incur smaller near-term payment burden for the same mortgage amount. It also gives the borrower the free option of downward rate adjustment, subject to certain clauses on the contract, if the index the ARM coupon rate is based on goes down, whereas it is costly for the FRM borrowers to achieve the same purpose through refinance. The downside is that the borrower is exposed to interest rate risk when rates increase, though the upward coupon rate adjustment is periodic and subject to contract restrictions. The payment shock caused by the expiration of the initial 'teaser rate' period and the underlying rate increase could catch some borrowers unprepared and subject them to default risk.

Based on these differences, it is possible that there is a clientele effect on the variety of mortgage products being offered and a number of studies have been presented to explain borrowers' rationales behind the mortgage product choice. Theories that justify the preference for ARMs over FRMs include: ARMs serve as protection against future uncertainties in inflation, income and wealth (Baesel and Biger 1980, Statman 1982,

Smith 1987, Alm and Follain 1987); ARMs can be used to achieve optimal risk sharing between lenders and borrowers (Arvan and Brueckner 1996, Edelstein and Urosevic 2003, Dokko and Edelstein 1991); ARMs can yield desired cash flow for borrowers who value current income/consumption more (Brueckner 1986, 1993); ARMs attract more mobile borrowers (Brueckner 1992 and Rosenthal and Zorn 1993); ARMs can separate borrowers with higher default risk (Posey and Yavas 2001).

In the context of total household portfolio risk and return, Alm and Follain [1987] show that an increase in the covariance between the mortgage rates and other variables relevant to the value of the portfolio, including house prices, return on risky assets, income growth, and inflation rate, increases the likelihood that the borrower will choose ARMs because they all offer some level of insurance against the interest rate risk with the ARMs, be it in the form of housing capital gain, or wealth gain through risky asset, or increase in income.

From the optimal contract design point of view, Arvan and Brueckner [1996] propose that the lender and the borrower should share the interest rate risk according to their relative absolute risk-aversion measures, and features of ARMs help achieve desired risk-sharing. Edelstein and Urosevic [2003] find that the expected term of the mortgage is a deciding factor on the optimal type of contract, with long-term borrowers choosing fixed-rate contracts, and short-term borrowers variable contracts.

Brueckner [1986] shows that borrower valuation of future consumption increases the likelihood that the FRM is chosen. An increase in the difference between future and current income makes ARMs more appealing. When there is an increase in the level of income, while the income differential remains unchanged between current and future

periods, and the housing choice is flexible, higher-income households will choose larger housing and mortgages that bear lower interest rate risk. Brueckner [1993] focuses on the borrower's decision in achieving a favorable time path of mortgage payments. If interest rates are expected to increase, ARMs are preferred by borrowers with high discount rates about future income and expecting an increasing income stream. The low payments in the initial years and the expected gradually increasing payment stream under an ARM matches the borrower's income stream better than under an FRM.

Where the expected speed of prepayment of the mortgage is concerned, more mobile borrowers are theorized to favor ARMs because the benefits of the low initial rates of ARMs outweigh the risks of future rate fluctuations if they intend to move and prepay the mortgage in the near future. Brueckner[1992] and Rosenthal and Zorn [1993] explore this fact and show that by attracting mobile borrowers from FRM pool, the introduction of ARMs to where they were previously unavailable leads to higher FRM interest rates.

Linking ARM-FRM choice to different levels of borrower default risk, represented by the possibility of receiving a negative income shock in the future, Posey and Yavas [2001] show that depending on the probability and the disutility of default, it is possible to have a unique pooling equilibrium where either ARM or FRM is the instrument of choice. It is also possible to have a separating equilibrium in which the high-risk borrowers choose ARMs, and low-risk borrowers choose FRMs.

Empirical tests in the ARM-FRM choice include utilizing probit or logit models that estimate the connection between borrowers' ARM-FRM choices and characteristics of borrowers and economic and mortgage market (Dhillon et al. 1987, Brueckner and

Follain 1988, Phillips and VanderHoff 1991, Tucker 1989, Sa-Aadu and Sirmans 1995); aggregate ARM demand and macroeconomic time series factors from the mortgage, housing, capital and labor markets (Buist and Yang 2000, Berkovec et al. 2001); and survey responses that link consumer preferences for ARM features and their professions (Gardner et al. 1987). Generally the important factors identified that affect the product choice are the interest rate level, the pricing difference between market ARMs and FRMs, expected rate movements, affordability of housing, borrower mobility, borrower income and the expected pattern of the borrower's income stream.

Fairly few studies have been done on other products such as the difference between balloons and fixed-rate mortgages of different maturity terms. The 30-year FRM offers stability, flexibility and relatively low payment obligations, while the 15-year FRM provides accelerated principal reduction and housing equity accumulation. The effect of mortgage term choice on the probability of default is less clear: with 15-year FRMs, the shorter amortization period typically entails larger periodic payment burden and financial strain, but the longer maturity associated with the 30-year FRM slows the reduction in mark-to-market LTV for a fully-amortizing loan and creates a long horizon of holding period that increases the chances of incidences that might negatively affect borrower's ability to make payments. Empirical studies that specifically test the 15-year versus 30-year FRM selection include Dhillon et al. [1990], Phillips et al. [1992], and Berkovec and Nothaft [1997]. The relative cost of the two instruments is shown to be influential on borrower choices.

The prepayment risk of fixed-rate mortgages has been well studied and mostly explained as financially motivated. Comparatively there has not been much research done

on the prepayments of ARMs as the financial incentives are less obvious, since ARM borrowers benefit from downward rates adjustments without incurring refinancing costs in a falling interest rates environment. A few link the prepayment risk with initial year discounts (Green and Shilling 1997, Ambrose and LaCour-Little 2001), the convertible option feature of ARMs (Sanyal 1994), and the period around rate resets as well as the accompanying magnitude of the payment shock as a result of the rate reset (Ambrose et al. 2005). Some studies compare the termination patterns between ARM and FRM (VanderHoff 1996, Calhoun and Deng 2002). But no study has considered the switching of product types as a potential refinance incentive[11], or taken the further step to examine the subsequent product choice in a refinance and the motivations behind product switching.

This paper attempts to explore the incentives in refinancing other than immediate financial gains by applying theories from the product selection literature that link borrower characteristics to their product choice. Existing empirical studies on ARM-FRM selection mostly use localized data from the eighties and the results are not consistent with one another. With a more updated sample that includes refinances between 1997 and 2003, this study follows the changes in borrower characteristics between the originations of their first and subsequent mortgages, and examines both static product choice and dynamic product switching. Further distinction is made between balloon mortgages, 15-year FRMs and 30-year FRMs. Categorical values are used for independent variables instead of continuous values. Both approaches allow flexibility in

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[11] Yang and Maris [1993] consider the impact of having the option to refinance into either an ARM or FRM on the current FRM contract. But the incentive in their model is financially driven and ARMs are

model specifications and help reconcile the conflicting results of some earlier studies. Examining the product switch not only offers another angle at the product selection debate, but also provides evidence in terms of borrower responsiveness to changes in their socioeconomic characteristics and the rationality of their product choice related to short-term and long-term priorities.

3.2 Data and Methodology

3.2.1 Data

This paper uses loans purchased by Freddie Mac that were originated between 1997 and 2003, and were subsequently prepaid due to borrower refinancing in the same time period. Information on loan type and borrower characteristics was collected on both the original and the refinance loans. Individual loans were matched into pairs based on property address and borrower social security number first, and then the sample is restricted to the ones where the payoff date on the first mortgage falls within a year's difference from the origination date on the second mortgage. The sample contains a total of 262,149 pairs of loans that divide into 5 categories: ARMs (including 3/1 and 5/1 hybrid ARMs), balloons (5-year and 7-year maturities), 15-year FRMs, 20-year FRMs and 30-year FRMs. The distribution of the original loans and the subsequent refinance

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found to be strictly preferable than FRMs except for borrowers whose expected holding period of the loan exceeds 30 years, the supposed life of the mortgage.

loans by loan product, geographical location and origination year can be found in Table 3.1.

A comparison between the product types of the pair of loans shows that 90,443, or 34.5% of the borrowers switched loan product categories in their refinance. The distributions of the mortgage choices in these switches by the loan type of the previous mortgage are listed in Table 3.1.

3.2.2 Cross-Sectional Preference, Short-Term and Long-Term Switching

While the product choice exhibited by the cross-sectional panel data shows the general preference of a particular group of borrowers, within the same group, there may be two types of product switching activities driven by different incentives. One is triggered by current necessity, such as a drop in income and thus affordability becomes an issue, and the borrower is pressed to find a product that suits the short-term needs. The second type is that after holding the loan for a while, the borrower may decide that though the current loan solved the immediate crisis, it is not a good fit for the longer term and a product switch is necessary. Refinancing thus is a chance to correct to the 'right' product that suits their long-term utility maximization problem. Factors that are considered near-term in nature might include change in mobility where a move is expected and the ability to make payments. Factors that are of longer-term concern include achieving desired consumption stream and building up and the protection of home equity.

This paper tests three types of relationships: 1) the link between the selection of products, regardless of whether it is the result of a switch or not, and cross-sectional borrower characteristics; 2) the link between product switching and the change in borrower characteristics, which measures the probability of product switching as a result of characteristics change, or the short-term trend; 3) the link between product switching and borrower characteristics, which is non-event-related, and reflects switching for better product fit, or the long-term trend in switching.

The cross-sectional selection of products shows how favorable or unfavorable a product is among borrowers of certain characteristics group. And this product preference is taken as the 'rational' outcome and served as a benchmark to compare to the other two kinds of switches. Assuming the current preference exhibited by the borrowers of certain characteristics are the true outcome of a clientele effect, then the shift between products should be either insignificant or have the same order of preferences on the aggregate level as those at the steady state.

If there is no conflict between the borrowers' short-term and long-term goals, then their short-term choice is the rational outcome exhibited by the cross-sectional sample and there will be no significant long-term drift towards another product other than their short-term choice. If the borrowers address their immediate concerns that are different from the long-term goals just as their profile changes then their first-response switch is different from the long-term rational outcome and a discovery process takes place, so there would be significant product transition as they move from one product to another even though their profile remains unchanged. And the outcome of this transition will conform to the rational outcome. A third possibility is that some characteristics changes

are not significant enough to automatically trigger a product switch, or that the progress among characteristics categories is hard to pinpoint in our statistical study, the effect of characteristics change may not be significant on product changes, but the long term drifting trend should be toward the long-term outcome.

3.2.3 Methodology

To account for borrowers' mutually exclusive discrete choice of products, the multinomial logit model is deemed the appropriate methodology for this study. Each independent variable is stratified into groups if multiple values are involved, such as age, instead of using one continuous variable, to allow flexibility in the variable's effects in case that the relationship is non-linear.

The general form of the multinomial logit is

$$\log\left(\frac{\pi^{j}_{1,2,\ldots,n}}{\pi^{r}_{1,2,\ldots,n}}\right) = \alpha_j + x'_{1,2,..,n}\,\beta_j \quad \text{for j=1,2,…,(r-1),}$$

where j is the response level that has r possible outcomes, $\pi^{j}_{1,2,\ldots,n}$ is the probability of achieving the response level j given the population with the specific values of the n explanatory variables of the sample, and the logit is defined as the probability of each response category over the last response category. α_j is the intercept variable, β_j is the vector of regression parameters of the explanatory variables, and the matrix $x_{1,..,n}$ is the set of explanatory variables for the population given.

In the cross-sectional preference model, the product types of the refinance mortgages, regardless of whether a particular one was a switch from the original mortgage, are used as the possible response levels for the dependent variable, where r=5, with j=1 corresponding to borrower choosing ARM, j=2 for choosing Balloon, etc. The variables that describe the characteristics of the borrowers, market conditions, and financial incentives are used as independent variables. Here π^j =probability of choosing a product, and $x_{1,\ldots,n}$ ={borrower age, income, marital status…}. I use the choice of 30-year FRM as the last choice category, so the dependent variable measures the relative preferences for other products over the 30-year FRM. This reports the cross-sectional preference of borrowers and is the generalized application of the dichotomous response logit model where only two outcomes are allowed, as employed by previous works such as Dhillon et al. [1987]. The regression parameters estimate the differential effect of each variable contributing to the comparative preference.

For short-term switching, the possible responses that form the dependent variable is the choice made by borrowers, given their current mortgage type, whether to switch to one of the four other types of mortgages or refinance into the same product. There are five possible response levels for each types of mortgage previously held. If the first mortgage is an ARM, j=1 represents switching to balloons from ARMs; j=2 represents switching to 15-year FRM, etc. The last response level is the case where borrowers choose to stay within their current mortgage type, i.e., in this case, the borrower replaces their current ARM with another ARM product. The independent variables of interest are the transition variables, those that measure the changes in borrower characteristics between when the first mortgage was taken out and the time of the refinance. Here

π^j =probability of switching to a product, and $x_{1,\ldots,n}$ ={ Δ income, Δ marital status…}. The parameters measure the impact of the various life cycle and socioeconomic changes on the probability of choosing another type of mortgage over the current type, and the results reflect the choice of switching in relationship with short-term events rather than long-term status, e.g. 'getting married' versus 'being married'. This exercise is repeated for each product type of the first mortgage. Then at the aggregate level, all those that switched products instead of staying with the original types are pooled, and the effects of the explanatory variables on the probability of switching to any product over switching to the 30-year FRM are estimated. Since the probability of switching to a product is dependent on the distribution of the previous product the borrowers switched from, the sample is re-weighted so that the total number of observations is unchanged but switching from each type of original product receives the same weight.

In estimating the probability of switching products given that the borrower bears certain characteristics, or the long-term switching trend, the response levels are the same as the second type of test, which reflects the choice made by borrowers, given their current mortgage type, whether to switch to one of the four other types of mortgages or refinance into the same product. The difference is that instead of changes in borrower characteristics, the explanatory variables are simply borrower characteristics, the same as the first test. Here π^j =probability of switching to a product, and $x_{1,\ldots,n}$ ={borrower age, income, marital status…}. The parameters thus obtained show the probability of switching into certain types of mortgage because the borrower belongs to certain categories, e.g. 'being married' rather than 'getting married' and therefore is a reflection of the long-term trend by the cohort of borrowers that have the same characteristics.

3.3 Results

For the total sample, the cross-sectional preference model is estimated on the loans that were refinanced into. The parameters are presented in Appendix I. Then separate attention is given to each original type of mortgage and the probability of switching into a different product than the current one is estimated for each of the starting mortgage type. This switching probability is correlated with both the changes and the features of borrower characteristics. Appendices II through V list these results by individual product type. All those that have switched instead of staying within the original type are pooled and the probability of switching to any product relative to switching to the 30-year FRM is estimated over the changes and levels of borrower characteristics. This aggregated result can be found in Table 3.7.

Although the 20-year FRM is included in every test to make the selection complete, the pattern of borrower choices in this type of mortgage is a blend of the 15-year and 30-year FRMs. Mostly the patterns of preference of the 20-year FRM among borrower types are very close to those of the 15-year FRM with occasional exception of being similar to the 30-year FRM. The results are therefore not discussed in the following section for succinct reasons.

3.3.1 Age and Product Choice

In theory, younger borrowers are linked with higher mobility and higher future income potential and therefore should favor ARM more heavily. In the middle age stage they become settled and their full income potential realized and long-term fixed-rate

mortgages should be favored. As age gradually progresses and retirement comes closer, mobility becomes an issue again and ARMs and short-term mortgages such as balloons become products of choice again. Brueckner and Follain [1988] and Dhillon et al. [1987] did not find age to be a significant factor in determining ARM choice, possibly because of the reversal of preference when borrower's retirement approaches, but Sa-Aadu and Sirmans [1995] did find a negative relationship between borrower age and ARM preference.

Phillips et al. [1992] postulate an increasing relationship between the likelihood of choosing 15-year FRMs and borrower age, as relatively younger borrowers may be more financially constrained for the need of raising a family. The same argument may be applied to borrowers at retirement age that face more limited financial resources. Both Dhillon et al. [1990] and Phillips et al. [1992] find a positive relationship between age and choosing 15-year FRMs over 30-year FRMs.

I separate the borrowers into six categories according to the age of the primary borrower at the time the refinancing was done: those between the ages 18 and 28, between 28 and 38, between 38 and 48, between 48 and 55, between 55 and 65, and lastly those that are 65 or above.

Results from the cross-sectional product choice model (see Figure 3.1.1) show that borrower preferences conform to the prior hypothesis. The ARM and balloon products are much favored over the 30-year FRMs, which is also preferred over the 15-year FRM in the youngest group. But the appeal of the ARMs dissipates quickly moving on to the second youngest group, aged 28 to 38. Here the 15-year FRM is still clearly the least favorite, but the ARM and balloon products do not have a distinctive margin over

the 30-year FRM any more. The favor of 30-year FRMs over ARMs and balloons reaches its height among the 38 to 48 aged group, where 15-year FRMs emerge as even more favorable than the 30-year FRM. The popularity of the 15-year FRM is most evident among those aged 48-55 and ARMs and balloons increased in popularity relative to 30-year FRMs again. In the group aged 55-65, all ARMs, balloons, and 15-year FRMs are favored over 30-year FRMs by small margins. The overall switching pattern is very similar to that of the product choice (see Figure 3.1.2), with ARMs and balloons most likely switched into by younger borrowers and those aged 55-65, while 15-year and 30-year FRMs are most switched into by middle-aged borrowers.

The switching pattern for each product type previously held agrees with the overall result as well, as shown in Figure 3.1.3-6. When borrowers start with an ARM mortgage, their preference for fixed-rate mortgages and balloons over ARMs increases from negative to positive as the age categories go up, though in the first three categories, aged 18 through 48, the dislike was insignificant for balloons. The aversion for 15-year and 30-year products is strongest in the youngest age group, as the hypothesis suggests, and then the negative preference turns positive. For 30-year products, the preference peaks with the age 38-48 group and for 15-year products, the preference peaks at the 48-55 group, while the preference for balloons reaches highest in the 55-65 group.

The results for those who previously had balloons exhibit very similar patterns to those with an ARM as the first mortgage. Balloon holders are indifferent between products in the youngest group and show increasing preference for 30-year fixed rate mortgages, most preferred by the 38-48 age group. Switching to 15-year FRMs peaks

with those aged 48-55. With the 55-65 group, the preference turns to strong dislikes for 15-year and 30-year FRMs but a strong switching tendency to ARMs.

The switching patterns of those who traded in a 15-year mortgage into an ARM or balloon and those who swapped a 30-year mortgage into an ARM or balloon are similar as well, and both support the evidence from the ARM and balloon first-mortgage group. Younger borrowers are most likely to switch from the FRM to ARMs or balloons. The effect weakens, though still significant from the 18-28 group to the 28-38 group, and reverses for groups 38-48 and 48-55, where borrowers show strong aversion for ARM and balloon products. Then the preference turns again with the 55-65 age group and ARMs and balloons are favored over their existing FRMs again.

Overall, evidence shows that the younger borrowers, especially those between 18 and 28, prefer adjustable rate or balloon mortgages. As they shift into the height of their earning potential and family forming age, between 38 and 55, they look to longer term fixed rate mortgages as they offer protection a household needs and a steady payment stream matches their income stream, both near term and in the long run. When retirement looms near and possible moving is closing in, again they switch to short term alternatives such as ARMs and balloons, which offer both savings in payments with relatively lower rates and a shorter horizon that matches their expected tenure.

3.3.2 Income, Income Change and Product Choice

The theoretical models on the relationship between income level and ARM likelihood yield conflicting predictions. Posey and Yavas [2001]'s model shows that an

increase in borrower income makes ARM more attractive. Brueckner [1986] finds that high-income borrowers are less likely to choose ARM when the housing choice is not fixed, and indifferent when the housing choice is fixed, and Alm and Follain [1987] predict that an increase in the level of household income makes the ARM choice less likely, though the effect is miniscule. In empirical studies, Sa-Aadu and Sirmans [1995] find that income level is not a significant factor in determining ARM likelihood. Brueckner and Follain [1988]'s results show high-income borrowers are more likely to choose an ARM than low-income borrowers. Nothaft and Perry [2002] also find lower ARM share among lower income neighborhoods. It is suggested that higher income allow the borrower to weather interest rate fluctuations better while taking advantage of the relatively low interest rates. Higher income borrowers also may have larger share of investment income in their portfolio, which according to Statman [1982], should favor ARM borrowing.

Between 15-year and 30-year FRMs, in most cases 15-year loans require a higher monthly payment stream than the 30-year option. Households with higher levels of current income and wealth are expected to be more willing to assume the higher payment burdens for lower rates and faster debt retirement at the relatively lower expense of default probability. Dhillon et al. [1990] find a positive impact of income on choosing 15-year FRM over 30-year FRM. But Phillips et al. [1992] find it insignificant.

I compare the borrower's family income in the year the refinancing loan was made to the area median family income matched at county level in the same year and divide the sample into 5 categories: those with income equal to or below 80% of area median income, those with income between 80% and 100% area median income, those

with 1 to 1.2 times area median income, those with income 20% to 50% above area median income and those with income higher than 1.5 times area median income.

The product choice model shows that the ARM-FRM preference is not linear along income level, shown in Figure 3.2.1, which suggests that multiple theories are at work and reconciles the differences between previous theoretical works. There is a distinctive divergence between 15-year and 30-year products, 15-year being the product of choice among the high income borrowers with its relative popularity growing with income, whereas 30-year FRMs are least favorable in the highest income group with decreasing popularity as income advances. At the opposite end of the income tiers, 30-year FRM is the strong favorite. High-income borrowers have low default risk with a 15-year FRM, which offers the benefit of lower rates than a 30-year FRM and reduced total payments over the life of the loan, compared to the 30-year FRM. Low income borrowers prefer 30-year FRM because of the low interest rate risk and the affordability of relatively low payments per period compared to FRMs of shorter amortization terms.

Relating product switching to the income categories, the preference is almost identical to what the cross-sectional examination shows, as seen in Figure 3.2.3. In the long run, among borrowers of the lowest income ranks, the shift is uniformly toward the 30-year FRM. The tastes for ARMs, balloons and 15-year FRMs all grow as the income category goes up and in the top income tier the 30-year mortgage is favored over by all other types of products and the 15-year fixed mortgage has the highest likelihood of being switched to. This is also supported by each sub-category where the previous mortgages are of different types.

When switching from ARMs, those in the lowest income category show strong preference for 30-year fixed rates, but that liking deteriorates as income categories go up and the highest income category shows strong dislike for 30-year fixed rates compared to ARMs. Progressing up the income categories, they also have decreasing preference for balloons and 15-year fixed rates, though in the top income category 15-year FRMs are significantly preferred over staying with ARMs. ARMs are mostly preferred in the 1.2 to 1.5 area median income category, especially compared to balloons.

Those switching from balloons also show similar inclination as those from ARMs. They have increasing preference for ARMs as income goes up, which peaks in the 1.2 to 1.5 area median income category. The top income borrowers strongly prefer 15-year fixed rates and strongly avoid 30-year fixed rates.

The preference for 30-year FRM among the lowest income borrowers and the opposite position taken by the highest income borrowers is also evident through the 15-year FRM switching and 30-year FRM switching results. 15-year FRM borrowers show a decreasing preference for 30-year products as income category goes up. Those with 30-year FRMs in the lowest income category show negative response to every alternative product while those in the highest income category prefers every other product than their own. Those in the second lowest income category, 0.8 to 1 times area median income, also strongly avert 15-year FRMs, while in the second highest income category, 1.2 to 1.5 times area median income, also strongly prefer 15-year FRM.

Yet looking at the effect of income change on product switch reveals a much different picture (Figure 3.2.2). I specify the categories of the income change variable as those who are in one income category at the time of refinance but wasn't in the same

category in the previous loan application. A second way to stratify income change is by the actual dollar amount change in annual income, according to which 5 categories are formed: those who experienced an income drop of more than $10,000, those who had an income decrease, but the amount is equal to or less than $10,000, those who had an income increase but less than $10,000, those whose income increase was between $10,000 and $50,000, and those who saw their income increase by more than $50,000. The results from both specifications are similar.

As income drops by the largest amount affordability becomes urgent and borrowers falling to the bottom income category are mostly switching to ARMs and balloons. But those that experience the largest increase in income or rise to the top income tier are still playing it safe by switching to 30-year FRMs and 15-year FRMs with higher likelihood. As Figure 3.2 shows, this is a strong reversal of pattern from the steady state and the long-term trend where the top and bottom income categories are concerned. The results suggest that a negative income shock sends the borrower seeking to take care of the most immediate need of making payments and therefore resorting to ARMs or balloons, but for the most borrowers in the low income category they get to realize which product matches their goals for the longer term security and utility maximization and the refinancing toward that product is observed.

3.3.3 Job Seniority and Product Choice

Alm and Follain [1987] and Brueckner [1986] predict that borrowers who expect their income to rise more rapidly are more inclined to take out ARMs. Higher future

income reduces the default risk associated with future rate fluctuations. Also, if interest rates are expected to rise, the matching of income and interest expenses will result in a smoother consumption stream, which is desirable for the borrower. Those at the starting stage of their job expect higher or more rapid income growth than those more entrenched at their positions. Therefore in general those new at the job should favor ARMs more.

Gardner et al. [1987] apply a logit regression on their survey of 488 residents of Illinois and Wisconsin in 1984. They find significant results relating the respondents' attitude toward the preference of ARMs with various caps and adjustment periods over FRMs to their occupation variables, proxies for income and expected patterns of income stream. They find that professions typically associated with low income growth potential, such as the teaching occupation, tend to favor FRMs. Those with high expected income growth and relative stability such as in the professional/managerial category are more likely to pick ARMs. FRMs are preferred by those with higher expected income variability as those in the sales category.

The 5 categories I created for job seniority is whether the person is at the current job less than 2 years, between 2 and 5 years, between 5 and 10 years, between 10 and 20 years, or above 20 years. When there are two borrowers present I use the one with the longer job history as the representative years on job. In creating the change of job seniority variables, borrowers are assigned to one of five categories if their current years-on-job is categorically different from that at the time of their previous loan application. This may include both the cases of switching jobs, where the new years on job may be longer or shorter than their previous one, and staying in one job from the application of

the previous mortgage to the refinance application, where the borrower cross categories because of the growing cumulative years on job.

In the cross-sectional study, the strongest preferences among the most junior employment group are ARMs and balloons (Figure 3.3.1). The same is true for those employed between 2 and 5 years, only the preference is slightly weaker than the youngest group. Between 5 and 10 years, the preference for ARMs and balloons turns negative and the 15-year mortgages, regarded as undesirable by the more junior groups, start to look favorable. The trend continues for those employed between 10 and 20 years and 20 years and above. The strongest dislike for ARMs and balloons are among those employed 10 to 20 years.

In the relationship between switching products and employment history change, those that switched from a job with longer employment history to a relatively new job and have been on the new job for less than two years are switching away from ARMs, balloons and 15-year FRMs, favoring 30-year FRMs, which is the opposite from the cross-sectional results where ARMs and balloons are concerned. The results are charted in Figure 3.3.2. Of much significance are those who held 30-year FRMs as their original mortgages. They strongly avoid ARMs and balloons in favor of keeping their long-term fixed rate mortgages. At the same time, the former ARM holders also select 30-year FRM as their choice product to switch into when they experience such employment change, signaling that their first response is that to job uncertainty, and choosing a product that carries the least endogenous risk is their priority.

In contrast, the long run switching choices for each job seniority group have the same pattern as the cross-sectional preferences exhibited by that group (Figure 3.3.3).

ARMs and balloons are where the new ones on the job switch to, and the seasoned ones switch from. Therefore, the evidence suggests that there is a discovery process for borrowers that experience employment changes. They move to a safer product in the beginning, and then the long-term goal of matching expected income stream with payments dominates the decision and they find themselves transferring out once again from those safe products into ARMs and balloons.

3.3.4 Marital Status and Product Choice

Dhillon et al. [1987] hypothesize that married couples should be more in favor of fixed-rate mortgages than single borrowers, due to the increased financial responsibilities and higher vulnerability to payment problems. In the case of double-income borrowers, if both incomes are needed for mortgage qualification and making payments, then they are also more likely to subject to income shocks, and the greater the uncertainty about earnings, the greater the probability that borrowers will choose fixed-rate mortgages. Besides, single borrower may have higher mobility, which makes ARMs more desirable to them. But in their study, married borrowers and those with co-borrowers are found to prefer ARM.

Here in the cross-sectional preference study, single male and single female prefer ARMs and balloons to long-term mortgages. Single male also shows more interest in 15-year FRM than 30-year FRM. Married couples prefer long-term fixed-rate mortgages than ARMs and balloons, as Figure 3.4.1 shows.

In the event of a marital status change for the householder, the observed product shift is the opposite from the eventual preference showed (Figure 3.4.2). Those that lost their marriage since their first loan was taken out are observed to switch into 30-year fixed rates with the highest likelihood. Those that got married since their first mortgages are switching into short-term products such as ARMs and mid-term FRMs such as 15-year FRMs. The immediate concern for the newly divorced or widowed is the stability of their finances and the 30-year fixed rate offers them the most protection against income fluctuations and other uncertainties they might have to deal with. For the newly weds, the consideration is another type of uncertainty. Moving might enter the picture and their expected duration at the residence is shortened. Joined finances might encourage them to take on additional risk in exchange of lower interest rates, and joint assets make them more inclined toward 15-year FRMs than 30-year FRMs (Phillips et al. 1992).

But within the singles group, there is a distinctive trend of switching from long-term fixed mortgages to ARMs and balloons, while the married group shows a shift from ARMs and balloons to longer-term fixed mortgages (Figure 3.4.3). This reversal in trend is showing up in every subgroup by their initial product types, especially those that held 30-year mortgages in the first place, which indicates that after the initial uncertainties are resolved in a change of marital status, borrowers pick mortgage types that suit their longer term outlooks and goals.

3.3.5 Employment Status and Product Choice

The prior assumption on the mortgage choice between a self-employed person and someone that works for others is unclear. The effect of this variable depends on the position of the borrower at the life cycle of the self-employment. At the company's startup, or when the borrowers newly switched to self-employment, they tend to be in need of capital and expect a highly tilted future income stream, which makes ARM a likely choice. The fact that they take up self-employment in the first place may indicate that they have lower risk aversions than those who work for others, and as Alm and Follain [1987] posit, such an individual will have more tolerance for uncertain future mortgage payments, and therefore become an ARM borrower. Dhillon et al. [1987] also point out that self-employed borrowers may find borrowing on their personal accounts cheaper than using other debts on the company's account and choose an ARM as their financing instrument to qualify for larger loan amounts. But self-employment implies more uncertainties in future income, and therefore an FRM can be used to reduce the interest rate risk. Once the company has fully matured, the owner will have significant asset accumulation and income will stabilize, and ARMs may lose their appeal. This might be the reason why self-employment variable is not found to be significant in affecting product choices in the study by Dhillon et al. [1987].

Among those that are currently self-employed, ARMs, balloons and 15-year FRMs are preferred over 30-year FRMs (Figure 3.5.1), indicating the collective effects of lower risk aversion, higher expected income stream, and a preference for larger loan amounts. The correlation between mortgage product switch and job switch is insignificant, as shown in Figure 3.5.2. Those that changed from previously self-

employed to currently working for someone else show no significant switching pattern. Those that changed to self-employed from working for someone else are significant in avoiding 15-year fixed rates, as 15-year mortgages require higher payments and increase default risks in the case of an income shock. ARMs are weakly more likely switched into than others. The currently self-employed borrowers further switch to balloons and 15-year mortgages, signaling a change in preference as they advance in the life cycle of the company. The results are presented in Figure 3.5.3.

3.3.6 Loan-to-Value and Product Choice

The loan-to-value (LTV) ratio, defined as the balance of the mortgage at a given time over the concurrent market value of the house, changes through the life of the loan as the loan balance changes with periodic payments made and house price fluctuates. The borrower may choose to voluntarily decrease or increase their LTV by paying off part of their mortgage balance ahead of scheduled amortization or by cashing out their equity through refinancing or taking out second mortgages and home equity loans. There haven't been theoretical or empirical studies that link LTV levels to loan product choices. Very high LTV is often an indicator of elevated default risk. At this level, the homeowner may have incentives to use an ARM if he has very little equity in the house and the cost of default is low. But if the borrower does not wish to lose his residence, an ARM might not be a good choice since a high LTV usually indicates a high loan amount, which makes it more sensitive to interest rate fluctuations. The borrower should therefore choose fixed-rate mortgages for protection. At the very low end of LTV, the owner has a lot of equity in the house and he stands to lose significantly at defaults induced by interest

rate risks. So fixed-rate mortgages should be preferred at the low LTV level. The borrower may further choose to accelerate paying off the mortgage with shorter-term fixed-rate mortgages or balloons since the remaining amount is not prohibitively high and he will save in total payments.

I classify borrowers into four categories according to their LTV level: less than or equal to 50%, between 50% and 80%, between 80% and 90%, and above 90%. The highest LTV level in the sample is 98%. The variable that describes the change of LTV categories also takes one of four categories if the borrower's current LTV fall into one category while the LTV on the previous loan is different. If a borrower did not incur a change in LTV significant enough to cross categories that sample is left as null.

The cross-sectional selection model shows that ARMs are most preferred in the 80% to 90% LTV category since at this level the loan amount may be substantial and the savings significant with ARMs and balloons. In the top LTV category ARMs are about the same popularity as, or weakly less preferred than the 30-year FRM and both are preferred over balloons and 15-year FRMs, meaning that at this stage the desire of keeping the house from default starts to be significant. ARMs are least preferred in the lowest LTV category. The results are charted in Figure 3.6.1.

In the switching patterns, those who experience an increase in LTV that puts them in the top LTV category are more likely to switch to ARMs if they had a 30-year FRM before. If a borrower had an ARM as the previous mortgage and is now pushed to the top LTV category, he is significantly less likely to switch to other products, though in the long run switching to a 30-year FRM is also present. Overall, the response is a switch to ARMs or balloons at the increase of LTV, signaling that the extra debt burden calls for

the lowest near-term rates, and that takes priority over the equity-protection concern (Figure 3.6.2). But the long-term trend of those in the high LTV category is switching to the 30-year FRMs over other products including ARMs, indicating a balanced consideration of affordability and security (Figure 3.6.3). If the borrower's LTV drops to the lowest category, there is increased likelihood of switching to balloons and 15-year FRMs relative to ARMs and 30-year FRMs. And that trend continues in the long-term switching evidence, only now that ARMs are further switched away from. Borrowers that started with 15-year or 30-year mortgages favored ARMs when they experience a drop in LTV, but in the long run ARMs were abandoned in favor of 15-year FRMs and balloons.

In all, ARM-FRM selection conforms to the equity protection hypothesis and borrowers exert caution in choosing the right product in the highest LTV category. But in the short term affordability still is a possible influence behind mortgage choices.

3.3.7 Credit Score and Product Choice

Borrower credit score, or FICO (Fair Isaac Corporation) score, a number between 300 and 850 with higher numbers signaling good creditworthiness, is directly tied to the difficulty and costliness of current and future funding opportunities. Borrowers with low FICO scores may seek adjustable-rate mortgages to reduce the need for future costly refinances, yet for the benefits of credit-buildup, thus reducing future borrowing costs, a long-term fixed-rate mortgage may be a better instrument as it reduces the likelihood of delinquency due to payment shocks. Those with marginally low FICO scores may also desire longer term fixed-rate mortgages because the cost of default is too high for them if

an added blemish on their credit history pushes them to the sub-prime borrower category and borrowing costs increase substantially. Borrowers with high FICO scores usually have more freedom in choosing mortgages of their choices and a high credit score is an indicator that they manage their finances with care and knowledge, if not slightly more risk-averse than others.

The national median credit score is about 725 and typically a score below 620 lands the borrower into the sub-prime category. While a number below 600 is considered of poor credit, a number above 700 is considered good credit. I designate 4 categories to the borrowers' FICO scores, those of 620 and below, those between 620 and 660, between 660 and 720 and those above 720.

The cross-sectional mortgage choice results show a favor of 30-year FRMs among the lowest credit score group, a preference for ARMs and balloons in the middle range, and a partiality for 15-year FRMs in the highest credit score group (Figure 3.7.1). This result might not be complete reflections of borrower's choice as sometimes low-credit borrowers are restricted by their choice set of products.

The FICO category change-related product switching results are mostly insignificant (Figure 3.7.2). It might be the case that a change in credit rating does not automatically entail a need for refinance, as sometimes income change or marital status change might do. When borrowers drop to the low credit category, which might be a signal of recent financial distress, there is a significant inclination of taking out ARMs and balloons over 30-year FRMs, which might not be in their best interest in the long run, given the endogenous high interest rate risk in these products, but temporarily it helps

offset the rate hike they are likely to incur as their credit ratings dip and a reduced payment provides them more flexibility to deal with their current financial situation.

Conclusions derived from those that refinanced while their own characteristics haven't changed indicate that, among borrowers of the lowest credit categories, there is a significant uniform shift toward 30-year fixed rate mortgages as the borrowers weigh in the long-term factors (Figure 3.7.3). As the credit scores go up, ARMs, balloons and 15-year FRMs are all emerging as favorites, but among the highest credit score group borrowers do not favor ARMs over 30-year FRMs any more, especially those with a 30-year FRM in the first place are significantly turning away from ARMs, probably a result of their own increased risk aversion compared to borrowers of less credit ratings. The contrast of short-term and long-term preferences is also present in the group that had ARMs as the first mortgage. In the short term results, those with an ARM to begin with least prefer 30-year fixed-rate mortgages when they had a decrease in credit ratings, possibly because the rate jump would be the highest given the product difference and the additional spread they have to pay for increased riskiness, but in the long run in all the lowest rating ARM borrowers, 30-year fixed rate is their first preference to switch to.

3.3.8 Other factors

Other factors I control for in both the mortgage selection and the product switch models are financial incentives to refinance, time and geographical location of the origination of the refinance mortgage, and other borrower characteristics.

For financial incentives, I include the difference between effective average 30-year mortgage rates and effective average 1-year Treasury-indexed ARM rates from the Primary Mortgage Market Survey at the time of the refinance. It is expected that the higher the difference between the current fixed and adjustable rates the more incentive there is for borrowers to switch to ARMs. This figure is also closely tied to the shape of the interest rate curve, usually expressed as the difference or the ratio of the ten-year Treasury constant maturity rate and the corresponding 1-year rate. Results show that the higher the difference between the fixed and adjustable rates, the less likely ARM holders will switch into any kind of fixed rate products including balloons, while the more likely 30-year FRM holders switch into any other product. The effects on balloons are not clear while a higher difference also deters 15-year FRM holders switching into 30-year products.

I also include the level of current interest rates, proxied by the prevalent 30-year fixed rates. Evidences from past studies argue for both an increased and decreased likelihood of choosing ARMs when the general rate level is high. I find that borrowers are more likely to switch to ARMs than 30-year fixed rates as the interest rate level increases, but the 30-year fixed rates is still a more popular choice to switch to than balloons and 15-year fixed rates. With borrowers starting with different products, the direction of switching is unclear. An ARM holder is more likely to switch to any other fixed-rate products than staying with ARMs when rates are high. Yet with higher current rates, 30-year FRM holders find ARMs more attractive than refinancing into another 30-year FRM or with a 15-year FRM. Balloon holders and 15-year FRM holders find both ARMs and 30-year fixed rates more appealing than staying with their own product. And

the end result, after considering all the switcher and non-switchers, is that current rate level is positively tied to the choice of 30-year fixed rates and negatively tied to others.

To measure the refinance incentives for ARMs, I create a variable that measures how much the mortgage rates have increased since the loan was taken out. It takes the difference between the one-year Treasury rate at the time of refinance and that at the origination of the prior mortgage. Results show that the more the rates have increased since origination the more likely ARM holders switch to any other fixed-rate product. I used other variables that take into account the initial discount on the ARMs as well and the results do not change.

To account for the geographical differences, I create a variable to designate the census divisions where the properties are located that takes the values of one through nine for different divisions. Categorically it represents the differences between people's risk attitude in different areas, general mobility differences, employment conditions, industrial mix, home values, and other demographical and macroeconomic environment differences. I use a dummy variable that separates borrowers from inside MSA areas and those outside. It turns out that being inside an MSA significantly increases the likelihood that a borrower will choose or switch to an ARM or a balloon mortgage over 30-year mortgages while avoiding 15-year fixed rate mortgages, possibly due to affordability and mobility differences. I also use a variable that takes the value of the year the refinance mortgage was originated to account for temporal differences. The innovations in products, especially those in ARMs, have changed the landscape of the mortgage market in recent years and will create bias in the cross-sectional examinations if uncontrolled for.

In borrower characteristics, I include indicators that designate whether the borrower is a first-time homebuyer and whether the borrower has a savings account or not. I also merged the percentage of population that have a college degree or above from the 2000 Decennial Census with the sample by zip code to proxy for the education level of the borrowers. In addition, whether the current refinance is a cash-out refi, the purpose of the previous mortgage, and the size of the house relative to the median house price within the same census tract is also controlled for. Higher education borrowers are found to prefer ARMs and balloons in their mortgage choice or switching choice. Savings accounts are likely proxies for borrower wealth, financial sophistication, and holdings of other investment assets in their portfolio. Those who have savings accounts are more likely to become ARM borrowers, as a portion of their future income is tied to interest rate levels, and additional savings help them through interest rate fluctuations. Phillips et al. [1992] find that expected housing price appreciation, measured by the most recent rate of change in median house prices in the SMSA where the property is located, is negatively related to the 15-year FRM term choice. I control for the cumulative house price appreciation from the first mortgage was taken out to the time of the refinance as well, and also find a negative relationship between house price appreciation and the likelihood of choosing the 15-year product over the 30-year FRM.

I compare the institutions the borrower took out their first and refinance loans from and employ an indicator to show if they refinanced with the same lender as their original loan. Across the board in every product, it has a significant effect on deterring the borrower from refinancing into a different product. While it is possible that the lender has some influence on the loan choice of the borrowers, it also could be the case that the

borrower is satisfied with their mortgage choice in the first place and decide to be repeat customers for the same product.

Specifically for ARMs, I also indicate if the first mortgage is convertible or not, that is, if the mortgage came with an option that allows the borrower to convert it into a fixed-rate mortgage in the future. It reveals the inert preference toward fixed-rate mortgages among ARM borrowers. Borrowers who took a non-convertible ARM in the first place are less likely to switch to any types of fixed-rate mortgages in their refinance.

3.3.9 Marginal Effects

Table 3.8 illustrates the marginal effects of the variables in each category on the distribution of product shares among the population. The predicted market shares for the base case is obtained by applying the parameters from the product choice model (Appendix I) to a set of assumed base characteristics. Each cell in the table shows that compared to the base case, how the product share will change if one variable in one category is allowed to change at a time while holding others constant.

The effect of borrower's age is shown to be quite large. As the ARM share falls from 27.9 percent among borrowers aged 18-28 to 19.3 percent among borrowers aged 38-48, and 30-year FRM share increases from 47.2 to 55.1 percent between the two age categories. 15-year FRM share varies between 6 percent among those aged 18-28, to 11.2 among those aged 48-54. Similarly, ARM share takes 30 percent among single males, compared to 19.3 percent among married couples, while 30-year FRM share is 9.4 percent less among single males than their married counterparts.

The loan-to-value ratio is also a significant factor in determining product shares. 15-year FRM share more than triples from 8.8 percent among those with LTV greater than 90% to 21.4 percent among those with less than 50% LTV. FRM drops from 64.5 percent among the highest LTV category to 41.7 percent among the lowest LTV category. Income and credit score categories do not see as dramatic effects, but the trend is still clear: The 30-year FRM has decreasing shares from the lowest income category to the highest, the difference being about 14 percent, and decreasing shares from the lowest FICO score category to the highest, the difference 8.1 percent. Number of years on the current job also explains fluctuations in product shares among different groups in the magnitude of about 10 percent in ARMs and 30-year FRMs.

Table 3.9 shows the marginal effects of the variables on the propensity to switch to different products where the same method is repeated on the product-switching model (Table 3.7). The patterns are similar to those of the product choice model in each category. While 32 percent of the borrowers aged 18-28 are likely to switch to ARMs, only 22 percent will do so among borrowers aged 38-48. A higher propensity to switch to ARMs is also found among single male and female borrowers compared to married couples. 56 percent of those with FICO scores 620 or below are likely to switch to 30-year FRMs, compared to 33.5 percent in the top FICO group (above 720). The share of switching to 30-year FRM jumps from 24.2 percent to 50 percent from the lowest to the highest LTV group, while the share of switching to 15-year FRM falls from 46.1 percent to 19.1 percent. Increasing income category has a positive effect on the share of switching to 15-year FRM, but a negative one on the share of switching to 30-year FRM.

The results shown in Tables 3.8 and 3.9 illustrate the overall expected marginal effects of each variable. These results help explain and predict product shares among different groups of the population and the overall product share as the demographic profile of all borrowers shifts.

3.4 Conclusion

By studying the mortgage product choice made by a sample of borrowers who refinanced between 1997 and 2003, especially those that chose a different product than their previous loan, this paper offers evidence on the importance of the relationship between borrower socioeconomic characteristics and their mortgage choice. Furthermore, borrowers' product-switching behavior is found to be a two-step process. While borrowers respond to recent shocks by switching to different products that address their immediate concerns, such as maintaining current payments or readying for expected tenure changes, they gradually make an adjustment to their mortgage choice that fit their long term goals of utility maximization, such as smoothing their expected consumption stream or home equity protection.

One important empirical finding is that borrowers with low income or poor credit rating are more likely to refinance into a 30-year FRM, most likely because this product provides payment certainty and protection from interest-rate risk, and lower payments than a 15-year FRM, though in the near term, ARMs and balloons provide immediate payment relief in the cases of negative income shocks. In similar cases ARMs and balloons suit the needs of the borrowers who increase their loan-to-value for qualification

reasons and reduced payment burden, while 15-year and balloons are popular choices for borrowers with lower loan-to-values for accelerated payoff and equity protection. Younger borrowers and borrowers new on their current jobs are more likely to become ARM borrowers because of their greater income growth potential and the mortgage payment stream matches their expected income patterns. Temporarily, those who switch to new jobs choose to switch to 30-year fixed-rate mortgages as well for security. The 30-year fixed-rate mortgage also gives temporary protection for those who become newly single, but in general the long-run factors such as expected income tilt and expected length of tenure take over and ARMs or balloons become the choice products for singles as a group. ARMs suit the needs of recently married couples that expect tenure changes, but the long-term fixed-rate mortgages prove to be more fit for the typical families that are sensitive to interest rate risks. These results suggest that borrowers are responsive to the factors that affect their near-term and long-term mortgage selection and mortgage choice is integral to borrowers' financial planning and utility maximization. The results also confirm the clientele effect of different mortgage products, and the availability of the variety of products to borrowers of different characteristics at different stages of life offers great value to the borrowers.

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Table 3.1 Sample Product Distribution and Switching Patterns

1. Full Sample Product Distribution

New Mortgage			Prepaid Mortgage		
Product Type	Count	Percentage	Product Type	Count	Percentage
ARM	13,600	5.2	ARM	7,815	3.0
Balloon	13,780	5.3	Balloon	8,343	3.2
15-Year FRM	91,992	35.1	15-Year FRM	59,233	22.6
20-Year FRM	27,018	10.3	20-Year FRM	18,677	7.1
30-Year FRM	115,759	44.2	30-Year FRM	168,081	64.1
Total	262,149	100	Total	262,149	100.0

2. Product Distribution of Sample that Switched Product Types in Refinance

Switched from ARMs			Switched from 30-year FRMs		
Product Type	Count	Percentage	Product Type	Count	Percentage
Balloon	968	12.4	Balloon	7,020	4.2
15-Year FRM	535	6.8	15-Year FRM	6,138	3.7
20-Year FRM	170	2.2	20-Year FRM	30,725	18.3
30-Year FRM	1,708	21.9	ARM	18,871	11.2
Stay Same	4,434	56.7	Stay Same	105,327	62.7
Total	7,815	100	Total	168,081	100.0

Switched from 15-year FRMs			Switched from balloons		
Product Type	Count	Percentage	Product Type	Count	Percentage
ARM	920	1.6	ARM	848	10.2
Balloon	1,439	2.4	15-Year FRM	727	8.7
20-Year FRM	1,382	2.3	20-Year FRM	218	2.6
30-Year FRM	4,971	8.4	30-Year	1,613	19.3
Stay Same	50,521	85.3	Stay Same	4,937	59.2
Total	59,233	100.0	Total	8,343	100.0

Products Switched to			Products Switched from		
Product Type	Count	Percentage	Product Type	Count	Percentage
ARM	9,045	10.0	ARM	3,381	3.7
Balloon	8,843	9.8	Balloon	3,406	3.8
15-Year FRM	41,471	45.9	15-Year FRM	8,712	9.6
20-Year FRM	20,652	22.8	20-Year FRM	12,190	13.5
30-Year FRM	10,432	11.5	30-Year FRM	62,754	69.4
Total	90,443	100.0	Total	90,443	100.0

3. Full Sample Geographical Distribution

Division	Count
East North Central	105,726
East South Central	13,822
Mid Atlantic	19,170
Mountain	10,080
New England	14,782
Pacific	29,781
South Atlantic	34,612
West North Central	27,035
West South Central	7,141

4. Full Sample Distribution by Origination Year

Prepaid Mortgage			New Mortgage		
Origination Year	Count	Percentage	Origination Year	Count	Percentage
1997	4,001	1.5	1997	14	0.0
1998	23,622	9.0	1998	1,418	0.5
1999	30,708	11.7	1999	1,123	0.4
2000	38,272	14.6	2000	1,158	0.4
2001	92,778	35.4	2001	45,273	17.3
2002	69,496	26.5	2002	79,669	30.4
2003	3,272	1.2	2003	133,494	50.9
Total	262,149	100.0	Total	262,149	100.0

5. Origination Year Distribution of Sample that Switched Product Types in Refinance

Mortgages Switched from			Mortgages Switched to		
Origination Year	Count	Percentage	Origination Year	Count	Percentage
1997	1,724	1.9	1997	1	0.0
1998	11,472	12.7	1998	366	0.4
1999	13,378	14.8	1999	349	0.4
2000	12,132	13.4	2000	302	0.3
2001	32,166	35.6	2001	13,983	15.5
2002	18,818	20.8	2002	30,261	33.5
2003	753	0.8	2003	45,181	50.0
Total	90,443	100	Total	90,443	100.0

Table 3.2 Multinomial Logit Results: Product Selection in Refinances

		ARM		Balloon		15-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
Intercept		Suppressed for Confidentiality					
Borrower Age	18--28	0.24	<.0001	0.29	<.0001	-0.16	<.0001
	28-38	0.02	0.44	-0.01	0.69	-0.17	<.0001
	38-45	-0.28	<.0001	-0.27	<.0001	0.21	<.0001
	45-55	-0.12	0.00	-0.04	0.14	0.36	<.0001
	55-65	0.10	0.01	0.10	0.00	0.03	0.08
	>=65	0.05		-0.06		-0.27	
FRM-ARM Diff		-0.03	0.01	-0.91	<.0001	-1.04	<.0001
Market Rate		-0.22	<.0001	-0.07	0.00	-0.08	<.0001
Loan Age		0.04	0.00	0.10	<.0001	0.36	<.0001
Education		0.20	<.0001	0.19	<.0001	-0.24	<.0001
Appreciation	<0	0.27	<.0001	0.18	<.0001	0.39	<.0001
	0-5%	0.13	<.0001	0.15	<.0001	0.05	<.0001
	5-15%	-0.10	<.0001	-0.06	0.01	-0.13	<.0001
	15-50%	-0.39	<.0001	-0.43	<.0001	-0.43	<.0001
	>50%	0.09		0.16		0.12	
Same Originator		-0.17	<.0001	-0.20	<.0001	-0.07	<.0001
Became Single		-0.03	0.21	-0.04	0.13	-0.27	<.0001
Got Married		0.07	0.00	0.06	0.01	0.06	<.0001
1st Time Buyer		-0.08	0.00	-0.01	0.52	0.09	<.0001
Out Self-Emplyd		0.09	0.01	0.01	0.73	0.11	<.0001
Into Self-Emplyd		0.06	0.12	-0.07	0.04	-0.10	<.0001
Have Savings		0.19	<.0001	0.01	0.53	0.01	0.62
Marital Status	Single M	0.27	<.0001	0.17	<.0001	0.06	<.0001
	Single F	0.09	<.0001	0.00	0.81	-0.05	<.0001
	Married	-0.36		-0.16		-0.01	
Division	ENC	0.34	<.0001	0.26	<.0001	-0.10	<.0001
	ESC	-0.17	0.00	0.00	0.96	0.42	<.0001
	MAT	-0.62	<.0001	-0.82	<.0001	0.33	<.0001
	MTN	0.69	<.0001	0.42	<.0001	-0.38	<.0001
	NEG	-0.69	<.0001	-0.90	<.0001	-0.18	<.0001
	PAC	-0.01	0.71	0.23	<.0001	-0.99	<.0001
	SAT	-0.10	0.00	-0.09	0.00	0.07	<.0001
	WNC	0.19	<.0001	0.55	<.0001	0.26	<.0001
	WSC	0.37		0.35		0.57	
FICO Score	<=620	-0.07	0.44	-0.31	0.01	-0.27	<.0001
	620-660	0.03	0.53	0.04	0.53	-0.18	<.0001
	660-720	0.12		0.15		0.03	
	>720	-0.08	0.02	0.13	0.00	0.41	<.0001
Income (as a percent of area median income)	<=0.8	-0.18	<.0001	-0.13	<.0001	-0.49	<.0001
	0.8-1	-0.07	0.03	-0.02	0.62	-0.19	<.0001
	1-1.2	-0.06		-0.07		-0.07	
	1.2-1.5	0.05	0.10	0.02	0.59	0.14	<.0001
	>1.5	0.26	<.0001	0.20	<.0001	0.60	<.0001
Income Change (if previous income in different category)	<=0.8	0.21	<.0001	0.06	0.14	-0.07	0.00
	0.8-1	0.08	0.07	-0.01	0.86	0.00	0.88
	1-1.2	-0.03	0.55	0.07	0.10	0.06	0.01
	1.2-1.5	-0.02	0.70	-0.04	0.27	0.02	0.30
	>1.5	-0.12	0.00	-0.04	0.31	-0.01	0.53

Table 3.2 Multinomial Logit Results: Product Selection in Refinances-Continued

		ARM		Balloon		15-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
FICO Change (if different from previous FICO)	<=620	-0.02	0.88	0.01	0.97	-0.03	0.69
	620-660	-0.01	0.86	-0.05	0.46	0.05	0.17
	660-720	-0.02	0.59	0.00	0.99	0.04	0.08
	>720	0.08	0.04	0.04	0.44	-0.09	0.00
LTV	<=50%	-0.06	0.09	0.45	<.0001	1.01	<.0001
	50-80%	-0.09		0.32		0.09	
	80-90%	0.23	<.0001	0.11	0.04	-0.40	<.0001
	>90%	-0.08	0.11	-0.87	<.0001	-0.70	<.0001
Inside MSA		0.31	<.0001	0.06	0.00	-0.20	<.0001
Cash-Out Refi?		-0.15	<.0001	-0.30	<.0001	-0.47	<.0001
Previous Loan Purpose	Cashout	-0.07	<.0001	-0.06	<.0001	-0.03	0.00
	Purchase	0.02	0.17	0.01	0.64	-0.07	<.0001
LTV Change (if different from previous LTV)	<=50%	0.10	0.12	0.15	0.02	0.33	<.0001
	50-80%	-0.02	0.59	-0.16	0.00	-0.08	0.00
	80-90%	-0.20	0.00	-0.08	0.27	-0.06	0.12
	>90%	0.32	0.00	0.24	0.18	-0.18	0.02
Yr. Employment	0-2	0.40	<.0001	0.34	<.0001	-0.05	0.00
	2-5	0.14	<.0001	0.14	<.0001	-0.05	0.00
	5-10	-0.09		-0.13		-0.02	
	10-20	-0.28	<.0001	-0.23	<.0001	0.06	<.0001
	>=20	-0.17	<.0001	-0.12	<.0001	0.07	<.0001
Refi Year		Collectively Significant					
House Price (compared to median house price by zip)	<1	-0.02	0.40	-0.06	0.00	0.52	<.0001
	1-1.25	-0.01		-0.08		0.16	
	1.25-1.5	0.01	0.54	0.01	0.77	0.01	0.39
	1.5-2	-0.02	0.40	0.03	0.13	-0.20	<.0001
	>=2	0.04	0.13	0.10	<.0001	-0.49	<.0001
Self-Employed		0.08	<.0001	0.20	<.0001	0.24	<.0001
Age Change	28-38	0.28	<.0001	0.17	0.01	-0.04	0.29
	38-45	0.09	0.09	0.00	0.94	-0.10	<.0001
	45-55	-0.06	0.37	-0.13	0.02	0.00	0.98
	55-65	0.03	0.64	0.03	0.64	0.14	0.00
	>=65	-0.38	0.02	0.01	0.94	0.05	0.49
Yr. Employment Change (if different from previous)	0-2	-0.17	<.0001	-0.23	<.0001	-0.04	0.19
	2-5	0.15	<.0001	0.09	0.01	0.05	0.02
	5-10	0.06	0.10	0.18	<.0001	0.03	0.11
	10-20	0.04	0.36	0.09	0.03	0.00	1.00
	>=20	0.02	0.71	-0.07	0.21	0.02	0.47

Table 3.3 Multinomial Logit Results: Switching from ARMs to Other Products

		Balloon		15-Year FRM		30-Year FRM	
Explanatory Variable		Estimate	Pr>ChiSq	Estimate	Pr>ChiSq	Estimate	Pr>ChiSq
Intercept		Suppressed for Confidentiality					
Borrower Age	18--28	-0.18	0.69	-0.88	0.07	-0.25	0.09
	28-38	-0.26	0.32	-0.56	0.02	0.07	0.45
	38-45	-0.22	0.40	-0.11	0.65	0.28	0.00
	45-55	0.27	0.38	0.63	0.04	0.01	0.96
	55-65	0.88	0.02	0.55	0.13	0.21	0.12
	>=65	-0.49		0.37		-0.32	
FRM-ARM Diff		-35.72	0.07	-35.50	0.07	-0.25	0.00
Market Rate		2.73	<.0001	2.51	<.0001	0.17	0.01
Loan Age		-0.70	0.00	-0.19	0.32	0.18	0.02
Education		0.10	0.27	-0.35	0.00	-0.21	<.0001
Rate Change		0.71	<.0001	0.91	<.0001	0.17	0.00
House Price Appreciation	<0	-0.79	0.03	-0.59	0.08	-0.18	0.14
	0-5%	0.01	0.99	-0.43	0.16	0.04	0.68
	5-15%	0.33	0.34	-0.10	0.77	0.26	0.03
	15-50%	0.97	0.39	1.64	0.10	-0.18	0.62
	>50%	-0.52		-0.52		0.06	
Same Originator		-0.55	<.0001	-0.37	0.00	-0.37	<.0001
Became Single		0.00	0.99	0.00	1.00	-0.09	0.45
Got Married		-0.03	0.90	0.01	0.96	-0.02	0.83
1st Time Buyer		0.00	0.98	0.00	0.99	0.02	0.73
Out Self-Emplyd		0.49	0.12	0.42	0.18	-0.04	0.73
Into Self-Emplyd		0.23	0.54	0.21	0.55	0.22	0.10
Have Savings		-0.28	0.07	-0.50	0.00	-0.14	0.02
Marital Status	Single M	0.30	0.12	0.29	0.13	-0.15	0.01
	Single F	-0.58	0.02	-0.40	0.09	0.08	0.22
	Married	0.28		0.11		0.07	
Division	ENC	-0.05	0.85	-0.42	0.11	-0.39	<.0001
	ESC	1.07	0.03	1.59	0.00	0.75	0.00
	MAT	0.41	0.57	0.45	0.54	0.07	0.73
	MTN	-0.89	0.03	-1.29	0.00	-0.83	<.0001
	NEG	0.54	0.44	0.57	0.43	0.50	0.01
	PAC	-0.64	0.13	-0.97	0.02	-0.24	0.02
	SAT	-0.19	0.56	0.14	0.65	0.15	0.13
	WNC	-0.04	0.92	0.05	0.90	-0.07	0.53
	WSC	-0.21		-0.12		0.06	
FICO Score	<=620	-0.70	0.57	0.78	0.47	0.92	0.00
	620-660	0.10	0.89	-0.58	0.40	-0.02	0.93
	660-720	0.28		-0.18		-0.38	
	>720	0.33	0.48	-0.03	0.95	-0.52	<.0001
Income (as a percent of area median income)	<=0.8	0.12	0.72	-0.16	0.63	0.27	0.00
	0.8-1	0.25	0.48	-0.11	0.76	0.12	0.27
	1-1.2	-0.38		-0.53		0.06	
	1.2-1.5	-0.09	0.78	-0.02	0.95	-0.12	0.22
	>1.5	0.10	0.69	0.82	0.00	-0.33	<.0001
Income Change (if previous income in different category)	<=0.8	0.50	0.31	-0.15	0.77	-0.22	0.18
	0.8-1	-0.23	0.64	0.08	0.88	-0.21	0.20
	1-1.2	0.56	0.32	0.38	0.51	-0.22	0.17
	1.2-1.5	-0.45	0.30	-0.27	0.53	0.12	0.40
	>1.5	-0.32	0.42	0.14	0.72	0.42	0.00

Table 3.3 Multinomial Logit Results: Switching from ARMs to Other Products – Continued

		Balloon		15-Year FRM		30-Year FRM	
Explanatory Variable		Estimate	Pr>ChiSq	Estimate	Pr>ChiSq	Estimate	Pr>ChiSq
FICO Change (if different from previous FICO)	<=620	-0.30	0.84	-1.62	0.22	-0.78	0.03
	620-660	0.59	0.46	0.64	0.41	0.24	0.28
	660-720	-0.26	0.62	0.07	0.89	0.03	0.85
	>720	-0.24	0.63	0.31	0.51	0.39	0.01
LTV	<=50%	1.16	0.02	1.46	<.0001	-0.20	0.16
	50-80%	0.98		0.63		0.05	
	80-90%	-0.90	0.11	-1.92	<.0001	-0.19	0.18
	>90%	-1.24	0.29	-0.17	0.81	0.34	0.06
Inside MSA		-0.38	0.07	-0.50	0.01	-0.30	0.00
Cash-out Refi?		-0.37	0.03	-1.01	<.0001	0.22	0.00
Previous Loan Purpose	Cashout	0.18	0.36	0.01	0.96	-0.06	0.33
	Purchase	-0.28	0.10	0.22	0.18	0.30	<.0001
LTV Change (if different from previous LTV)	<=50%	0.01	0.98	2.74	.	0.21	0.39
	50-80%	0.80	0.00	2.58	.	-0.01	0.94
	80-90%	1.39	0.00	2.95	.	0.13	0.53
	>90%	-2.64	.	-10.46	.	-0.15	0.70
Convertible?		0.32	0.04	0.38	0.01	0.44	<.0001
Yr. Employment	0-2	-0.05	0.86	-0.23	0.39	-0.37	<.0001
	2-5	0.12	0.62	0.06	0.81	-0.06	0.49
	5-10	0.23		0.34		0.03	
	10-20	0.04	0.87	0.13	0.57	0.15	0.06
	>=20	-0.35	0.29	-0.29	0.35	0.25	0.03
Refi Year		Collectively Significant					
House Price (compared to median house price by zip)	<1	-0.47	0.07	-0.02	0.93	0.13	0.11
	1-1.25	0.50		0.57		0.04	
	1.25-1.5	0.10	0.64	0.20	0.34	0.00	0.96
	1.5-2	0.31	0.13	-0.05	0.80	0.07	0.37
	>=2	-0.44	0.10	-0.70	0.01	-0.24	0.02
Self-Employed		0.20	0.28	0.37	0.04	-0.16	0.05
Age Change	28-38	-0.44	0.53	-0.53	0.43	-0.34	0.15
	38-45	-0.09	0.87	0.04	0.94	0.02	0.91
	45-55	0.44	0.54	0.69	0.29	0.18	0.50
	55-65	-0.14	0.85	0.52	0.46	-0.18	0.52
	>=65	0.07	0.96	-0.88	0.54	0.29	0.62
Yr. Employment Change (if different from previous)	0-2	0.19	0.68	0.45	0.33	0.40	0.01
	2-5	0.18	0.64	0.13	0.74	-0.14	0.28
	5-10	-0.11	0.80	-0.19	0.64	0.06	0.70
	10-20	-0.35	0.45	-0.44	0.31	0.00	1.00
	>=20	0.08	0.89	0.09	0.88	-0.34	0.18

Table 3.4 Multinomial Logit Results: Switching from 30-Year FRMs to Other Products

		ARM		Balloon		15-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
Intercept		Suppressed for Confidentiality					
Borrower Age	18--28	0.23	<.0001	0.27	<.0001	0.09	0.01
	28-38	0.04	0.26	-0.05	0.13	-0.03	0.15
	38-45	-0.26	<.0001	-0.28	<.0001	0.17	<.0001
	45-55	-0.11	0.01	0.00	0.97	0.31	<.0001
	55-65	0.00	0.99	0.08	0.11	-0.04	0.17
	>=65	0.10		-0.02		-0.50	
FRM-ARM Diff		0.22	<.0001	0.23	<.0001	0.11	<.0001
Market Rate		0.11	<.0001	-0.01	0.53	-0.12	<.0001
Loan Age		0.10	<.0001	0.09	<.0001	0.56	<.0001
Education		0.19	<.0001	0.20	<.0001	-0.18	<.0001
House Price Appreciation	<0	0.06	0.13	-0.07	0.07	0.38	<.0001
	0-5%	0.13	<.0001	0.16	<.0001	0.11	<.0001
	5-15%	-0.04	0.10	0.02	0.38	-0.15	<.0001
	15-50%	-0.21	0.00	-0.16	0.01	-0.53	<.0001
	>50%	0.06		0.05		0.19	
Same Originator		-0.24	<.0001	-0.30	<.0001	-0.10	<.0001
Became Single		0.04	0.26	0.09	0.02	-0.19	<.0001
Got Married		0.06	0.01	0.02	0.49	0.08	<.0001
1st Time Buyer		-0.10	<.0001	-0.04	0.11	0.06	<.0001
Out Self-Emplyd		0.12	0.01	0.00	0.96	0.15	<.0001
Into Self-Emplyd		0.11	0.03	-0.02	0.73	-0.12	<.0001
Have Savings		0.11	<.0001	0.08	0.01	-0.01	0.58
Marital Status	Single M	0.24	<.0001	0.16	<.0001	0.10	<.0001
	Single F	0.10	<.0001	0.01	0.61	0.01	0.71
	Married	-0.34		-0.18		-0.10	
Division	ENC	0.26	<.0001	0.20	<.0001	-0.17	<.0001
	ESC	-0.15	0.02	0.01	0.85	0.37	<.0001
	MAT	-0.64	<.0001	-0.92	<.0001	0.19	<.0001
	MTN	0.65	<.0001	0.38	<.0001	-0.22	<.0001
	NEG	-0.59	<.0001	-0.77	<.0001	-0.25	<.0001
	PAC	0.10	0.01	0.26	<.0001	-0.78	<.0001
	SAT	-0.14	0.00	0.00	0.90	0.10	<.0001
	WNC	0.11	0.01	0.47	<.0001	0.21	<.0001
	WSC	0.40		0.37		0.55	
FICO Score	<=620	-0.13	0.24	-0.31	0.03	-0.33	<.0001
	620-660	0.08	0.17	0.09	0.20	-0.16	0.00
	660-720	0.16		0.17		0.04	
	>720	-0.11	0.01	0.05	0.38	0.45	<.0001
Income (as a percent of area median income)	<=0.8	-0.09	0.01	-0.10	0.01	-0.46	<.0001
	0.8-1	0.00	0.95	0.01	0.80	-0.20	<.0001
	1-1.2	-0.05		-0.04		-0.05	
	1.2-1.5	0.00	0.96	0.03	0.53	0.12	<.0001
	>1.5	0.15	<.0001	0.10	0.00	0.58	<.0001
Income Change (if previous income in different category)	<=0.8	0.25	<.0001	0.10	0.07	-0.18	<.0001
	0.8-1	0.00	0.94	0.01	0.88	-0.03	0.37
	1-1.2	-0.04	0.55	0.09	0.13	0.05	0.09
	1.2-1.5	-0.01	0.84	-0.15	0.01	0.07	0.02
	>1.5	-0.06	0.26	0.01	0.83	0.12	<.0001

Table 3.4 Multinomial Logit Results: Switching from 30-Year FRMs to Other Products - Continued

		ARM		Balloon		15-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
FICO Change (if different from previous FICO)	<=620	-0.05	0.71	-0.08	0.65	0.02	0.85
	620-660	-0.04	0.60	-0.07	0.44	0.04	0.49
	660-720	-0.02	0.76	-0.01	0.86	0.04	0.28
	>720	0.15	0.00	0.11	0.07	-0.09	0.00
LTV	<=50%	-0.37	<.0001	0.17	0.00	0.74	<.0001
	50-80%	-0.04		0.33		0.10	
	80-90%	0.32	<.0001	0.17	0.01	-0.30	<.0001
	>90%	0.09	0.12	-0.68	<.0001	-0.54	<.0001
Inside MSA		0.33	<.0001	0.11	<.0001	-0.13	<.0001
Cash-Out Refi?		0.01	0.76	-0.08	0.00	-0.57	<.0001
Previous Loan Purpose	Cashout	0.08	<.0001	0.07	0.00	-0.23	<.0001
	Purchase	-0.02	0.28	-0.10	<.0001	0.27	<.0001
LTV Change (if different from previous LTV)	<=50%	0.12	0.16	0.04	0.63	0.51	<.0001
	50-80%	-0.04	0.42	-0.10	0.12	-0.16	<.0001
	80-90%	-0.18	0.01	0.03	0.77	-0.13	0.00
	>90%	0.31	0.00	0.22	0.28	-0.12	0.18
Yr. Employment	0-2	0.37	<.0001	0.37	<.0001	0.04	0.07
	2-5	0.16	<.0001	0.13	0.00	0.00	0.90
	5-10	-0.14		-0.16		-0.01	
	10-20	-0.28	<.0001	-0.22	<.0001	0.01	0.56
	>=20	-0.12	0.00	-0.13	0.00	-0.04	0.03
Refi Year		Collectively Significant					
House Price (compared to median house price by zip)	<1	-0.11	0.00	-0.12	<.0001	0.40	<.0001
	1-1.25	-0.06		-0.07		0.10	
	1.25-1.5	0.03	0.28	0.01	0.72	0.01	0.58
	1.5-2	0.02	0.49	0.01	0.69	-0.14	<.0001
	>=2	0.12	0.00	0.17	<.0001	-0.37	<.0001
Self-Employed		0.04	0.23	0.13	<.0001	0.27	<.0001
Age Change	28-38	0.31	<.0001	0.19	0.01	-0.08	0.04
	38-45	0.07	0.31	-0.08	0.27	-0.06	0.10
	45-55	-0.08	0.31	-0.18	0.02	0.00	0.99
	55-65	0.11	0.23	0.05	0.57	0.12	0.01
	>=65	-0.46	0.02	0.05	0.78	0.09	0.43
Yr. Employment Change (if different from previous)	0-2	-0.16	0.00	-0.24	<.0001	-0.10	0.01
	2-5	0.10	0.02	0.08	0.09	0.00	0.95
	5-10	0.12	0.02	0.16	0.00	0.04	0.15
	10-20	0.04	0.46	0.09	0.10	0.04	0.16
	>=20	0.01	0.89	-0.02	0.80	0.09	0.01

Table 3.5 Multinomial Logit Results: Switching from 15-Year FRMs to Other Products

		ARM		Balloon		30-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
Intercept		Suppressed for Confidentiality					
Borrower Age	18--28	0.20	0.41	0.41	0.04	0.11	0.27
	28-38	0.22	0.02	-0.04	0.62	0.02	0.74
	38-45	-0.34	0.00	-0.34	<.0001	-0.14	0.00
	45-55	-0.32	0.00	-0.12	0.15	-0.23	<.0001
	55-65	0.26	0.02	0.22	0.01	0.10	0.06
	>=65	-0.02		-0.12		0.14	
FRM-ARM Diff		-0.02	0.78	-0.01	0.87	-0.11	0.00
Market Rate		0.16	0.01	0.07	0.14	0.22	<.0001
Loan Age		0.05	0.24	0.33	<.0001	0.05	0.01
Education		0.26	<.0001	0.13	<.0001	0.05	0.00
Appreciation	<0	0.00	1.00	0.03	0.59	-0.55	<.0001
	0-5%	-0.03	0.68	0.21	0.00	0.03	0.27
	5-15%	-0.01	0.86	0.01	0.87	0.17	<.0001
	15-50%	0.13	0.39	-0.28	0.04	0.62	<.0001
	>50%	-0.09		0.03		-0.27	
Same Originator		-0.27	<.0001	-0.17	<.0001	-0.04	0.02
Became Single		0.38	<.0001	0.14	0.11	0.54	<.0001
Got Married		-0.06	0.55	0.03	0.69	-0.09	0.07
1st Time Buyer		-0.21	0.13	0.19	0.11	-0.09	0.21
Out Self-Emplyd		-0.08	0.50	0.10	0.20	0.06	0.21
Into Self-Emplyd		0.15	0.13	0.03	0.68	0.10	0.06
Have Savings		0.17	0.01	0.16	0.00	0.00	0.93
Marital Status	Single M	0.28	<.0001	0.07	0.20	0.06	0.04
	Single F	0.08	0.30	0.10	0.13	0.15	<.0001
	Married	-0.36		-0.17		-0.21	
Division	ENC	0.30	<.0001	0.42	<.0001	-0.17	<.0001
	ESC	-0.09	0.55	-0.06	0.64	-0.13	0.04
	MAT	-0.45	0.00	-1.14	<.0001	-0.20	0.00
	MTN	0.82	<.0001	0.59	<.0001	0.16	0.03
	NEG	-0.95	<.0001	-1.55	<.0001	-0.05	0.47
	PAC	0.06	0.60	0.28	0.00	0.27	<.0001
	SAT	-0.06	0.50	0.06	0.48	0.08	0.06
	WNC	-0.02	0.83	0.82	<.0001	-0.20	<.0001
	WSC	0.39		0.58		0.24	
FICO Score	<=620	-0.09	0.83	-0.42	0.44	0.49	0.00
	620-660	0.31	0.15	0.06	0.82	0.18	0.03
	660-720	0.11		0.18		-0.16	
	>720	-0.33	0.04	0.18	0.36	-0.51	<.0001
Income (as a percent of area median income)	<=0.8	0.09	0.40	-0.22	0.03	0.46	<.0001
	0.8-1	-0.05	0.71	-0.10	0.37	0.13	0.02
	1-1.2	0.13		0.01		0.02	
	1.2-1.5	-0.17	0.14	0.04	0.64	-0.18	0.00
	>1.5	0.00	0.98	0.27	<.0001	-0.43	<.0001
Income Change (if previous income in different category)	<=0.8	0.34	0.03	0.74	<.0001	0.16	0.01
	0.8-1	0.24	0.17	0.07	0.65	0.05	0.53
	1-1.2	-0.29	0.09	-0.09	0.53	0.00	1.00
	1.2-1.5	0.21	0.16	-0.13	0.30	0.07	0.29
	>1.5	-0.26	0.05	-0.40	0.00	-0.10	0.13

Table 3.5 Multinomial Logit Results: Switching from 15-Year FRMs to Other Products - Continued

		ARM		Balloon		30-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
FICO Change (if different from previous FICO)	<=620	0.43	0.41	0.33	0.61	-0.11	0.55
	620-660	-0.06	0.81	0.07	0.79	-0.07	0.52
	660-720	-0.26	0.13	-0.06	0.75	0.06	0.42
	>720	0.03	0.87	-0.18	0.32	0.16	0.01
LTV	<=50%	-0.44	0.02	2.56	.	-1.05	<.0001
	50-80%	-0.02		-2.02		-0.26	
	80-90%	0.22	0.38	2.02	<.0001	0.49	<.0001
	>90%	0.24	0.59	-6.96	.	0.82	<.0001
Inside MSA		0.29	<.0001	0.05	0.21	0.12	<.0001
Cash-Out Refi?		-0.18	0.00	-0.34	<.0001	0.47	<.0001
Previous Loan Purpose	Cashout	0.14	0.01	0.16	0.00	0.29	<.0001
	Purchase	-0.04	0.61	-0.33	<.0001	-0.29	<.0001
LTV Change (if different from previous LTV)	<=50%	0.29	0.19	0.14	0.99	-0.51	<.0001
	50-80%	0.07	0.73	0.16	0.99	0.33	<.0001
	80-90%	-0.43	0.20	-0.20	0.99	0.12	0.31
	>90%	0.30	0.66	-0.15	1.00	0.29	0.25
Yr. Employment	0-2	0.43	<.0001	0.23	0.02	0.13	0.03
	2-5	0.14	0.14	0.24	0.00	-0.01	0.77
	5-10	-0.23		-0.25		0.01	
	10-20	-0.23	0.00	-0.13	0.03	-0.09	0.01
	>=20	-0.10	0.24	-0.09	0.16	-0.03	0.42
Refi Year		Collectively Significant					
House Price (compared to median house price by zip)	<1	-0.30	<.0001	-0.13	0.03	-0.24	<.0001
	1-1.25	-0.16		-0.15		-0.04	
	1.25-1.5	0.09	0.20	0.00	0.98	0.01	0.74
	1.5-2	0.16	0.02	0.11	0.04	0.17	<.0001
	>=2	0.21	0.02	0.17	0.00	0.10	0.02
Self-Employed		-0.03	0.56	0.14	0.00	-0.11	0.00
Age Change	28-38	0.14	0.59	0.47	0.03	0.19	0.15
	38-45	0.25	0.12	-0.02	0.88	0.00	0.96
	45-55	0.12	0.47	-0.33	0.01	0.07	0.40
	55-65	-0.33	0.06	-0.02	0.88	-0.19	0.04
	>=65	0.04	0.92	0.11	0.73	-0.04	0.83
Yr. Employment Change (if different from previous)	0-2	-0.21	0.22	-0.23	0.17	0.04	0.65
	2-5	0.15	0.25	-0.09	0.46	0.04	0.54
	5-10	0.34	0.02	0.32	0.01	0.03	0.67
	10-20	0.03	0.85	-0.06	0.55	0.07	0.25
	>=20	-0.18	0.27	-0.05	0.67	-0.13	0.06

Table 3.6 Multinomial Logit Results: Switching from Balloons to Other Products

		ARM		15-Year FRM		30-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
Intercept		Suppressed for Confidentiality					
Borrower Age	18--28	-0.04	0.82	-0.14	0.54	0.01	0.97
	28-38	0.06	0.59	-0.29	0.01	0.06	0.41
	38-45	0.02	0.86	0.31	0.00	0.29	0.00
	45-55	-0.10	0.42	0.32	0.01	0.06	0.53
	55-65	0.23	0.08	-0.39	0.01	-0.33	0.00
	>=65	-0.16		0.19		-0.09	
FRM-ARM Diff		-0.04	0.61	-0.01	0.91	0.03	0.68
Market Rate		0.17	0.02	-0.03	0.71	0.11	0.06
Loan Age		0.25	0.00	0.51	<.0001	0.19	0.00
Education		-0.01	0.68	-0.24	<.0001	-0.16	<.0001
Appreciation	<0	-0.15	0.24	0.08	0.54	-0.20	0.04
	0-5%	0.01	0.91	0.03	0.84	-0.03	0.77
	5-15%	0.02	0.90	0.13	0.35	0.22	0.03
	15-50%	0.31	0.42	-0.35	0.38	0.19	0.52
	>50%	-0.19		0.11		-0.18	
Same Originator		-0.61	<.0001	-0.11	0.03	-0.20	<.0001
Became Single		-0.09	0.51	0.09	0.53	-0.08	0.48
Got Married		0.01	0.91	-0.06	0.60	-0.04	0.67
1st Time Buyer		-0.06	0.60	-0.07	0.56	-0.14	0.11
Out Self-Emplyd		0.10	0.46	0.03	0.85	0.07	0.55
Into Self-Emplyd		0.30	0.05	0.05	0.74	0.06	0.64
Have Savings		0.15	0.03	0.11	0.14	0.16	0.01
Marital Status	Single M	0.17	0.01	-0.11	0.18	-0.16	0.01
	Single F	0.09	0.27	0.18	0.08	0.10	0.16
	Married	-0.27		-0.06		0.06	
Division	ENC	0.22	0.02	0.13	0.21	-0.20	0.00
	ESC	-0.47	0.12	0.42	0.10	0.00	0.98
	MAT	-0.25	0.47	0.34	0.26	0.45	0.03
	MTN	-0.31	0.07	-0.20	0.28	-0.14	0.26
	NEG	-0.25	0.37	-0.89	0.04	-0.24	0.23
	PAC	-0.29	0.01	-0.65	<.0001	0.00	0.97
	SAT	0.40	0.00	0.09	0.62	0.06	0.62
	WNC	-0.05	0.74	0.19	0.16	-0.26	0.01
	WSC	1.00		0.57		0.33	
FICO Score	<=620	-0.81	0.31	0.23	0.71	0.26	0.52
	620-660	0.37	0.28	-0.38	0.28	-0.02	0.93
	660-720	0.30		-0.10		-0.01	
	>720	0.15	0.60	0.26	0.25	-0.22	0.13
Income (as a percent of area median income)	<=0.8	-0.08	0.50	-0.30	0.04	0.07	0.44
	0.8-1	-0.24	0.09	-0.07	0.65	0.05	0.64
	1-1.2	0.10		-0.35		0.18	
	1.2-1.5	0.21	0.06	0.17	0.21	0.06	0.48
	>1.5	0.02	0.87	0.54	<.0001	-0.36	<.0001
Income Change (if previous income in different category)	<=0.8	0.08	0.66	-0.59	0.01	-0.40	0.01
	0.8-1	0.22	0.27	-0.21	0.35	0.02	0.86
	1-1.2	-0.18	0.33	0.33	0.17	-0.05	0.69
	1.2-1.5	-0.11	0.47	0.16	0.38	-0.10	0.43
	>1.5	0.09	0.53	0.37	0.02	0.55	<.0001

Table 3.6 Multinomial Logit Results: Switching from Balloons to Other Products - Continued

		ARM		15-Year FRM		30-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
FICO Change (if different from previous FICO)	<=620	0.74	0.42	-0.39	0.61	-0.13	0.79
	620-660	-0.12	0.74	0.22	0.61	0.26	0.30
	660-720	-0.36	0.19	0.08	0.75	-0.15	0.37
	>720	-0.18	0.51	0.06	0.79	-0.02	0.90
LTV	<=50%	-0.12	0.59	0.74	0.01	-0.61	<.0001
	50-80%	-0.03		0.11		-0.26	
	80-90%	0.55	0.03	-0.46	0.22	-0.07	0.66
	>90%	-0.39	0.50	-0.38	0.63	0.95	0.00
Inside MSA		0.32	0.01	-0.24	0.00	-0.03	0.63
Cash-Out Refi?		-0.03	0.63	-0.35	<.0001	0.16	0.00
Previous Loan Purpose	Cashout	0.02	0.70	-0.19	0.00	0.05	0.32
	Purchase	0.04	0.57	0.38	<.0001	0.20	0.00
LTV Change (if different from previous LTV)	<=50%	-0.28	0.46	1.25	<.0001	-0.07	0.79
	50-80%	0.17	0.61	0.83	<.0001	-0.08	0.73
	80-90%	-0.41	0.34	1.63	<.0001	-0.13	0.69
	>90%	0.51	0.67	-4.46	.	0.42	0.59
Yr. Employment	0-2	0.04	0.71	-0.27	0.03	-0.26	0.00
	2-5	-0.08	0.42	0.06	0.55	-0.02	0.74
	5-10	-0.06		0.03		0.10	
	10-20	0.06	0.51	0.21	0.02	0.20	0.00
	>=20	0.04	0.73	-0.03	0.78	-0.03	0.76
Refi Year		Collectively Significant					
House Price (compared to median house price by zip)	<1	0.14	0.11	0.42	<.0001	0.12	0.10
	1-1.25	0.24		0.31		0.10	
	1.25-1.5	-0.17	0.04	-0.11	0.24	-0.04	0.47
	1.5-2	-0.06	0.43	-0.27	0.00	-0.10	0.10
	>=2	-0.15	0.16	-0.35	0.00	-0.08	0.32
Self-Employed		-0.28	0.00	0.02	0.80	-0.14	0.02
Age Change	28-38	0.04	0.89	0.04	0.90	-0.01	0.96
	38-45	0.16	0.55	-0.21	0.34	-0.28	0.12
	45-55	0.24	0.43	0.00	0.99	-0.10	0.64
	55-65	0.17	0.59	0.32	0.26	0.50	0.03
	>=65	-0.81	0.39	-0.02	0.97	-0.09	0.84
Yr. Employment Change (if different from previous)	0-2	-0.08	0.66	0.28	0.19	0.07	0.64
	2-5	0.16	0.27	-0.05	0.76	-0.12	0.32
	5-10	-0.30	0.08	0.06	0.72	-0.20	0.12
	10-20	-0.06	0.73	0.01	0.95	-0.04	0.78
	>=20	0.45	0.05	-0.35	0.24	0.26	0.19

Table 3.7 Multinomial Logit Results: Switching Choices in Refinances

		ARM		Balloon		15-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
Intercept		Suppressed for Confidentiality					
Borrower Age	18--28	0.30	<.0001	0.46	<.0001	0.08	0.00
	28-38	0.06	0.00	0.08	<.0001	-0.06	<.0001
	38-45	-0.25	<.0001	-0.19	<.0001	0.19	<.0001
	45-55	-0.14	<.0001	-0.01	0.65	0.26	<.0001
	55-65	0.20	<.0001	0.08	0.00	-0.32	<.0001
	>=65	-0.17		-0.42		-0.16	
FRM-ARM Diff		-0.15	<.0001	-0.24	<.0001	0.70	<.0001
Market Rate		0.18	<.0001	0.01	0.30	-0.10	<.0001
Loan Age		-0.02	0.03	0.01	0.21	0.25	<.0001
Education		0.20	<.0001	0.18	<.0001	-0.13	<.0001
Appreciation	<0	0.26	<.0001	0.17	<.0001	0.45	<.0001
	0-5%	0.01	0.72	0.17	<.0001	0.00	0.94
	5-15%	-0.14	<.0001	-0.02	0.17	-0.19	<.0001
	15-50%	-0.23	<.0001	-0.42	<.0001	-0.57	<.0001
	>50%	0.10		0.10		0.31	
Same Originator		-0.29	<.0001	-0.28	<.0001	0.01	0.03
Became Single		-0.12	<.0001	-0.19	<.0001	-0.30	<.0001
Got Married		0.06	0.00	0.06	<.0001	0.07	<.0001
1st Time Buyer		-0.04	0.04	0.10	<.0001	0.06	<.0001
Out Self-Emplyd		-0.03	0.27	0.07	0.00	-0.06	0.00
Into Self-Emplyd		0.07	0.01	-0.12	<.0001	-0.14	<.0001
Have Savings		0.13	<.0001	0.09	<.0001	0.08	<.0001
Marital Status	Single M	0.25	<.0001	0.16	<.0001	0.00	0.63
	Single F	-0.06	<.0001	-0.14	<.0001	-0.10	<.0001
	Married	-0.19		-0.02		0.09	
Division	ENC	0.38	<.0001	0.38	<.0001	0.03	0.00
	ESC	-0.35	<.0001	-0.10	0.00	0.18	<.0001
	MAT	-0.28	<.0001	-0.24	<.0001	0.51	<.0001
	MTN	0.24	<.0001	0.18	<.0001	-0.37	<.0001
	NEG	-0.48	<.0001	-0.76	<.0001	0.07	0.00
	PAC	0.04	0.02	-0.14	<.0001	-0.65	<.0001
	SAT	-0.15	<.0001	-0.06	0.00	-0.13	<.0001
	WNC	0.11	<.0001	0.37	<.0001	0.18	<.0001
	WSC	0.49		0.37		0.18	
FICO Score	<=620	-0.51	<.0001	-0.93	<.0001	-0.51	<.0001
	620-660	0.11	0.01	0.14	0.00	-0.15	<.0001
	660-720	0.21		0.32		0.06	
	>720	0.19	<.0001	0.47	<.0001	0.60	<.0001
Income (as a percent of area median income)	<=0.8	-0.22	<.0001	-0.25	<.0001	-0.43	<.0001
	0.8-1	-0.18	<.0001	-0.04	0.05	-0.13	<.0001
	1-1.2	0.01		-0.02		-0.09	
	1.2-1.5	0.12	<.0001	0.02	0.37	0.11	<.0001
	>1.5	0.27	<.0001	0.29	<.0001	0.53	<.0001
Income Change (if previous income in different category)	<=0.8	0.29	<.0001	0.30	<.0001	-0.32	<.0001
	0.8-1	0.15	<.0001	-0.03	0.25	-0.13	<.0001
	1-1.2	-0.14	<.0001	0.01	0.71	0.05	0.03
	1.2-1.5	-0.01	0.79	-0.02	0.42	0.18	<.0001
	>1.5	-0.24	<.0001	-0.31	<.0001	0.13	<.0001

Table 3.7 Multinomial Logit Results: Switching Choices in Refinances – Continued

		ARM		Balloon		15-Year FRM	
Explanatory Variable		Estimate	Pr	Estimate	Pr	Estimate	Pr
FICO Change (if different from previous FICO)	<=620	0.28	0.00	0.56	<.0001	0.12	0.04
	620-660	-0.09	0.05	-0.05	0.34	-0.10	0.01
	660-720	-0.11	0.00	-0.14	0.00	0.05	0.02
	>720	-0.05	0.14	-0.23	<.0001	-0.12	<.0001
LTV Change (if different from previous LTV)	<=50%	0.22	<.0001	0.93	<.0001	0.90	<.0001
	50-80%	0.00		0.40		0.19	
	80-90%	0.15	<.0001	0.08	0.05	-0.37	<.0001
	>90%	-0.38	<.0001	-1.41	<.0001	-0.71	<.0001
Inside MSA		0.28	<.0001	-0.03	0.02	-0.19	<.0001
Cash-Out Refi?		-0.27	<.0001	-0.28	<.0001	-0.54	<.0001
Previous Loan Purpose	Cashout	-0.04	0.00	-0.15	<.0001	-0.32	<.0001
	Purchase	-0.10	<.0001	-0.02	0.03	0.13	<.0001
LTV Change	<=50%	0.27	<.0001	0.10	0.04	0.67	<.0001
	50-80%	-0.14	<.0001	-0.28	<.0001	-0.20	<.0001
	80-90%	-0.40	<.0001	-0.14	0.01	-0.15	<.0001
	>90%	0.23	0.01	0.41	0.01	-0.46	<.0001
Yr. Employment	0-2	0.31	<.0001	0.21	<.0001	-0.08	<.0001
	2-5	0.07	<.0001	0.08	<.0001	0.05	0.00
	5-10	-0.14		-0.13		0.02	
	10-20	-0.17	<.0001	-0.12	<.0001	0.04	<.0001
	>=20	-0.08	0.00	-0.04	0.01	-0.04	0.01
Refi Year		Collectively Significant					
House Price (compared to median house price by zip)	<1	-0.08	<.0001	-0.04	0.00	0.29	<.0001
	1-1.25	0.01		-0.07		0.10	
	1.25-1.5	-0.05	0.00	0.04	0.00	0.06	<.0001
	1.5-2	0.02	0.10	0.03	0.01	-0.17	<.0001
	>=2	0.10	<.0001	0.04	0.01	-0.28	<.0001
Self-Employed		-0.03	0.02	0.17	<.0001	0.14	<.0001
Age Change	28-38	0.22	<.0001	0.09	0.03	0.02	0.58
	38-45	0.26	<.0001	-0.01	0.85	0.08	0.00
	45-55	0.04	0.33	-0.22	<.0001	-0.06	0.04
	55-65	-0.10	0.02	0.00	0.93	0.20	<.0001
	>=65	-0.45	<.0001	0.26	0.00	-0.24	0.00
Yr. Employment Change (if different from previous)	0-2	-0.24	<.0001	-0.29	<.0001	-0.13	<.0001
	2-5	0.14	<.0001	0.00	0.93	-0.04	0.07
	5-10	0.08	0.01	0.21	<.0001	0.07	0.00
	10-20	0.00	0.96	-0.04	0.12	0.03	0.13
	>=20	0.11	0.00	0.09	0.01	0.08	0.00

Table 3.8 Estimated Marginal Effects on Product Shares

	Prob-ARM	**Prob-Balloon**	**Prob-FRM15**	**Prob-FRM20**	**Prob-FRM30**
Predicted Shares for Base	19.3	10.2	10.2	5.2	55.1
	ARM	**Balloon**	**FRM 15**	**FRM 20**	**FRM 30**
Age	Base is 38-45				
18-28	8.6	5.1	-4.2	-1.5	-7.9
28-38	5.4	2.4	-3.6	-1.3	-2.9
45-55	2.1	1.9	1.0	-1.6	-3.3
55-65	6.6	3.3	-2.4	-2.9	-4.6
>=65	6.9	2.1	-4.1	-3.4	-1.5
Marital Status	Base is being married				
Single Male	10.6	1.5	-1.2	-1.5	-9.4
Single Female	7.7	0.5	-1.4	-1.4	-5.5
FICO Score	Base is 660-720				
<620	-1.4	-3.0	-1.7	-0.5	6.7
620-660	-0.6	-0.5	-1.4	-0.7	3.2
>720	-3.9	-0.5	4.4	1.4	-1.4
Income	Base is 101-120% area median income				
≤80% Area Median Income	-0.8	0.2	-3.0	-0.9	4.4
81-100% Area Median Income	0.0	0.7	-1.1	-0.4	0.7
121-150% Area Median Income	1.0	0.3	1.7	0.0	-3.0
>150% Area Median Income	2.5	0.9	6.3	-0.2	-9.5
LTV	Base is 80-90%				
<=50%	-8.5	0.7	21.4	-0.2	-13.4
51-80%	-5.9	1.9	5.7	0.2	-2.0
>90%	-2.8	-5.7	-1.4	0.6	9.4
Years on Job	Base is 5-10 years				
<=2	7.6	3.6	-1.8	-1.2	-8.3
2-5	3.4	2.2	-1.0	-0.7	-3.9
10-20	-2.8	-0.7	1.3	0.6	1.7
>20	-1.4	0.0	1.0	0.3	0.1
Self-Employment	Base is working for someone else				
Self-Employed	0.5	3.0	4.3	-0.7	-7.1

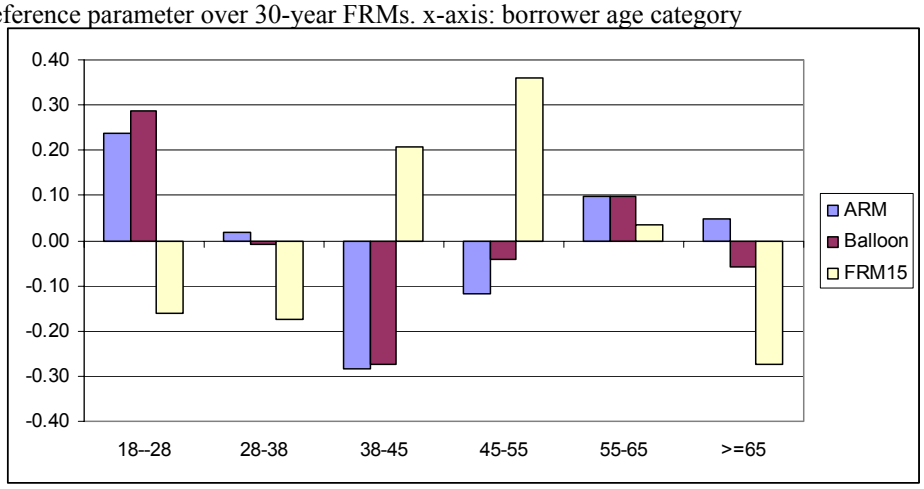
Table 3.9 Estimated Marginal Effects on Long-Term Product Switching

	Prob-ARM	**Prob-Balloon**	**Prob-FRM15**	**Prob-FRM20**	**Prob-FRM30**
Predicted Shares for Base	22.1	5.1	21.8	10.5	40.5
	ARM	**Balloon**	**FRM 15**	**FRM 20**	**FRM 30**
Age	Base is 38-47				
18-27	10.0	3.1	-5.4	-1.2	-6.4
28-37	7.1	1.4	-5.3	-2.1	-1.2
48-54	1.7	0.8	0.8	-2.0	-1.3
55-64	12.5	1.6	-8.7	-5.5	0.1
>=65	5.1	-0.5	-4.4	-5.7	5.5
Marital Status	Base is being married				
Single Male	9.3	0.5	-3.6	-2.8	-3.5
Single Female	3.7	-0.5	-3.3	-1.1	1.1
FICO Score	Base is 661-720				
<=620	-7.2	-3.1	-4.9	-0.3	15.4
621-660	-0.6	-0.5	-2.9	1.2	2.9
>720	-4.0	-0.2	9.2	2.0	-7.0
Income	Base is 101-120% area median income				
≤80% Area Median Income	-1.7	-0.4	-3.7	-0.7	6.5
81-100% Area Median Income	-2.9	0.2	0.3	0.2	2.2
121-150% Area Median Income	0.8	-0.2	3.0	-0.7	-2.9
>150% Area Median Income	0.2	0.3	9.7	-1.1	-9.1
LTV	Base is 81-90%				
<=50%	-7.9	2.0	24.3	-2.1	-16.3
51-80%	-5.8	0.9	10.7	0.0	-5.9
>90%	-6.0	-3.7	-2.7	3.0	9.4
Years on Job	Base is 5-10 years				
<=2	8.7	1.3	-4.2	-1.5	-4.3
2-5	3.5	0.8	-0.8	-1.2	-2.4
10-20	-0.7	0.0	0.5	0.1	0.1
>20	1.2	0.4	-1.4	-0.1	-0.2
Self-Employment	Base is working for someone else				
Self-Employed	-2.6	1.6	5.4	-1.9	-2.4

Figure 3.1 Borrower Age and Product Selection

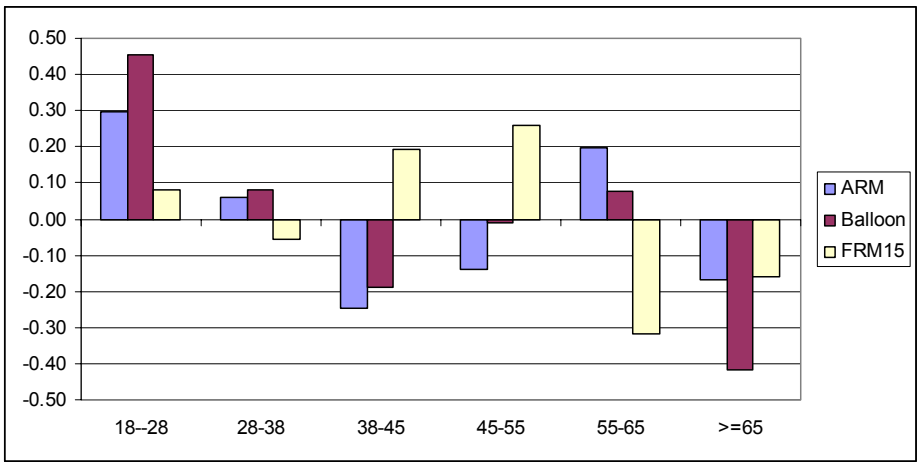
1. Cross-Sectional Preference

y-axis: preference parameter over 30-year FRMs. x-axis: borrower age category



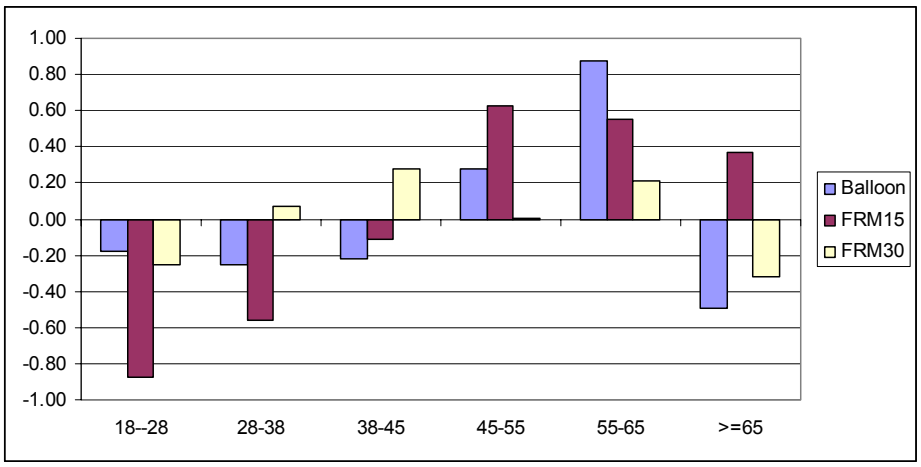
2. Age Categories and Switching Products

y-axis: preference parameter of switching to certain product over switching to 30-year FRM



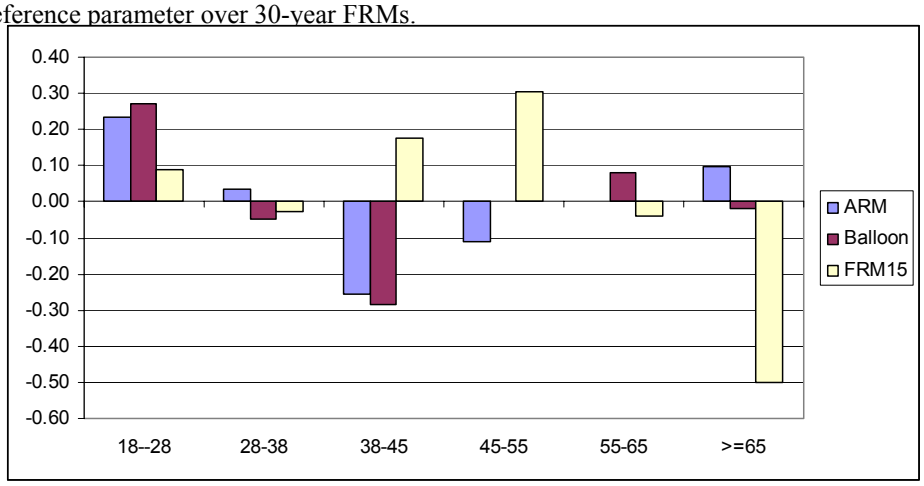
3. Age Categories and Switching from ARMs

y-axis: preference parameter over ARMs.



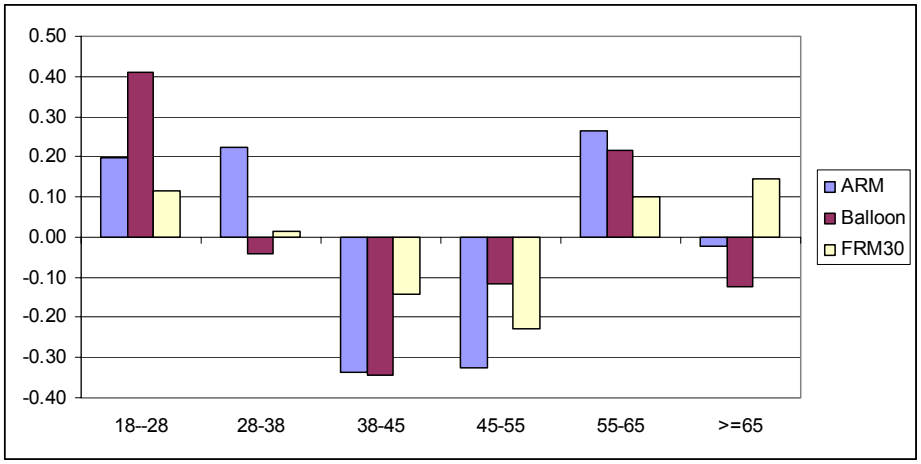
4. Age Categories and Switching from 30-Year FRMs

y-axis: preference parameter over 30-year FRMs.



5. Age Categories and Switching from 15-Year FRMs

y-axis: preference parameter over 15-year FRMs.



6. Age Categories and Switching from Balloons

y-axis: preference parameter over balloons.

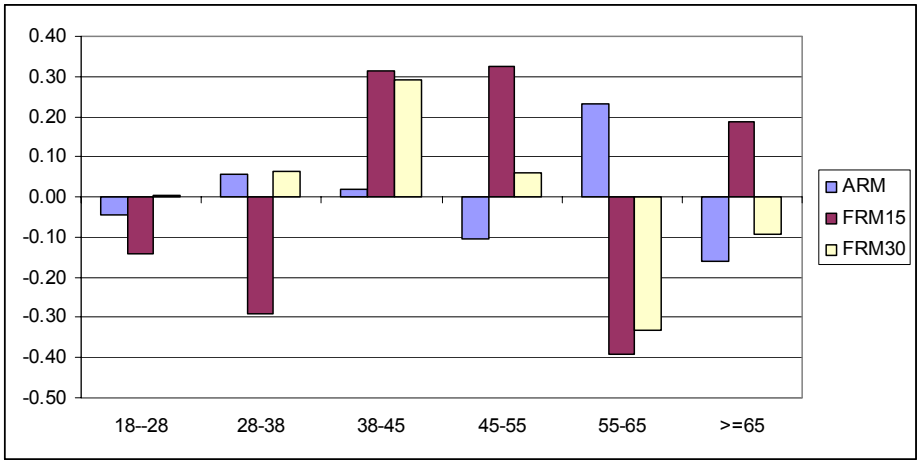
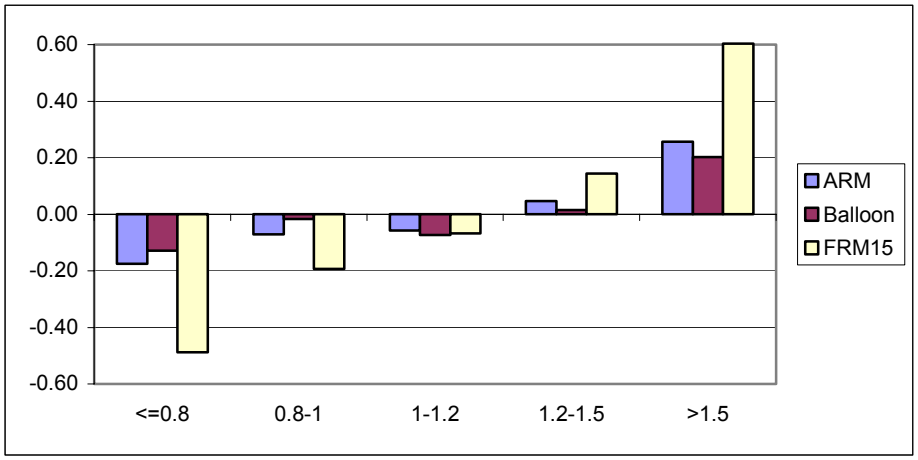


Figure 3.2 Income Level and Product Choice

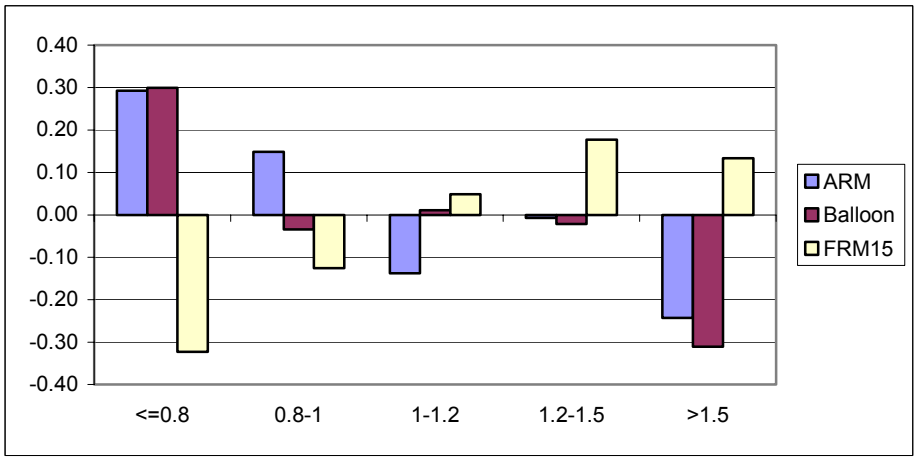
1. Cross-Sectional Preference

y-axis: preference parameter over 30-year FRMs. x-axis: income categories relative to area median income



2. Income Level Change and Switching Products

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs



3. Income Levels and Switching Products

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs

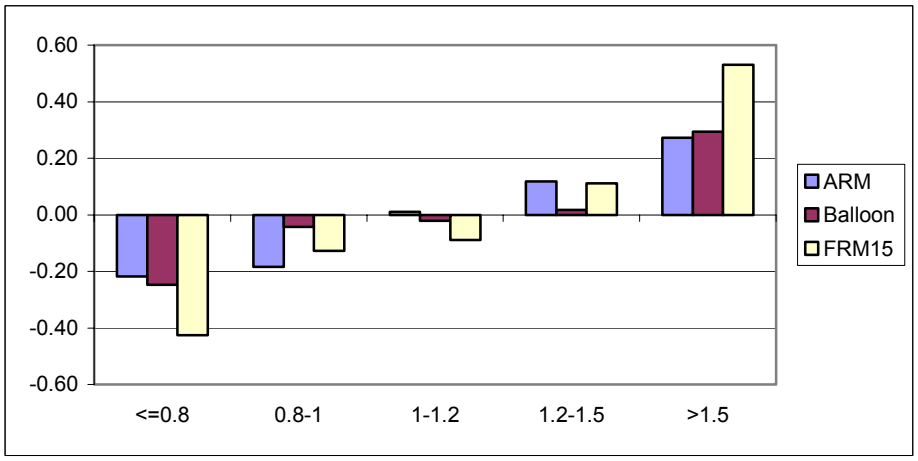
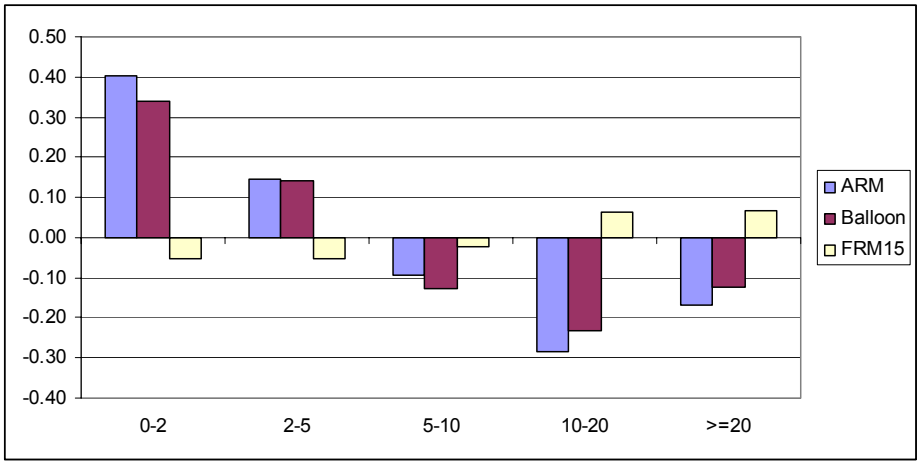


Figure 3.3 Year-on-Job and Product Selection

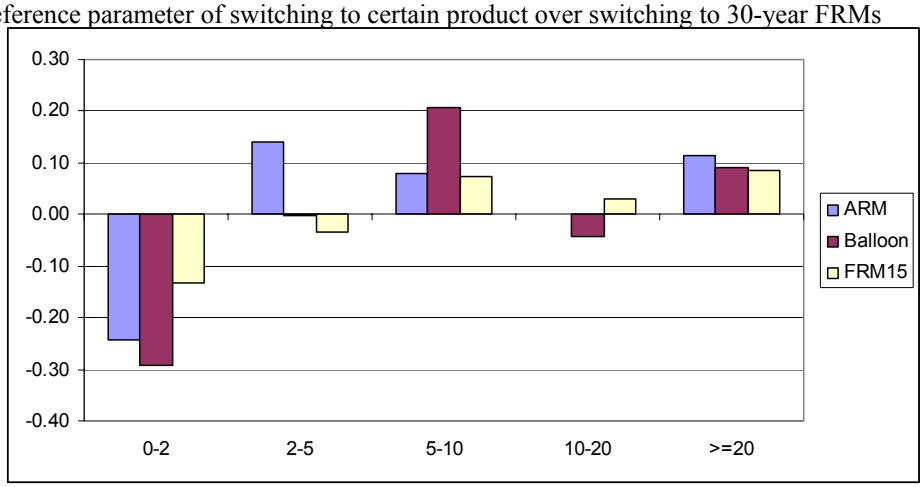
1. Cross-Sectional Preference

y-axis: preference parameter over 30-year FRMs. x-axis: number of years on the current job



2. Year-on-Job Change and Switching Products

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs



3. Switching Products within Constant Job Seniority

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs

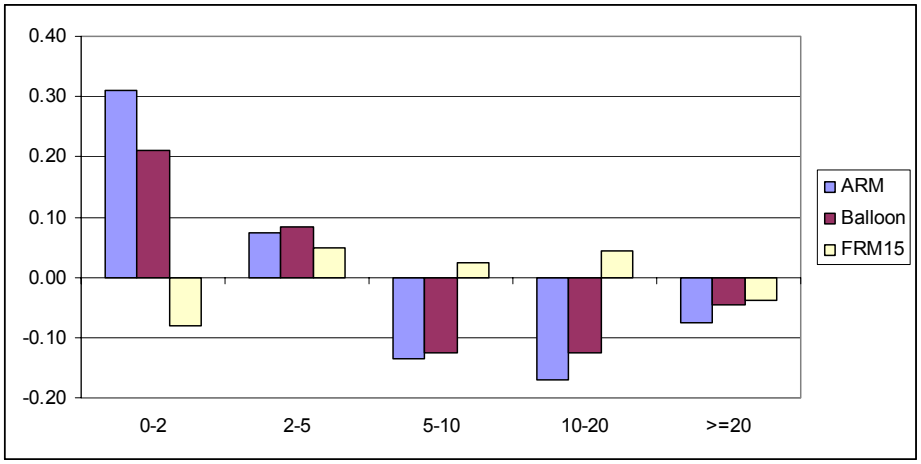
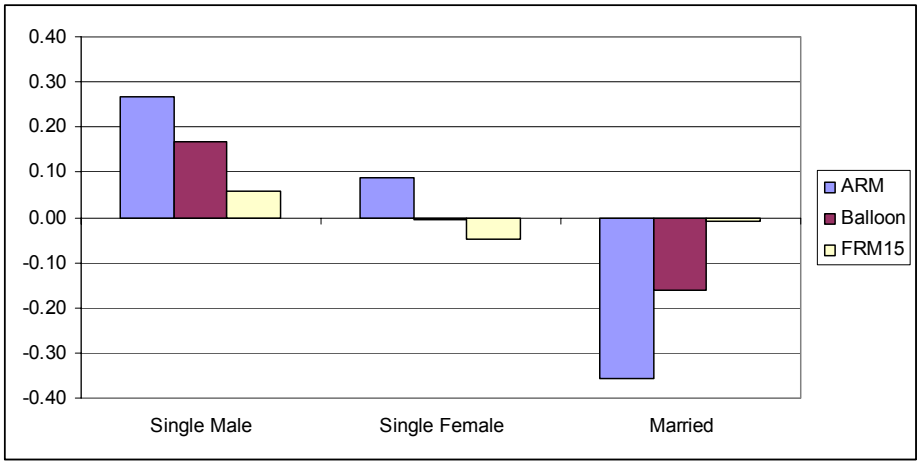


Figure 3.4 Marital Status and Product Selection

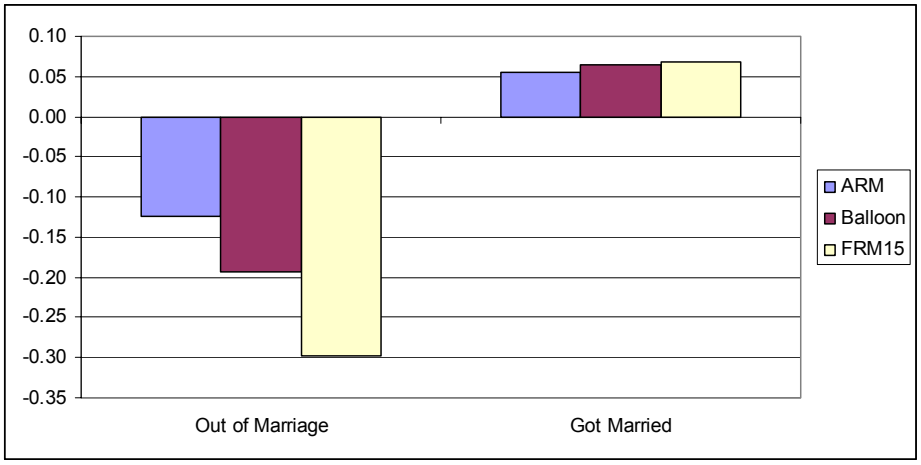
1. Cross-Sectional Preference

y-axis: preference parameter over 30-year FRMs. x-axis: marital status



2. Marital Status Change and Switching Products

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs



3. Switching Products within Constant Marital Status Categories

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs

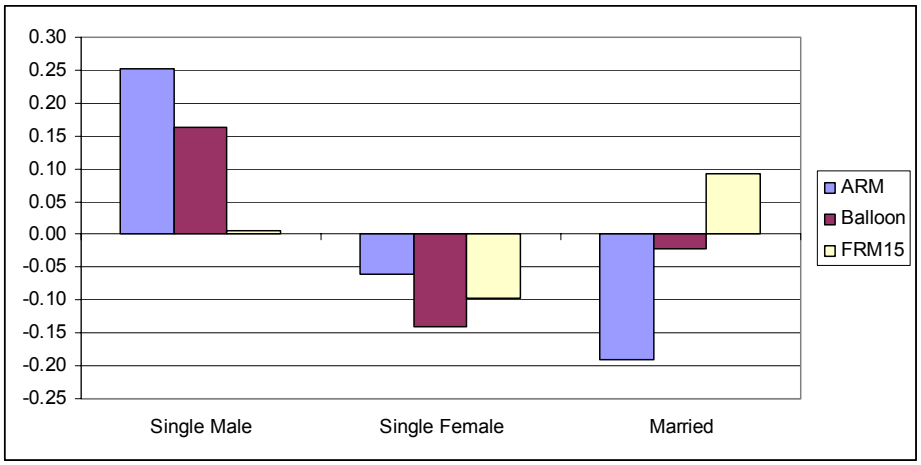


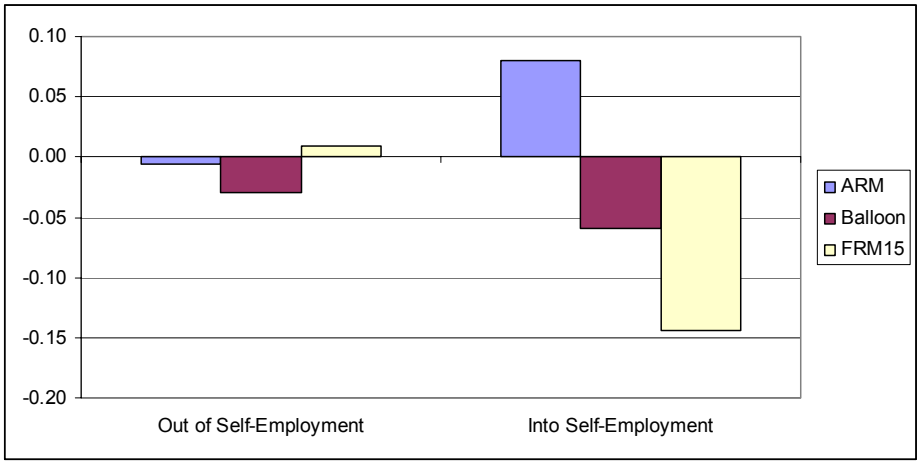
Figure 3.5 Employment Status and Product Selection

1. Cross-Sectional Preference

y-axis: preference parameter over 30-year FRMs. x-axis: self-employment status

2. Employment Status Change and Switching Products

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs



3. Switching Products within Constant Employment Status Categories

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs

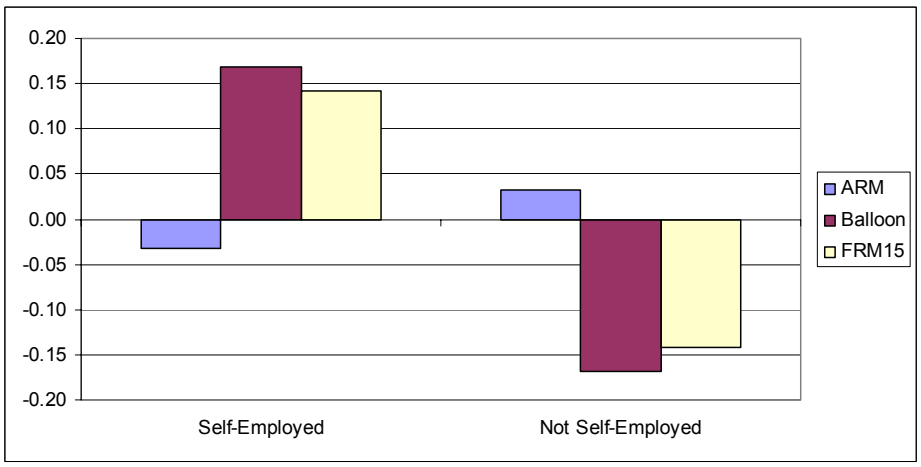
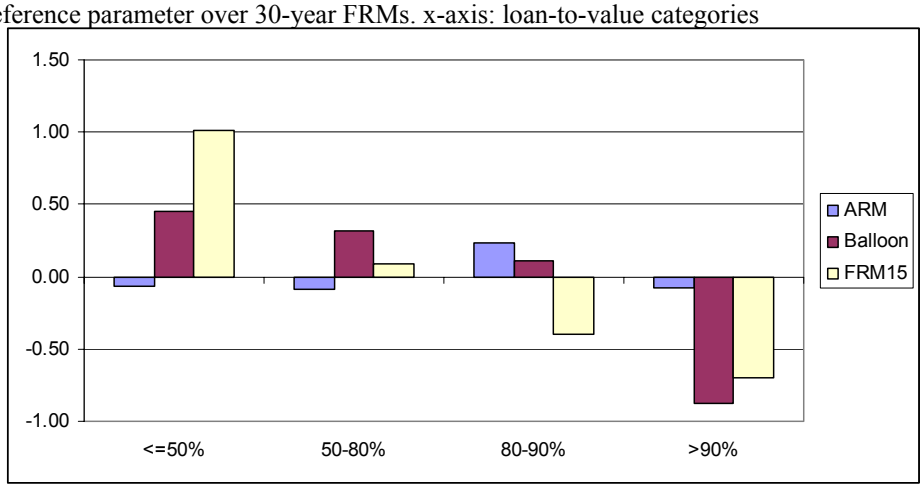


Figure 3.6 Loan-to-Value and Product Selection

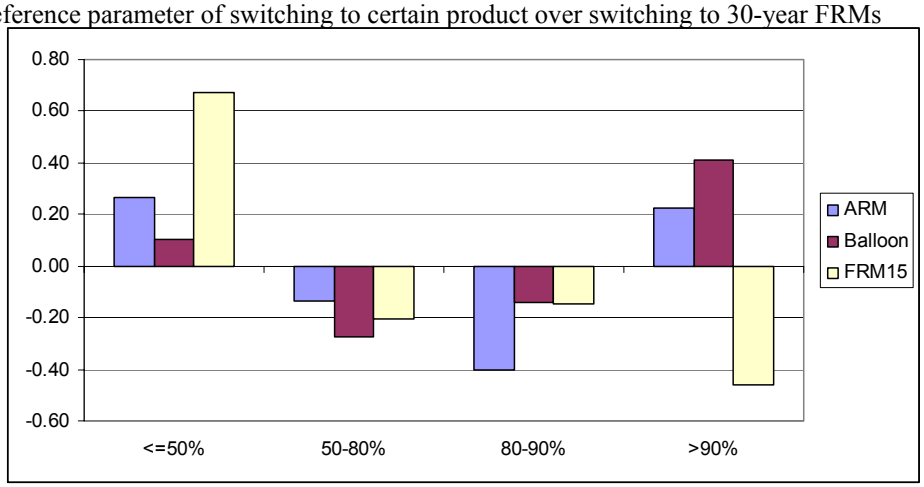
1. Cross-Sectional Preference

y-axis: preference parameter over 30-year FRMs. x-axis: loan-to-value categories



2. Changes in LTV Category and Switching Products

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs



3. Switching Products within Constant LTV Categories

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs

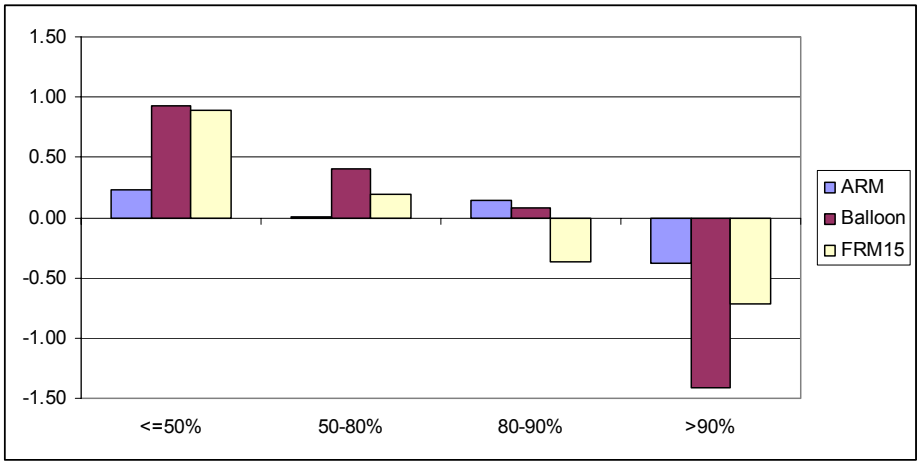
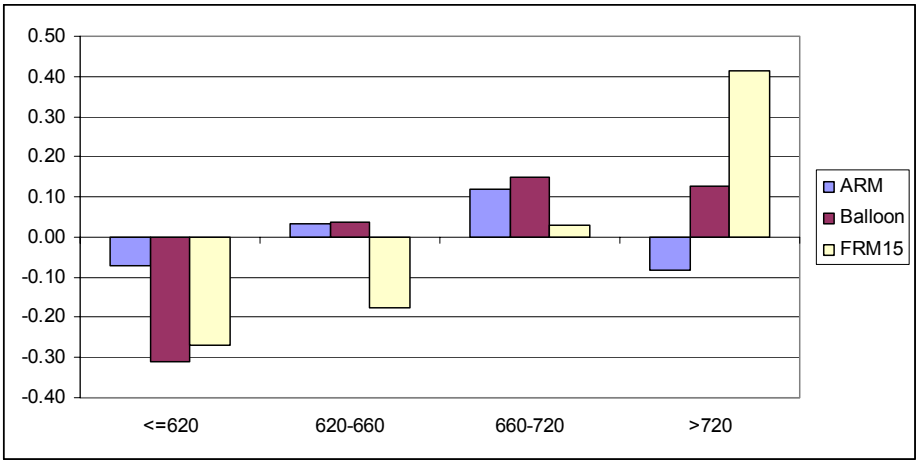


Figure 3.7 Credit Score and Product Selection

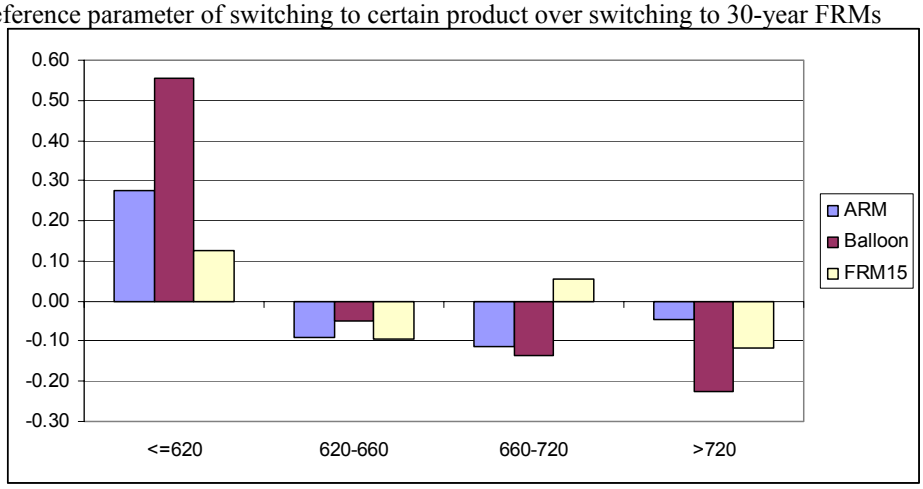
1. Cross-Sectional Preference

y-axis: preference parameter over 30-year FRMs. x-axis: credit score categories



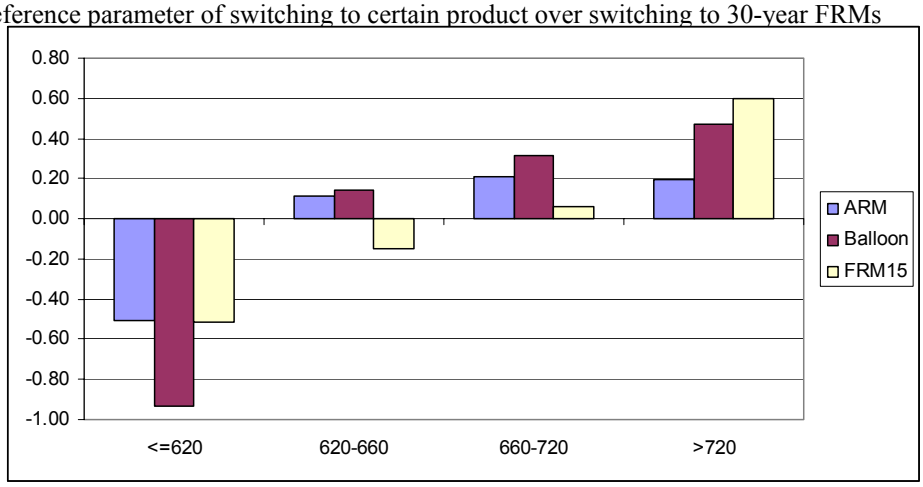
2. Credit Change and Product Switching

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs



3. Product Switching within Constant Credit Categories

y-axis: preference parameter of switching to certain product over switching to 30-year FRMs



Chapter 4

De-Mystifying the Refi-Share Mystery

4.1 Introduction

Refinance has important implications to the health of household finance and the general economy. Household consumption and investment benefit from refinance through lowering their interest payments and extracting home equity in the form of cash-out refinancing. Federal Reserve Chairman Greenspan recognizes the contribution of housing sector, especially the refinance activities of households, to bolstering the economy. Especially important in the United States have been the flexibility and the size of the secondary mortgage market. Since early 2000, this market has facilitated the large debt-financed extraction of home equity that, in turn, has been critical in supporting consumer outlays in the United States throughout the recent period of economic stress. Zandi [2002] estimates that housing and mortgage activity accounted for nearly one-third of US economic growth between 2000 and 2002. A study that covered refinancing in 2001 and early 2002 found that about 61 percent of the monies went toward home improvements and the repayment of other debts; the use of the remaining funds was approximately split between consumer expenditures and various financial or business investments (Canner *et al*., 2002, Table 6).

A fairly accurate estimate of the refinance share is basis for estimating total dollar amount cashed-out through refinances. The share of refinance loans in the total volume of

new single-family mortgage originations is of interest to many parties: those in the mortgage industry, the academia, and the regulatory agencies.

Currently there are four sources that independently collect and report the refinance share information: data from the Home Mortgage Disclosure Act (HMDA) aggregated by the Federal Financial Institutions Examinations Council (FFIEC), the weekly mortgage application survey conducted by the Mortgage Bankers Association (MBA), Freddie Mac's monthly Primary Mortgage Market Survey (PMMS), and the quarterly mortgage data reports from the National Mortgage News (NMN).

The NMN surveys about 100 largest mortgage originators each quarter since 1998. Their reported total market share is near 85 percent, according to the latest survey as of the fourth quarter of 2004. From the surveyed lenders, a portion would not disclose their refinance shares; therefore, their population for the refinance calculation is smaller than the total, usually between 60 and 95 lenders. In the most recent survey 87 lenders reported refinance shares. NMN adds up the total refinance dollar volume across these lenders and divides by the total origination volume of the same group of lenders to arrive at the refinance share. The PMMS surveys 125 lenders on a monthly basis since 1987. Lenders are asked about the proportion of applications they received in the previous month that are refinances. Both large and small lenders are included in the survey, a representative mix of thrifts, commercial banks and mortgage lending companies, roughly proportional to the level of mortgage business each type commands nationwide. The refinance shares reported by each lender are totaled and averaged for the final reported market refinance share. The MBA surveys about 20 large lenders each week since 1990, including mortgage bankers, commercial banks and thrifts and covers

approximately 50 percent of the market. Both shares of number of applications and dollar volumes are reported. HMDA was implemented by the Federal Reserve Board and made permanent in 1988 to serve the multiple purpose of making public the lending institutions' efforts in extending housing credits, identifying potential areas where the efforts are needed, and discouraging discriminatory lending. Institutions that are required to report under HMDA must meet the minimum level of assets or origination volume requirement and have a home or branch office in a metropolitan statistical area (MSA), or, in the case of nondepository institutions, have lending activity in an MSA. Our annual HMDA data go back to 1990 that have both application and origination data, based on which refinance share can be calculated. We also receive a quarterly origination volume series from the Federal Reserve Board, which report total refinance volume and origination volume by quarter, and a refinance share can be calculated for each quarter by dividing the refinance amount by the origination amount. For comparison purposes, we convert all the series into quarterly series, taking average of monthly or weekly refinance shares that comprise the quarter.

We observe persistent discrepancies between the refinance shares reported from different sources. Refinance share reported by HMDA is consistently higher than that reported by PMMS or MBA. For quarterly data between 1990 and 2003, the difference between HMDA and PMMS runs between –9 to 17 percent, with an average of 5.4 percent. Of the 56 quarterly data points compared, only in 11 quarters is the PMMS refinance share higher than the HMDA refinance share. Compared with MBA reported refi-share for the same time period, the refinance share from HMDA is only lower than that from MBA in 4 out of 56 quarters. The difference from the two series averages 7.3

percent, with a range of –7 to 21 percent. NMN also reports lower share than HMDA in the earlier years. Since 2002, that difference has practically disappeared and the two series are almost identical. The average difference between the two series from the first quarter of 1998 to the fourth quarter of 2003 is 2.6 percent, while since the first quarter of 2002, the average difference is only 0.25 percent. The MBA and PMMS series show greater similarity. The average difference from 1990 to 2003 is 2 percent. They have also converged in the latter half of the period studied: since 1996, the average difference is only 0.5 percent. Figure 4.1 illustrates the behavior of the series described above. The line representing HMDA refinance shares consistently lies above the others. While NMN and HMDA move together in most cases, MBA and PMMS appear to be in close proximity.

The patterns of the difference between the series suggest that the discrepancy between the series is systematic rather than random. It is the purpose of this paper to investigate the various sources that may lead to the observed differences separately. Our study contributes to the better understanding of the different refinance series, reconciliation between the reported shares, and directions for the proper application of the appropriate series for different purposes.

4.2 Analysis

In our analysis, we evaluate the potential sources of differences in the way each refinance series is constructed, from the survey correspondents covered to the final computation of the refinance shares. We perform tests to determine the validity of each

hypothesis, and quantify the effect of each factor on the differences between the refinance shares reported to single out one or more largest contributing factors.

4.2.1 Application vs. Origination Series

The most apparent discrepancy lies in the stages of the mortgage-lending process different series intend to describe. The PMMS and MBA survey the refinance percentage of mortgage applications. The HMDA and NMN focus on the refinance percentage of mortgage originations. Under this hypothesis, the differences between the refinance shares measured in the application stage and the origination stage arise from the differences in behavior between purchase and refinance mortgages from application to origination. Specifically, three types of difference exist: difference in fallout rates of purchase versus refinance applications, or the probability of an application resulting in origination; difference in the timing of report, in that a mortgage is included in the calculation of refinance share of applications before it is counted in the origination refinance series, usually by one or two months ahead; difference in the time needed from application to closing of the loan between purchase and refinance applications, which could mean that some purchase and refinance loans are matched up by the origination refinance series as originated in the same quarter, yet with their applications made in different quarters, the application refinance series account for them in different quarters.

4.2.1.1 Fallout Rates

One hypothesis is that purchase mortgages have higher fallout rates from application to origination due to more elements of uncertainty: the deal of the purchase may fall through; purchase mortgage applications may be rejected at a higher rate than those for refinance due to the fact that some of the purchasers are first-time applicants for a mortgage without established credit; the borrowers may put in several applications with different lenders before settling with the one that offers the preferred rate and terms, and as a result the other applications, even though approved by the lender, may not result in originations due to the borrower's cancellation. All of these are potential factors that contribute to a higher refinance rate in mortgage originations than applications.

To test this hypothesis, we use HMDA annual data to compare the fallout rates between home-purchase and refinance loans by year of application. We find that consistently home-purchase loans do not exhibit higher fallouts than refinance loans. For most of the years the rates are comparable. In some cases, home-purchase loans even have lower fallout rates than refinance loans. The fallout rates can be found in Table 4.1.

Alternatively, we use HMDA annual data to compare the refinance share for all loans that are originated with that of all the loan applications that did not result in an origination. The results are listed in Table 4.2. We find that the refinance percentages are similar for loan originations and applications, both in total number and dollar volume of loans. Occasional exceptions support the opposite of the hypothesis: total loan applications have higher refinance rate than loan originations.

4.2.1.2 Report Timing

Since it usually takes one to two months for a mortgage to complete the process from application to origination, it is possible that the refinance series based on loan applications lead the series based on originations by approximately the same amount of time. In the case of quarterly series, this timing difference should not result in an absolute lead-lag relationship where one series traces the other by a quarter, but rather a 'subdued' effect. This should be more pronounced right before and after a change in the refinance environment, such as a refi-boom, with the application series showing elevated refinance rates relative to the origination series in anticipation of the boom, and a drop in refinance levels before the origination series confirms that the boom is over.

With the PMMS monthly data and MBA weekly data, we are able to construct hypothesized quarterly series of originations with the leading time taken into consideration. Both a one-month and a two-month lead are used to test the hypothesis and the resulted origination series are compared with HMDA quarterly refinance percentages. This results in a mitigation of the differences between the series in some quarters, such as 2002Q1 and 2003Q3, where a large drop in application is observed but not in originations. The third quarter of 2003 shows the most significant improvement: the difference is reduced from 15 percent to 0 when a two-month lead is considered with the PMMS data. An even more dramatic reduction is observed with the MBA data for the same quarter: from 19 percent to 1 percent.

However, in some other quarters lagging the application series magnifies the differences instead of reducing them. While the application series lead the originations in falling out from a refinance boom, the two series tend to go up by about the same

magnitude at the same time from the beginning to the peaking of the boom. Therefore, lagging the application series causes it to trail the origination series when there is a rapid increase in refinance share. Overall, adjusting for the time lead does not show much improvement in accounting for the differences. The average quarterly difference from 1990Q1 to 2003Q4 between HMDA and PMMS refinance series is 5.43 percent. When moving the PMMS series one month behind to match with HMDA reporting quarters, the average difference from the resulting series is 5.54 percent, even larger than the original series. Allowing the PMMS to lag by two months results in an average difference of 5.64 percent. The average absolute differences are 6.70, 6.22 and 6.86 percent respectively. We repeat the same exercise with MBA refinance shares. The average quarterly differences between HMDA and MBA reported refinance percentages, MBA lagged by one month, and MBA lagged by two months are 7.33 percent, 7.46 percent, and 7.63 percent respectively. Taking the absolute value of the quarterly differences shows an average of 7.46 percent and 7.70 percent when one-month and two-month lags are used, compared to an average difference of 7.79 percent with the original series. Therefore, it is suspected that the effect of the mismatch of reporting timing is inconsistent through time and insignificant overall.

4.2.1.3 Time to Close

As explained previously, purchase and refinance applications might take different length of time from application to closing of the loan. The direct impact on the difference in measurement of refinance share by originations and applications is that the origination series may put together purchase and refinance loans applied for in different quarters in

tabulating refinance share for a certain quarter. Specifically, the application for refinance loans is hypothesized to take less time to be approved than the purchase application, since the refinance customers supposedly have more complete and better qualifying documentation as a result of their previous purchase or refinance experience. Furthermore, some refinance programs such as streamline refinancing are designed to shorten the time a refinance application spends waiting for approval. If this is indeed the case, the difference between the series based on originations and applications should be most prominent in the fourth quarter because according to HMDA, loans whose decisions are still pending at year end should be included in the next year's report. If more purchase loans are pushed off to the next year's reporting, higher refinance percentages should be observed in the fourth quarter with HMDA data than MBA or PMMS.

This can be tested by taking the difference between HMDA and PMMS or MBA quarterly refinance series and checking to see if the series of differences in the fourth quarter of each year is significantly different from series of differences from other quarters of the year. The series of quarterly differences can be found in Table 4.3. We see that, contrary to the hypothesis, differences in the fourth quarter are actually smaller than those of the first and second quarter. The t-test results do not show any significance in comparison of the means between the fourth quarter and other quarters at 5 percent level. Another test performed is a simple regression with the HMDA series as dependent variable and MBA or PMMS series as independent variable, together with quarterly dummy variables. The results are presented in Table 4.4. With PMMS as independent variable, none of the indicators for first, second or third quarters are significant at 5 percent level. In the regression with MBA, the first and second quarter dummy variables

are significant and positive, meaning that the amount by which HMDA exceeds MBA is significantly smaller in the fourth quarter than in the first or second quarters. This contradicts our assumption about the effect of time-to-close between home-purchase and refinance loans. Overall, our findings suggest that either the time it takes from loan application to origination does not make a difference in refinance share calculations, or it actually takes longer time for a refinance loan to close than the home-purchase loans, which results in lower fourth quarter differences than first and second quarter differences as we observe between HMDA and MBA.

4.2.2 Inside- and Outside-MSA Coverage

There are inherent differences between the series in terms of coverage of reporting institutions. PMMS surveys both national and local lenders in compiling its results. NMN reports the cumulative refinance percentage, based on total refinance dollar volume divided by total origination volume summed across the 60 to 95 lenders that report their refinance originations from the list of top 100 lenders in origination volume for each quarter. The lender requirements for HMDA are slightly different for depository and nondepository institutions. A depository institution is required to file reports under HMDA if it has a home or branch office in an MSA, if it has at least one mortgages origination that is home-purchase or refinance of home-purchasing mortgage, and if it has assets more than a certain amount in the preceding year (for 2003 reporting, the amount is $32 million). A nondepository institution is required to report if it has at least 10 percent of its total dollar volume lending activities in home-purchase (including refinance) mortgages, and if it has a home or branch office in an MSA or receive applications for,

originate or purchase at least 5 mortgages in an MSA, and if its asset level meets certain amount requirement ($10 million for 2003 reporting) or it has originated more than 100 home-purchase loans in the year considered.

The requirement that a lender needs to have a branch in the city of an MSA to be covered by HMDA makes the sample lenders in HMDA likely to have a higher percentage of lending activity inside MSA areas. The geographical locations of borrowers may affect their likelihood of refinance. Borrowers who live in an MSA may be more financially savvy and better educated in managing household balance sheets. The concentration of lenders in the MSAs may lead to more competition in the form of advertisement that may result in more borrower awareness of refinance opportunities and a higher refinance possibility among households. Properties inside MSA areas may also experience faster house price appreciations, which may constitute additional incentives for borrowers to refinance as well.

To see whether this MSA effect contributes to the differences in the series, we stage a two-step test. First, we test to see if HMDA does represent more heavily MSA originations than other surveys that do not have a prior geographical bias in market representation. Second, we test for the difference in the refinance patterns between originations in the MSA and non-MSA areas.

In addition to HMDA, two surveys are used to compare the MSA versus non-MSA origination volumes: the residential finance survey (RFS) and the American Housing Survey (AHS). We use 2001 RFS to test for the percentage of loans originated inside an MSA for years 1999, 2000 and 2001, and compare the results obtained with the percentage of MSA originations from HMDA for the corresponding years. Single-family

residences from both the owner-occupied and rental properties are included in our calculation of the RFS sample. We find that there is no difference between the HMDA representation and that of the RFS of the relative weights between MSA and non-MSA areas for the years examined. If HMDA does over-represent MSA originations, RFS does not reflect a corrected representation either.

The AHS is a biannual national survey. Responses to questions regarding whether the current mortgage is a refinance of a prior mortgage are only collected recently starting in the 2001 survey. The question is asked for first and second liens only. The AHS differs from the RFS in that no mortgage characteristics information is available for non-owner occupied properties. According to our results from the RFS, the MSA percentage of originations can have a wide difference between the owner occupied and non-owner occupied properties. Therefore, we compare our AHS results with the subset of owner-occupied only properties from HMDA. We use both the 2001 and 2003 AHS data to find the MSA share of total originations for owner-occupied properties from 1999 to 2003. Comparison with the HMDA results reveals a higher percentage of non-MSA loans reported in the AHS than the HMDA, which seems to indicate that there is indeed a bias in geographical representation in the HMDA data, at least in the owner-occupied type of residence, if one believes that the AHS reflects more general sample coverage. One more caveat to this result is that the publicly available AHS microdata, based on which we obtained the foregoing results, use 1983 definitions of metropolitan area boundaries. These boundaries are based on population and commuting patterns reported in the 1980 census. Therefore, it may lead to an undercount of outside MSA originations due to the fact that some areas defined as outside MSA in the 1980 census may be included in an

MSA in more current censuses. The difference of MSA originations as a percentage of total originations runs between 3 to 6 percent. The comparison from the three sources can be found in Table 4.5.

With results from the AHS supporting our hypothesis regarding MSA representation of the HMDA, we turn our attention to the difference in refinance percentages between total MSA and non-MSA originations. We calculate the refinance percentages of mortgages originated inside and outside an MSA separately using both the RFS and AHS data. The results are in Table 4.6. In general, the refinance percentage reported by the RFS is both lower and with less variation across years compared to those reported by AHS and HMDA. Higher refinance percentages are found for the areas outside MSAs according to the RFS in years 2000 and 2001. Earlier years, 1998 and 1999, do show that areas inside MSAs have higher refinance percentages. The overall result is therefore inconclusive.

In contrast, results from the AHS show that, as expected, refinance percentages are consistently higher inside MSA areas, compared to the areas outside of MSAs, regardless of whether only first lien or both first and second liens are considered. The difference in refinance percentage runs from 0.6 percent in 2001 to 11 percent in 2002.

The effects of lender locations in MSAs on refinance percentages therefore could be inclusive or biased upward, depending on the benchmark data used. When the 2001 RFS is used as the benchmark, HMDA does not reveal either a higher concentration in MSA originations nor do the areas inside MSAs have higher refinance percentages than those outside. Yet when compared with the 2001 and 2003 AHS, HMDA shows an elevated percentage of inside-MSA originations. Combined with the results from AHS

that higher refinance percentages are associated with inside-MSA areas, this indicates that one possible explanation of the persistent higher refinance shares reported in HMDA is due to its requirements regarding lender locations relative to MSA areas.

4.2.3 Lender Size and Computation Methods

We investigate the double effect of lender size and calculation methods employed by the different sources. It is our hypothesis that large lenders, measured by origination volume, have higher refinance percentage in total originations. Therefore, the mixture of the lenders of different sizes in the sample makes a difference in the results. HMDA requirements regarding minimum lender asset level or minimum number of mortgages originated is likely to bias its refinance results upward compared to the general market. If origination amount and refinance percentage by lender are positively correlated, the calculation method of average refinance percentages across lenders also matters. In HMDA and NMN, the refinance percentage is calculated by dividing the total refinance dollars by the total origination dollars, or as the following equation describes:

$$\overline{P}_{refi} = \frac{\sum \mathrm{Re}\, fi_i}{\sum Originations_i},$$

where i represents individual lenders, and Refi and Originations refer to the dollar amounts for the period calculated.

In PMMS, the average of the refinance percentages across lender are taken to arrive at the mean refinance percentage. In other words, the sum of reported refinance percentages is divided by the total number of lenders,

$$\overline{P}_{refi} = \frac{\sum P_{refi,i}}{n}.$$

In this case, the large lenders' weights are reduced to the same as those of small lenders, whereas in the case of HMDA and NMN, the large lenders are assigned a bigger weight according to their total originations. With the positive correlation between origination volume and refinance percentage, HMDA and NMN should report higher refinance percentages even if the composition of lender sizes are the same across surveys.

4.2.3.1 Refinance Share and Lender Size

We test for hypothesized connection between lender origination volume and refinance percentage with HMDA data. For a description of the data, we separate HMDA data into different groups based on loan characters, lender characters, and geographical locations and study the refinance characteristics of each group.

First, we compare the refinance percentages between loans made by subprime lenders, lenders that specialize in manufactured housing, with loans made by prime lenders, which can be further divided into conventional conforming loans, government-insured loans, and jumbo loans. The lenders only start to report in HMDA their types in 1993, so we use the reported types for each lender as of 1993 to determine the types of loans originated between 1990 and 1992. Figure 4.2 shows the different patterns for these groups for years 1990 through 2003. Both the subprime loans and mobile home loans do not exhibit the same amount of variations as the other three types of prime loans. A partial explanation is that they are not as sensitive to rate changes as the prime loans given that there exist a higher percentage of loans with prepayment penalties among the

subprime loans, and the rate-savings induced refinance is not triggered under the option to refinance is deeper 'in-the-money' than ordinarily the case among prime loans where prepayment penalties are rare. While both series are relatively stable in refinance variations across years, the levels of subprime loans always have a higher refinance share than the mobile home loans. When compared to prime mortgages, the level of refinance share of subprime mortgages are always on the higher end, and that of the mobile home loans are always below the prime mortgage level. The average refinance level of the subprime loans is 62 percent for the period of 1990 to 2003, while the average level of the mobile home loans is only 21 percent. Among the prime loans, the year-over-year change in refinance percentage follows the same pattern for all three groups, with the level of the government insured mortgages consistently as the lowest. The average refinance percentage of the government insured group across the years is 25 percent, compared to about 50 percent with jumbo and conventional conforming loans. Through the years the level of refinance share of jumbo loans and conventional conforming loans do not differ from each other in any significant pattern. The reasons behind the difference in refinance propensity between jumbo and conforming loans have to do with the financial motives. Jumbo loans are known to bear higher interest rates than the conforming loans. The interest rate at which an average borrower considers profitable to refinance is thus higher for jumbo loans than conforming loans. Due to higher loan amount, the potential interest savings from refinancing at a lower rate is also greater with jumbo loans, even when the same rate drop is experienced by the jumbo and conforming borrowers. Borrowers with jumbo loans are more prone to financially motivated refinances also because the properties the jumbo loans are secured by tend to be of higher

values and experience more price appreciation. The borrowers then have the incentive to liquidate some of the home equity built up through cash-out refinancing. All of the above three reasons lead to the hypothesis that a higher percentage of refinance should be observed with jumbo loans. However, such is only the case for years 1990, 1994 through 1997, when the overall refinance shares were low and rates were high. This is consistent with the first hypothesis that higher refinance percentages are observed with jumbo loans because of the jumbo-conforming spread, which is particularly true when rates are considered too high for most conforming borrowers to find refinancing rewarding.

We also compare the refinance share of total originations by different types of financial institutions. Five types of institutions are considered: commercial banks, savings banks, credit unions, independent mortgage companies, and subsidiary mortgage companies. An illustration of their refinance shares through the years can be found in Figure 4.3. From the annual numbers, credit unions consistently show higher refinance rates than other types of institutions. The average refinance percentage across the years is 53 percent. Commercial banks and savings banks follow with 49 percent and 50 percent average refinance share respectively. Independent mortgage companies and subsidiary mortgage companies round out the bottom with an average of 45 percent each. The MBA survey reports that their respondents include mortgage bankers, commercial banks and thrifts. Since it is shown here that the credit unions, left out of the MBA survey, tend to have higher refinance percentages, and the mortgage companies tend to have the lowest, this could also help to explain the positive difference between HMDA refinance rates and the MBA percentages, though the effect may be limited, due to the small volume of mortgage originations of the credit unions.

By geographical location, originations inside an MSA area show higher refinance percentages than those outside an MSA from 1990 to 1994. The trend was reversed from 1995 to 2000, with loans originated outside MSAs having higher refinance shares. For years 2001 to 2003, the areas inside and outside MSAs are indistinguishable in refinance shares. When grouped into geographical regions, as shown in Figure 4.4, the West was the leading region in years 1990 through 1995, after which the West was caught up, and later surpassed, by the Midwest in refinance shares, though the difference is not substantial. The Northeast region comes in third consistently in refinance percentages, and the South is always with the lowest refinance share. The average of the South is only 40 percent, compared to the 52 percent average in the West. The fact that more mobile homes are found in the South region, which are shown to have the lowest refinance rates, may help explain the regional differences.

Because of the various refinance behaviors exhibited by the different groups, we use an OLS regression with a set of explanatory variables including lender size to test for the relationship between size and refinance percentage with individual lenders. We use both the fraction of refinance originations and the log transformation of the refinance percentage of total originations by lender, denoted by

$$y_i = Log\left(\frac{P_{refi,i}}{1 - P_{refi,i}}\right),$$

as our dependent variable. The results obtained are similar. We include only the results from the percentage regression in our tables.

We pay special attention to two years: 2000 and 2003 in our study, because year 2000 represents the lowest refinance percentage in a decade, and year 2003 the highest.

Much can be learned of the patterns of refinance originations across lenders from these extreme cases. Our analysis is based on both lenders, defined as individual HMDA filers, and lending organizations, defined as lender-state combinations. When a lender is active in several states, it is considered a separate lending organization in each state the lender engages in mortgage originations. We distinguish between the two definitions because while corporate characteristics and policies affect the originations at an overall lender level, individual markets differ in state laws and restrictions, local housing market conditions, mortgage rates and terms, strength of lender representation in the particular area, even borrower attitude toward refinance. We intend to capture both the general and local market characteristics by performing analysis at the lender-state level.

We first test the hypothesized relationship between lender size and refinance percentage across lenders on the national level. Our explanatory variables include dummy variables designating lender type: savings bank, commercial bank, credit union, or independent mortgage company; minority or women-owned institution flag; lender size proxied by the natural log of total origination volume in the year. Because of the different patterns between conventional and government-insured mortgages, we perform the OLS on the two types of mortgages separately. Excluded from the sample are subprime and mobile home loans. We also focus our study on loans made inside MSA areas only. The mean values of the variables included can be found in Table 4.7. Regression results for the conventional prime mortgages for both 2000 and 2003 are in Table 4.8.

For 2003, refinance share of both the conventional and government-insured mortgage originations are positively correlated with lender size, indicating that larger lenders, defined by higher origination volume on a national level, do have higher

refinance percentage than smaller lenders in both conventional and government-insured markets. While credit unions have a significantly positive coefficient in both regressions as well, meaning that they issue significantly higher refinance percentage of mortgages than the subsidiary mortgage companies, no other factors are significant in the government-insured regression. For conventional loans, savings banks have significantly higher refinance percentages than the mortgage company subsidiaries, and independent mortgage companies have significantly lower percentages. Institutions owned by minority or women have lower refinance percentages than others.

Results from the same regression applied to 2000 HMDA data show that for conventional originations, the lender size effect is small but significantly positive; for government-insured originations, larger lenders are associated with lower refinance percentages. No other explanatory variables are significant in the government-insured refinance percentages. Commercial banks and credit unions are shown to have significantly higher refinance rate than the subsidiary mortgage companies in the conventional mortgage originations.

In our investigations of the lending organizations, defined by the lender-state combinations, we create a series of state dummy variables to designate each of the 50 states and the District of Columbia expect for the state of California, which is left out for comparison. Other variables are the same as those in the lender regressions. We use two indicators as proxies for lender size: one is the natural log of total originations for the lender at national level, the other is the natural log of total originations for the lending organization, or total originations made by a lender in the particular state considered. Thus, we test for the separate effects of lender size as a whole and its intensity of

activities in the local market on the refinance share of a lender-state. The results on the primary factors are reported in Table 4.8 and the detailed regression parameters with individual state indicators are listed in Table 4.12.

For lending organizations in our regression using 2003 HMDA data, both the size variables still have significantly positive effect on the lender-state refinance shares for both conventional and government-insured mortgages. Both the nationwide origination volume and state-specific origination volume are significantly positive in the regression using 2000 data as well, but to a much less degree. The effects on the government insured mortgages are negative for both measures for year 2000. The results confirm our hypothesis that larger institutions, proxied by origination volumes, have higher percentage of refinance mortgages in their total originations.

Though the exact reason behind the observed relationship between refinance share and loan origination volume remains to be explored, we hypothesize that the institutions that have larger holdings of mortgage retained portfolios or mortgage-servicing portfolios have more incentives to maintain the size of their portfolio and thus devote more resources to encourage their existing customers to refinance with the same lender or pursue other customers for refinancing mortgages.

To test this hypothesis, we obtaine the dollar volume of the single-family mortgage holdings and the dollar amount of total single-family mortgage serviced from the call reports of the commercial banks and the savings banks. The portfolio information as of prior year's end for each individual bank is then matched to loan origination information from HMDA by each institution's Federal Reserve system ID. This match results in 3,441 institutions with non-missing or non-zero mortgage portfolios and 1,045

institutions with non-zero or non-missing servicing portfolios in 2000, and 3,700 institutions with non-missing or non-zero mortgage portfolios and 992 institutions with non-missing or non-zero servicing portfolios in 2003. We perform similar regression procedures as before with total refinance shares and lender-state combinations as dependent variables and include the log transformation of total mortgage holding portfolio and mortgage servicing portfolio separately as independent variables. The results on the main variables are presented in Table 4.9 while the detailed results are in Table 4.13.

The signs and significances of the coefficients on both the mortgage holdings and mortgage servicing portfolio sizes for both years tested confirm our hypothesis that lenders with larger mortgage portfolios originate larger shares of refinance loans. It is possible that because of the size of their mortgage portfolios, and potentially the relative importance of mortgages in their total portfolio, they are more active in maintaining their portfolio size, one way of which is through actively pursuing refinance loans.

4.2.3.2 Computation Methods

As we have established the relationship between lender size and refinance percentage of their business, we apply both calculation methods on the same set of data to find how much of a difference in the calculated refinance shares can result from alternating computation methods.

Since NMN reports each individual lender's refinance percentage as well as the composite figure for each quarter, we test our hypothesis by re-calculating the total

refinance percentage using the PMMS 'unweighted' method. Results are listed in Table 4.10 together with originally reported numbers under the 'weighted' method. We observe a difference of 1 to 8 percentage points in quarterly refinance percentages from 2001 to 2004, with an average reduction of 3.6 percentage points as we switch from the method of taking total refinance volume divided by total originations to that of taking the average of refinance rates among lenders.

We also apply both methods to HMDA total application data and obtain different annual refinance percentages. Annually the difference between the two series is between 1 and 14 percentage points for total single-family market. We find that the difference between the two series is most prominent during periods historically known as 'refi-booms'. During years 1992-93, 2001-03, an average of 12.6 percentage points is observed for each year with the 'weighted' average reporting higher refinance percentages. In year 1998, the difference is 9 percentage points. The other years report a smaller amount of differences between 1 and 8 percentage points. We repeat the same method on the conventional prime portion of the market and obtain similar results. The comparison of the results from the two methods can be found in Table 4.11. The results are robust when we take out the extreme observations: small lenders that report 100 or 0 percent refinances, or lenders whose total number of originations for the year is below 50, 250, or 500 loans. For comparison purposes, we also list the difference between the annual average refinance shares of quarterly HMDA reported numbers over those from MBA and PMMS. They are very comparable to the differences as a result of weighting scheme changes we just derived. The amount of reduction in refinance percentages we calculated using HMDA data is a 'simulated' result, which may be larger than smaller

than the actual differences in the corresponding years depending on the actual distribution of lenders included in the PMMS, compared to the HMDA universe we use for illuatration, but it does make the most significant impact on accounting for the differences among the factors considered.

4.3 Conclusion

We look at the differences between four series that keep track of refinance shares, namely, the PMMS, MBA mortgage application survey, NMN survey, and HMDA. We observe that PMMS and MBA, both reporting refinance share of total applications, track each other closely, while NMN and HMDA, both tallying refinance share of total originations, display great similarities, especially in recent years. Our exploration of the difference between mortgage applications and originations does not reveal potential explanatory factors, including the difference in fallout rates from application to origination between purchase and refinance loans, the disparity in report timing resulted from the fact that loan applications lead originations by one to two months, and the difference in the time lapse from loan application to close between purchase and refinance loans.

Our results show that the fact that larger lenders have larger share of refinance in their total loan applications and originations, compounded by the difference in calculating the refinance shares, with HMDA and NMN giving larger weights to larger lenders, accounts largely for the differences. By examining HMDA data, we also find that different loan types, institution types and geographical locations all affect the aggregate

refinance rate. Other factors that could also result in the higher percentage by HMDA than PMMS and MBA include the differences in the survey's respective coverage of inside- and outside-MSA areas. When the results from AHS are compared with those from HMDA, it is found that HMDA have higher percentage in representation of mortgage activities inside MSA areas, and loans originated inside MSAs have higher refinance percentage than those outside MSAs.

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Table 4.1 Fallout Rates from Application to Origination
(Percent by Dollar Volume)

Year	All Loans		Conventional Prime Loans	
	Refinance	Purchase	Refinance	Purchase
1990	37	30	37	29
1991	34	30	34	29
1992	29	28	28	26
1993	24	25	24	26
1994	35	27	32	23
1995	38	30	31	24
1996	42	32	35	25
1997	44	33	31	24
1998	36	33	24	23
1999	49	34	34	25
2000	58	35	41	26
2001	39	30	27	24
2002	36	28	25	24
2003	36	31	26	26
2004	50	35	36	30

Table 4.2 Refinance Share of Loan Originations and Applications
(Percent by Dollar Volume)

Year	All Loans			Conventional Prime Loans		
	Originations	Unsuccessful Applications	Total Applications	Originations	Unsuccessful Applications	Total Applications
1990	25	32	27	28	36	31
1991	40	45	41	46	51	47
1992	61	62	62	66	68	66
1993	65	60	64	68	64	68
1994	39	48	42	40	51	43
1995	31	39	33	33	41	35
1996	37	47	41	39	51	42
1997	38	51	43	39	47	41
1998	58	61	59	61	62	61
1999	43	58	49	45	56	48
2000	28	50	38	27	42	31
2001	61	70	64	64	67	65
2002	66	74	69	68	70	69
2003	72	77	74	74	73	74
2004	52	68	59	51	57	53

Table 4.3 Differences of Refinance Series by Quarter

Year	HMDA and PMMS				HMDA and MBA			
	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1990	-1.0	-1.2	-0.6	-2.3	8.4	6.2	3.4	1.3
1991	-6.4	-2.2	-5.9	-8.5	1.0	11.7	2.1	-6.9
1992	8.7	13.9	0.3	15.7	15.1	20.3	0.4	19.5
1993	10.3	10.8	-2.5	5.9	8.2	14.8	2.4	14.6
1994	10.7	7.9	4.7	10.0	18.7	18.1	8.4	9.0
1995	11.4	5.1	9.1	3.9	11.4	0.9	2.8	-0.8
1996	8.8	11.9	3.9	3.2	6.3	15.5	6.2	2.8
1997	11.8	7.0	5.4	3.6	12.3	9.9	4.0	3.8
1998	7.1	10.4	2.5	5.0	9.5	9.8	0.3	3.3
1999	6.1	9.8	9.8	8.7	11.4	10.4	8.7	6.8
2000	9.9	9.0	5.4	2.5	10.4	8.0	4.8	1.6
2001	-0.6	8.0	1.6	5.1	-0.4	10.0	1.5	2.1
2002	16.3	7.9	-3.3	1.3	18.2	8.2	-4.7	2.8
2003	0.6	0.5	15.3	7.7	2.7	2.8	20.7	9.8
2004	1.4	15.6	3.6	3.9	5.2	17.9	5.6	6.3
Average	6.3	7.6	3.3	4.4	9.2	11.0	4.4	5.1

Table 4.4 Regression Tests for Quarterly Differences 1990 to 2004

Dependent Variable: HMDA Refi Series			Dependent Variable: HMDA Refi Series		
	Estimate	p-Value		Estimate	p-Value
Intercept	0.077	0.002	Intercept	0.082	0.002
PMMS Refi	0.925	0.000	MBA Refi	0.929	0.000
1st Quarter Dummy	0.021	0.311	1st Quarter Dummy	0.041	0.056
2nd Quarter Dummy	0.026	0.205	2nd Quarter Dummy	0.051	0.022
3rd Quarter Dummy	-0.015	0.453	3rd Quarter Dummy	-0.011	0.611
R-Square	0.902		R-Square	0.893	
Number of Obs	60		Number of Obs	60	

Table 4.5 Percent of Loan Origination Inside MSA Areas by Origination Year

1. Results from the 2001 RFS

Year	All – Owner		All – Owner and Renter		Prime Conventional – Owner		Prime Conventional – Owner and Renter	
	First Lien	First, Second and Third Combined	First Lien	First, Second and Third Combined	First Lien	First, Second and Third Combined	First Lien	First, Second and Third Combined
1998	88.9	88.8	88.9	88.8	88.9	89.0	88.8	88.9
1999	90.7	90.7	89.7	89.8	91.5	91.4	90.2	90.2
2000	90.1	89.9	89.8	89.5	90.5	90.3	90.2	89.9
2001	89.3	89.2	89.2	89.1	88.6	88.6	89.0	89.0

2. Results from the 2001 and 2003 AHS

Year	2001 AHS		2003 AHS	
	First Lien	First and Second Combined	First Lien	First and Second Combined
1999	87.2	87.1	N/A	N/A
2000	86.0	86.0	N/A	N/A
2001	89.1	89.0	85.7	85.8
2002	N/A	N/A	87.6	87.5
2003	N/A	N/A	89.6	89.7

3. Results from HMDA

Year	All		Conventional Prime		Owner Occupied Only	
	Originations	Applications	Originations	Applications	Originations	Applications
1992	86.9	84.9	86.4	82.5		
1993	86.7	83.0	86.9	79.8		
1994	85.3	80.4	85.4	78.2		
1995	84.0	76.5	84.2	74.5		
1996	88.4	81.9	88.0	79.0		
1997	89.1	81.3	88.5	78.9		
1998	89.9	83.8	89.5	80.7		
1999	89.7	86.6	89.2	81.6	90.1	81.7
2000	89.8	86.9	89.4	81.0	90.4	81.2
2001	90.6	89.1	90.7	85.8	91.7	86.1
2002	91.5	90.2	91.6	88.7	92.7	89.1
2003	91.4	90.5	91.5	89.5	92.5	90.0
2004	92.4	89.7	92.3	90.6	93.2	89.9

Table 4.6 Comparison of Refinance Shares of Inside- and Outside-MSA Areas

1. Results from the 2001 RFS

Year	All – Owner				All – Owner and Renter			
	First Lien		First, Second and Third Combined		First Lien		First, Second and Third Combined	
	Inside MSA	Outside MSA	Inside MSA	Outside MSA	Inside MSA	Outside MSA	Inside MSA	Outside MSA
1998	27.6	23.9	27.8	24.0	26.2	24.4	26.4	24.5
1999	25.4	21.8	25.6	22.4	25.9	19.7	25.9	20.3
2000	17.4	24.1	18.5	25.7	18.8	20.9	19.6	22.2
2001	39.1	41.3	38.3	40.8	38.1	37.5	37.4	37.3

Year	Prime Conventional – Owner				Prime Conventional – Owner and Renter			
	First Lien		First, Second and Third Combined		First Lien		First, Second and Third Combined	
	Inside MSA	Outside MSA	Inside MSA	Outside MSA	Inside MSA	Outside MSA	Inside MSA	Outside MSA
1998	29.5	26.9	29.7	26.6	27.8	27.1	28.0	26.8
1999	26.7	24.9	26.8	25.4	27.0	21.5	27.0	22.1
2000	17.5	24.7	18.5	26.5	19.4	21.6	20.0	23.0
2001	40.6	45.3	39.9	44.7	39.3	42.3	38.7	42.2

2. Results from 2001 and 2003 AHS

Year	First Lien				First and Second Combined			
	2001 AHS		2003 AHS		2001 AHS		2003 AHS	
	Inside MSA	Outside MSA	Inside MSA	Outside MSA	Inside MSA	Outside MSA	Inside MSA	Outside MSA
1999	32.4	28.2	N/A	N/A	31.0	27.0	N/A	N/A
2000	20.3	18.9	N/A	N/A	19.5	18.2	N/A	N/A
2001	44.2	42.9	41.2	40.7	42.6	40.5	40.3	39.5
2002	N/A	N/A	53.7	42.7	N/A	N/A	52.5	42.7
2003	N/A	N/A	73.3	69.4	N/A	N/A	72.4	68.0

Table 4.7 Means of Regression Variables

2000				2003			
Lender Volume ($mil)	108.9	Lending Institution Volume ($mil)	35.1	Lender Volume ($mil)	425.6	Lending Institution Volume ($mil)	110.7
Savings Bank	15%	Savings Bank	15%	Savings Bank	14%	Savings Bank	15%
Commercial Bank	49%	Commercial Bank	36%	Commercial Bank	48%	Commercial Bank	36%
Independent Mrtg Co.	10%	Independent Mrtg Co.	22%	Independent Mrtg Co.	10%	Independent Mrtg Co.	23%
Credit Union	23%	Credit Union	15%	Credit Union	25%	Credit Union	16%
Minority or Women Owned	1%	Minority or Women Owned	1%	Minority or Women Owned	1%	Minority or Women Owned	1%
Refi Share	29%	Refi Share	29%	Refi Share	61%	Refi Share	63%
Number of Observations	7,277	Number of Observations	22,237	Number of Observations	6,942	Number of Observations	26,457

Table 4.8 Regression Results Testing for Lender Size Effect on Refinance Share
1. 2000 HMDA Conventional Prime Mortgages

Dependent Variable: Lender Refi Share			Dependent Variable: Lender-State Refi Share			Dependent Variable: Lender-State Refi Share		
Variable	Estimate	p-Value	Variable	Estimate	p-Value	Variable	Estimate	p-Value
Intercept	0.22	<.0001	Intercept	0.24	<.0001	Intercept	0.22	<.0001
Size – Total Origination	0.004	0.01	Size – Total Origination	0.002	0.01	Size – State Origination	0.01	<.0001
Savings Bk.	0.02	0.32	Savings Bk.	0.01	0.08	Savings Bk.	0.01	0.07
Commercial Bank	0.04	0.00	Commercial Bank	0.02	0.01	Commercial Bank	0.02	0.00
Independent Mrtg Co.	-0.02	0.15	Independent Mrtg Co.	0.05	<.0001	Independent Mrtg Co.	0.05	<.0001
Credit U.	0.09	<.0001	Credit U.	0.01	0.35	Credit U.	0.01	0.20
MWO*	0.03	0.17	MWO	0.10	<.0001	MWO	0.10	<.0001
Number of Observations	7,277		Number of Observations	22,237		Number of Observations	22,237	
R-square	0.0206		R-square	0.0379		R-square	0.0397	
			F-test for All State Dummies	16.13	<0.0001	F-test for All State Dummies	16.87	<0.0001

*MWO: Minority and Women-Owned Institution flag.

2. 2003 HMDA Conventional Prime Mortgages

Dependent Variable: Lender Refi Share			Dependent Variable: Lender-State Refi Share			Dependent Variable: Lender-State Refi Share		
Variable	Estimate	p-Value	Variable	Estimate	p-Value	Variable	Estimate	p-Value
Intercept	0.07	0.01	Intercept	0.30	<.0001	Intercept	0.45	<.0001
Size – Total Origination	0.05	<.0001	Size – Total Origination	0.03	<.0001	Size – State Origination	0.02	<.0001
Savings Bk.	0.06	0.00	Savings Bk.	0.04	<.0001	Savings Bk.	0.01	0.33
Commercial Bank	-0.02	0.40	Commercial Bank	-0.03	<.0001	Commercial Bank	-0.08	<.0001
Independent Mrtg Co.	-0.11	<.0001	Independent Mrtg Co.	-0.01	0.17	Independent Mrtg Co.	-0.03	0.00
Credit U.	0.16	<.0001	Credit U.	0.10	<.0001	Credit U.	0.03	<.0001
MWO*	0.00	0.91	MWO	0.02	0.49	MWO	-0.02	0.35
Number of Observations	6,942		Number of Observations	26,457		Number of Observations	26,457	
R-square	0.222		R-square	0.083		R-square	0.082	
			F-test for All State Dummies	18.16	<0.0001	F-test for All State Dummies	16.08	<0.0001

*MWO: Minority and Women-Owned Institution flag.

Table 4.9 Regression Results Testing for Lender Portfolio Size Effect on Refinance Share

1. 2000 HMDA Conventional Prime Mortgages

Dependent Variable: Lender Refi Share		Dependent Variable: Lender Refi Share		Dependent Variable: Lender-State Refi Share		Dependent Variable: Lender-State Refi Share	
Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
Intercept	0.282 (<0.001)	Intercept	0.212 (<0.001)	Intercept	0.108 (0.001)	Intercept	0.136 (<0.001)
Total Serving Portfolio	-0.001 (0.73)	Total Mortgage Portfolio	0.005 (0.02)	Total Serving Portfolio	0.007 (<0.001)	Total Mortgage Portfolio	0.005 (<0.001)
Savings Bk.	-0.023 (0.28)	Savings Bk.	0.001 (0.98)	Savings Bk.	-0.019 (0.32)	Savings Bk.	-0.014 (0.37)
Commercial Bank	0.039 (0.05)	Commercial Bank	0.032 (0.07)	Commercial Bank	0.066 (<0.001)	Commercial Bank	0.040 (<0.001)
Minority or Women Owned	-0.022 (0.56)	Minority or Women Owned	0.043 (0.07)	Minority or Women Owned	0.018 (0.69)	Minority or Women Owned	0.037 (0.21)
Number of Observations	3,441	Number of Observations	1,045	Number of Observations	8,533	Number of Observations	4,147
R-square	0.03	R-square	0.01	R-square	0.07	R-square	0.05
				F-test for All State Dummies	1.44 (0.025)	F-test for All State Dummies	1.44 (0.025)

2. 2003 HMDA Conventional Prime Mortgages

Dependent Variable: Lender Refi Share		Dependent Variable: Lender Refi Share		Dependent Variable: Lender-State Refi Share		Dependent Variable: Lender-State Refi Share	
Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
Intercept	0.639 (<0.001)	Intercept	0.221 (<0.001)	Intercept	0.590 (<0.001)	Intercept	0.437 (<0.001)
Total Serving Portfolio	0.008 (<0.001)	Total Mortgage Portfolio	0.041 (<0.001)	Total Serving Portfolio	0.010 (<0.001)	Total Mortgage Portfolio	0.019 (<0.001)
Savings Bk.	0.039 (0.12)	Savings Bk.	0.023 (0.34)	Savings Bk.	-0.074 (<0.001)	Savings Bk.	-0.061 (<0.001)
Commercial Bank	-0.025 (0.28)	Commercial Bank	-0.107 (<0.001)	Commercial Bank	-0.055 (<0.001)	Commercial Bank	-0.099 (<0.001)
Minority or Women Owned	-0.092 (0.03)	Minority or Women Owned	-0.041 (0.13)	Minority or Women Owned	-0.001 (0.98)	Minority or Women Owned	-0.038 (0.22)
Number of Observations	3,700	Number of Observations	992	Number of Observations	11,315	Number of Observations	4,991
R-square	0.04	R-square	0.12	R-square	0.05	R-square	0.09
				F-test for All State Dummies	3.05 (<0.001)	F-test for All State Dummies	3.05 (<0.001)

Table 4.10 Changing Calculation Methods on NMN Data

Quarter	Refi Share Weighted by Origination Volume	Average of Refi Shares across Lenders	Difference
2001Q1	54.5	53.3	1.3
2001Q2	55.7	53.0	2.6
2001Q3	52.0	50.9	1.1
2001Q4	63.6	62.4	1.3
2002Q1	65.0	59.5	5.6
2002Q2	49.4	47.0	2.4
2002Q3	64.1	60.2	3.9
2002Q4	75.7	72.9	2.8
2003Q1	75.8	71.0	4.9
2003Q2	74.0	71.2	2.8
2003Q3	74.0	69.4	4.5
2003Q4	60.6	53.3	7.3
2004Q1	60.3	55.5	4.8
2004Q2	56.6	51.6	5.0
2004Q3	43.9	40.5	3.4
2004Q4	50.3	46.2	4.1

Table 4.11 Changing Calculation Methods on HMDA Data

Year	Difference between HMDA and MBA*	Difference between HMDA and PMMS*	All Loans in HMDA			Conventional Prime in HMDA		
			Refi Share Weighted by Origination Volume	Average of Refi Shares across Lenders	Difference	Refi Share Weighted by Origination Volume	Average of Refi Shares across Lenders	Difference
1990	4.8	-1.3	27.1	24.5	2.6	30.9	25.2	5.7
1991	2.0	-5.7	41.3	35.4	5.9	47.4	36.8	10.6
1992	13.8	9.7	61.5	51.2	10.3	66.4	52.7	13.7
1993	10.0	6.1	64.4	53.3	11.1	67.8	54.8	13.0
1994	13.6	8.4	41.8	38.2	3.6	43.3	39.3	4.0
1995	3.6	7.4	33.3	32.8	0.5	34.8	33.9	0.9
1996	7.7	7.0	40.6	38.1	2.5	42.2	39.1	3.0
1997	7.5	6.9	43.0	37.1	5.9	41.3	37.9	3.4
1998	5.7	6.3	59.2	50.0	9.2	60.8	51.3	9.5
1999	9.3	8.6	49.4	41.7	7.8	47.8	42.5	5.3
2000	6.2	6.7	37.6	29.6	8.0	31.3	29.8	1.4
2001	3.3	3.5	64.4	51.0	13.4	64.6	52.1	12.5
2002	6.1	5.6	68.7	54.8	13.9	68.8	55.9	12.9
2003	8.8	6.0	73.7	59.5	14.2	73.8	60.7	13.1
2004	8.7	6.1	52.2	46.2	5.9	51.1	46.4	4.7

*Annual Percentage calculated by averaging quarterly numbers.

Table 4.12 Detailed Regression Results Testing for Lender Size Effect on Refinance Share

1. 2000 HMDA Conventional Prime Mortgages

Dependent Var: Lender-State Refi Share			Dependent Var: Lender-State Refi Share		
Variable	Estimate	p-Value	Variable	Estimate	p-Value
Intercept	0.24	<.0001	Intercept	0.22	<.0001
Size – Total Origination	0.002	0.01	Size – State Origination	0.01	<.0001
Savings Bk.	0.01	0.08	Savings Bk.	0.01	0.07
Commercial Bank	0.02	0.01	Commercial Bank	0.02	0.00
Independent Mrtg Co.	0.05	<.0001	Independent Mrtg Co.	0.05	<.0001
Credit U.	0.01	0.35	Credit U.	0.01	0.20
Minority and Women Owned	0.10	<.0001	Minority and Women Owned	0.10	<.0001
AL	0.04	0.03	AL	0.05	0.01
AK	0.02	0.52	AK	0.03	0.30
AZ	-0.07	<.0001	AZ	-0.06	0.00
AR	0.05	0.02	AR	0.06	0.00
CO	0.00	0.83	CO	0.01	0.57
CT	-0.05	0.01	CT	-0.04	0.03
DE	-0.01	0.60	DE	0.00	0.92
DC	0.06	0.01	DC	0.07	0.00
FL	-0.12	<.0001	FL	-0.11	<.0001
GA	0.01	0.67	GA	0.01	0.43
HI	0.07	0.02	HI	0.08	0.01
ID	-0.01	0.66	ID	0.00	1.00
IL	0.01	0.41	IL	0.01	0.35
IN	0.03	0.02	IN	0.04	0.01
IA	0.05	0.01	IA	0.06	0.00
KS	0.05	0.01	KS	0.06	0.00
KY	0.04	0.03	KY	0.05	0.01
LA	0.04	0.02	LA	0.05	0.00
ME	0.07	0.00	ME	0.08	0.00
MD	-0.01	0.67	MD	0.00	0.94
MA	0.02	0.13	MA	0.03	0.10
MI	0.07	<.0001	MI	0.07	<.0001
MN	0.01	0.47	MN	0.02	0.29
MS	0.08	0.00	MS	0.09	<.0001
MO	0.04	0.02	MO	0.04	0.01
MT	0.12	<.0001	MT	0.13	<.0001
NE	0.05	0.02	NE	0.06	0.00
NV	-0.08	<.0001	NV	-0.07	0.00
NH	0.00	0.86	NH	0.01	0.76
NJ	-0.08	<.0001	NJ	-0.08	<.0001
NM	0.08	<.0001	NM	0.10	<.0001
NY	-0.06	0.00	NY	-0.05	0.00
NC	-0.02	0.33	NC	-0.01	0.57
ND	0.04	0.19	ND	0.06	0.07
OH	0.03	0.06	OH	0.03	0.03
OK	0.01	0.54	OK	0.02	0.28
OR	0.04	0.04	OR	0.05	0.01
PA	-0.03	0.07	PA	-0.02	0.13
RI	0.00	0.93	RI	0.01	0.63
SC	0.01	0.70	SC	0.02	0.35
SD	0.06	0.05	SD	0.07	0.02
TN	0.01	0.48	TN	0.02	0.24
TX	-0.13	<.0001	TX	-0.13	<.0001
UT	0.07	0.00	UT	0.08	0.00
VT	-0.01	0.63	VT	0.00	0.95
VA	-0.02	0.20	VA	-0.01	0.35
WA	0.03	0.11	WA	0.03	0.05
WV	0.09	<.0001	WV	0.10	<.0001
WI	0.02	0.12	WI	0.03	0.06
WY	0.09	0.00	WY	0.10	0.00
R-square	0.0403		R-square	0.0421	

Table 4.12 Detailed Regression Results Testing for Lender Size Effect on Refinance Share-Continued

2. 2003 HMDA Conventional Prime Mortgages

Dependent Var: Lender-State Refi Share			Dependent Var: Lender-State Refi Share		
Variable	Estimate	p-Value	Variable	Estimate	p-Value
Intercept	0.30	<.0001	Intercept	0.45	<.0001
Size – Total Origination	0.03	<.0001	Size – State Origination	0.02	<.0001
Savings Bk.	0.04	<.0001	Savings Bk.	0.01	0.33
Commercial Bank	-0.03	<.0001	Commercial Bank	-0.08	<.0001
Independent Mrtg Co.	-0.01	0.17	Independent Mrtg Co.	-0.03	0.00
Credit U.	0.10	<.0001	Credit U.	0.03	<.0001
Minority and Women Owned	0.02	0.49	Minority and Women Owned	-0.02	0.35
AL	-0.06	0.00	AL	-0.02	0.33
AK	0.03	0.25	AK	0.13	<.0001
AZ	-0.07	<.0001	AZ	-0.02	0.35
AR	-0.08	0.00	AR	-0.02	0.34
CO	0.05	0.00	CO	0.08	<.0001
CT	0.02	0.24	CT	0.06	0.00
DE	-0.03	0.12	DE	0.04	0.07
DC	0.01	0.57	DC	0.08	<.0001
FL	-0.14	<.0001	FL	-0.11	<.0001
GA	-0.03	0.06	GA	0.00	0.81
HI	0.06	0.03	HI	0.13	<.0001
ID	-0.03	0.23	ID	0.04	0.07
IL	0.03	0.05	IL	0.03	0.04
IN	0.02	0.26	IN	0.05	0.00
IA	0.01	0.44	IA	0.06	0.00
KS	0.01	0.77	KS	0.05	0.01
KY	0.00	0.91	KY	0.05	0.01
LA	-0.03	0.15	LA	0.01	0.59
ME	0.00	0.83	ME	0.07	0.00
MD	0.02	0.15	MD	0.05	0.00
MA	0.06	0.00	MA	0.08	<.0001
MI	0.02	0.17	MI	0.04	0.02
MN	0.01	0.51	MN	0.04	0.03
MS	-0.06	0.00	MS	0.00	0.95
MO	0.00	0.89	MO	0.03	0.05
MT	0.08	0.01	MT	0.15	<.0001
NE	0.02	0.48	NE	0.08	0.00
NV	-0.08	<.0001	NV	-0.02	0.22
NH	0.04	0.08	NH	0.09	<.0001
NJ	-0.01	0.68	NJ	0.01	0.40
NM	-0.01	0.64	NM	0.06	0.00
NY	-0.05	0.00	NY	-0.03	0.06
NC	-0.05	0.00	NC	-0.01	0.45
ND	-0.06	0.05	ND	0.03	0.34
OH	0.01	0.57	OH	0.03	0.06
OK	-0.03	0.15	OK	0.02	0.31
OR	-0.02	0.41	OR	0.04	0.05
PA	-0.02	0.10	PA	0.00	0.77
RI	0.00	0.92	RI	0.07	0.00
SC	-0.05	0.00	SC	0.00	0.98
SD	0.03	0.22	SD	0.12	<.0001
TN	-0.03	0.05	TN	0.01	0.49
TX	-0.15	<.0001	TX	-0.14	<.0001
UT	0.00	0.93	UT	0.06	0.01
VT	0.01	0.81	VT	0.10	0.00
VA	-0.01	0.58	VA	0.03	0.09
WA	0.02	0.34	WA	0.05	0.00
WV	0.00	0.83	WV	0.06	0.00
WI	0.02	0.25	WI	0.04	0.01
WY	0.01	0.85	WY	0.10	0.00
R-square	0.0855		R-square	0.084	

Table 4.13 Detailed Regression Results Testing for Lender Portfolio Effect on Refinance Share

1. 2000 HMDA Conventional Prime Mortgages

Dependent Var: Lender-State Refi Share			Dependent Var: Lender-State Refi Share		
Variable	Estimate	p-Value	Variable	Estimate	p-Value
Intercept	0.14	<.0001	Intercept	0.11	0.00
Mrtg. Portfolio - Holding	0.00	0.00	Mrtg. Portfolio - Servicing	0.01	<.0001
Savings Bk.	-0.01	0.37	Savings Bk.	-0.02	0.32
Commercial Bank	0.04	<.0001	Commercial Bank	0.07	<.0001
MWO*	0.04	0.21	MWO*	0.02	0.69
AL	0.09	0.00	AL	0.09	0.04
AK	0.07	0.24	AK	0.08	0.24
AZ	-0.03	0.26	AZ	-0.05	0.24
AR	0.09	0.00	AR	0.05	0.30
CO	0.04	0.11	CO	0.09	0.03
CT	0.03	0.38	CT	0.02	0.65
DE	0.11	0.00	DE	0.09	0.06
DC	0.11	0.00	DC	0.05	0.27
FL	-0.07	0.00	FL	-0.09	0.01
GA	0.09	0.00	GA	0.06	0.11
HI	0.08	0.17	HI	0.09	0.17
ID	0.01	0.78	ID	-0.03	0.59
IL	0.07	0.00	IL	0.07	0.03
IN	0.09	0.00	IN	0.07	0.05
IA	0.09	0.00	IA	0.01	0.79
KS	0.12	<.0001	KS	0.07	0.17
KY	0.10	0.00	KY	0.06	0.12
LA	0.11	0.00	LA	0.05	0.28
ME	0.13	0.00	ME	0.10	0.04
MD	0.04	0.12	MD	0.02	0.58
MA	0.10	<.0001	MA	0.08	0.03
MI	0.15	<.0001	MI	0.13	0.00
MN	0.05	0.03	MN	0.05	0.20
MS	0.11	0.00	MS	0.11	0.02
MO	0.09	<.0001	MO	0.05	0.17
MT	0.23	<.0001	MT	0.23	0.00
NE	0.16	<.0001	NE	0.19	0.00
NV	-0.03	0.35	NV	-0.03	0.49
NH	0.09	0.01	NH	0.05	0.26
NJ	0.01	0.81	NJ	-0.01	0.77
NM	0.10	0.00	NM	0.11	0.02
NY	0.00	0.99	NY	-0.03	0.41
NC	0.07	0.01	NC	-0.01	0.75
ND	0.08	0.06	ND	0.05	0.43
OH	0.11	<.0001	OH	0.08	0.03
OK	0.06	0.03	OK	0.00	0.92
OR	0.10	0.00	OR	0.12	0.01
PA	0.05	0.04	PA	0.02	0.47
RI	0.06	0.08	RI	0.06	0.18
SC	0.07	0.01	SC	0.01	0.81
SD	0.09	0.03	SD	0.04	0.45
TN	0.06	0.01	TN	0.03	0.39
TX	-0.06	0.00	TX	-0.10	0.00
UT	0.12	0.00	UT	0.13	0.01
VT	0.08	0.11	VT	0.04	0.54
VA	0.03	0.19	VA	0.00	0.94
WA	0.07	0.02	WA	0.04	0.37
WV	0.19	<.0001	WV	0.17	<.0001
WI	0.09	0.00	WI	0.06	0.09
WY	0.17	0.00	WY	0.22	0.00
R-square	0.0511		R-square	0.0689	

*MWO: Minority and Women-Owned Institution flag.

Table 4.13 Detailed Regression Results Testing for Lender Portfolio Effect on Refinance Share-Continued

2. 2003 HMDA Conventional Prime Mortgages

Dependent Var: Lender-State Refi Share			Dependent Var: Lender-State Refi Share		
Variable	Estimate	p-Value	Variable	Estimate	p-Value
Intercept	0.44	<.0001	Intercept	0.59	<.0001
Mrtg. Portfolio - Holding	0.02	<.0001	Mrtg. Portfolio - Servicing	0.01	<.0001
Savings Bk.	-0.06	0.00	Savings Bk.	-0.07	0.00
Commercial Bank	-0.10	<.0001	Commercial Bank	-0.05	<.0001
MWO*	-0.04	0.22	MWO*	0.00	0.98
AL	-0.08	0.01	AL	-0.10	0.03
AK	0.07	0.20	AK	0.04	0.52
AZ	-0.01	0.75	AZ	-0.05	0.19
AR	-0.04	0.18	AR	-0.06	0.22
CO	0.09	0.00	CO	0.03	0.46
CT	0.08	0.01	CT	0.04	0.29
DE	0.03	0.48	DE	0.03	0.59
DC	-0.01	0.67	DC	-0.06	0.22
FL	-0.13	<.0001	FL	-0.14	<.0001
GA	-0.03	0.24	GA	-0.01	0.85
HI	0.07	0.13	HI	-0.02	0.77
ID	-0.01	0.86	ID	-0.04	0.49
IL	0.07	0.00	IL	0.05	0.16
IN	0.08	0.00	IN	0.01	0.69
IA	0.06	0.06	IA	-0.02	0.69
KS	0.02	0.52	KS	0.01	0.77
KY	0.06	0.04	KY	0.03	0.40
LA	0.01	0.75	LA	-0.01	0.85
ME	0.03	0.48	ME	0.02	0.62
MD	0.04	0.11	MD	0.02	0.59
MA	0.09	0.00	MA	0.08	0.02
MI	0.04	0.13	MI	-0.03	0.46
MN	0.05	0.05	MN	0.05	0.24
MS	-0.08	0.03	MS	-0.04	0.46
MO	0.03	0.30	MO	0.00	0.91
MT	0.17	0.00	MT	0.09	0.15
NE	0.04	0.27	NE	0.02	0.78
NV	-0.04	0.24	NV	-0.09	0.06
NH	0.07	0.03	NH	0.03	0.49
NJ	0.06	0.02	NJ	0.01	0.83
NM	0.03	0.40	NM	0.03	0.50
NY	-0.02	0.40	NY	-0.07	0.07
NC	0.00	0.98	NC	0.00	0.94
ND	-0.02	0.64	ND	-0.10	0.16
OH	0.06	0.01	OH	0.03	0.38
OK	-0.01	0.77	OK	-0.04	0.38
OR	0.07	0.04	OR	0.03	0.50
PA	0.03	0.24	PA	0.00	0.89
RI	0.01	0.69	RI	0.01	0.86
SC	-0.03	0.19	SC	-0.07	0.07
SD	0.09	0.05	SD	0.01	0.85
TN	-0.03	0.27	TN	-0.06	0.16
TX	-0.17	<.0001	TX	-0.13	0.00
UT	0.05	0.24	UT	0.04	0.43
VT	0.05	0.35	VT	0.00	0.99
VA	0.04	0.13	VA	0.04	0.29
WA	0.08	0.00	WA	0.02	0.72
WV	0.00	1.00	WV	-0.02	0.64
WI	0.09	0.00	WI	0.07	0.06
WY	-0.01	0.87	WY	-0.03	0.67
R-square	0.0859		R-square	0.0522	

*MWO: Minority and Women-Owned Institution flag.

Figure 4.1 Comparison of Refinance Series by Quarter 1990-2004

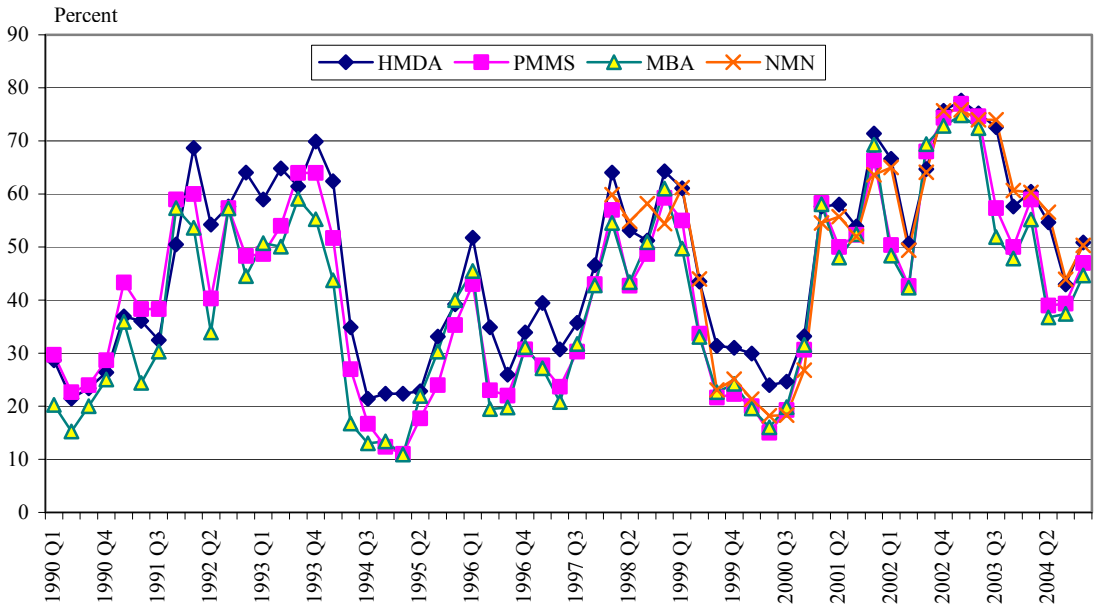


Figure 4.2 HMDA Refinance Percentage by Loan Type

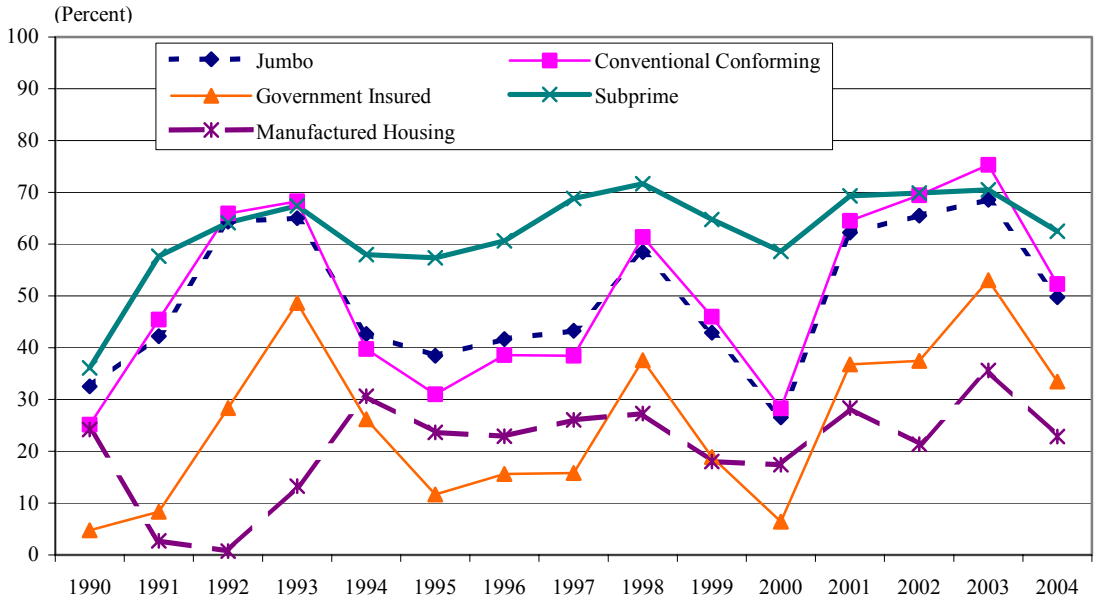


Figure 4.3 HMDA Refinance Percentage by Institution Type

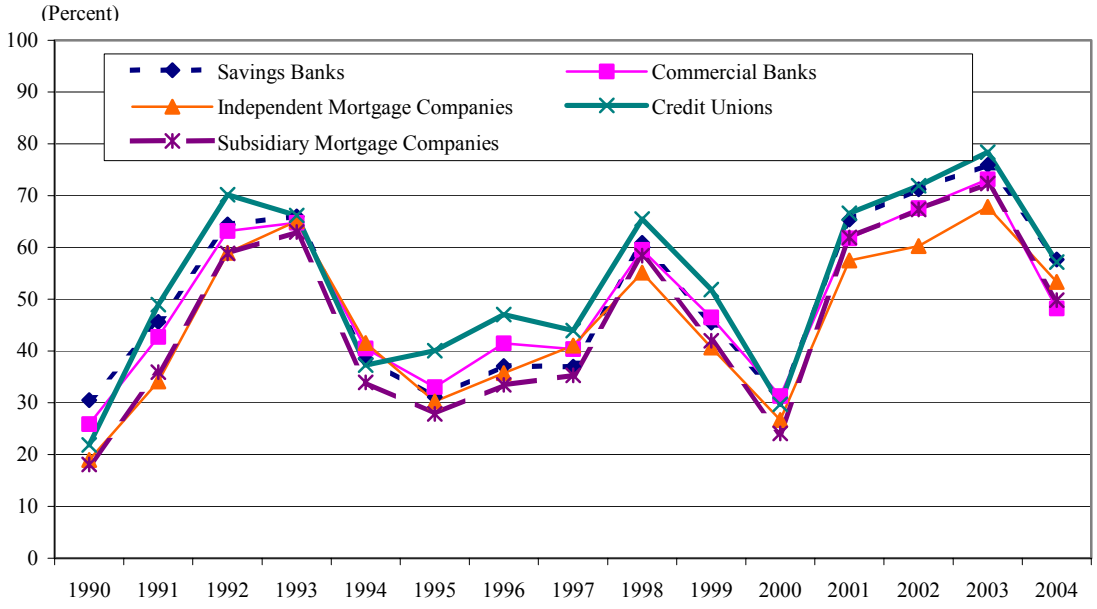
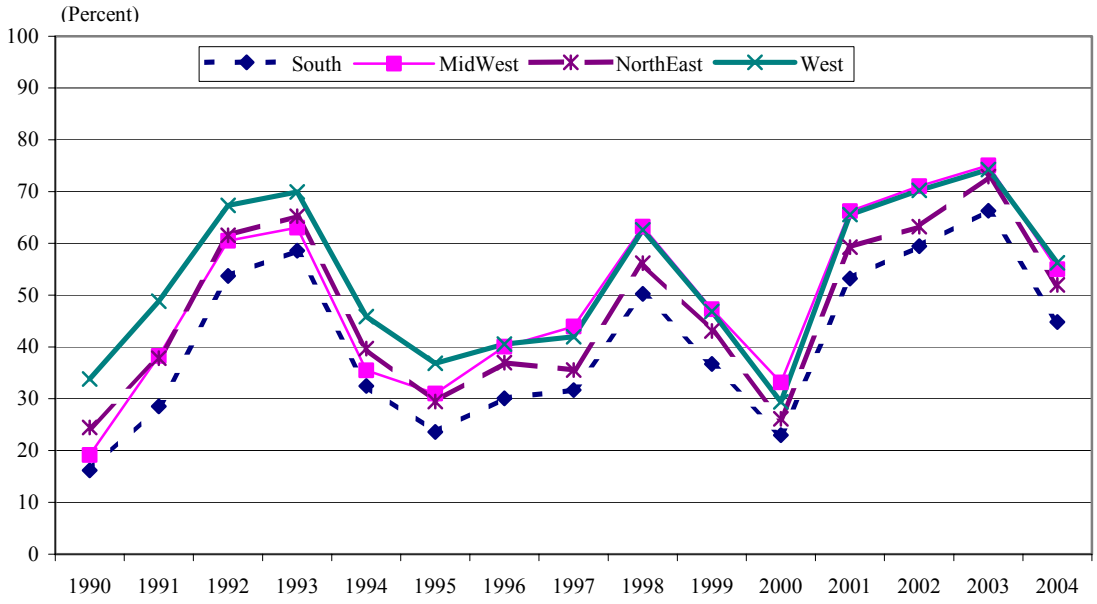


Figure 4.4 HMDA Refinance Percentage by Region



VITA

Yan Chang

Phone: Office: (703)903-2341 Cell: (703)965-5315
Email: yan_chang@freddiemac.com, yanzhang07@yahoo.com

Education

Ph.D. in Business Administration. Pennsylvania State University. May 2006.
M.S. in Business Administration. Pennsylvania State University. May 1997.
B.S. in Business Administration. The College of West Virginia. May 1995 (Graduated summa cum laude).

Experience

Oct. 2001 – Current: Business Economist, Freddie Mac
May 2000 – Oct. 2001: Reporting Specialist, PSINet
Sept. 1995 – May 2000: Instructor/Research Assistant/Teaching Assistant, Penn State University

Teaching Experience

Fundamentals of Finance, Penn State University, May – August 1998.
Financial Management, Penn State University, September 1998 – May 1999.

Publications

"Does Mortgage Hedging Raise Long-Term Interest Rate Volatility?" (with Douglas McManus and Buchi Ramagopal) *Journal of Fixed Income*, March 2005 14(4), 57-66.

"Refinance and the Accumulation of Home Equity Wealth" (with Frank Nothaft) *Building Assets, Building Credit, Joint Center for Housing Studies and Brookings Institution*, 2005, 71-102.

Papers Presented at Conferences

"Do Borrowers Make Rational Choices on Points and Refinancing?" (with Abdullah Yavas) American Real Estate and Urban Economics Association Annual Conference, January 6-8, 2006, Boston, MA.

"De-Mystifying the Refi-Share Mystery" (with Frank Nothaft) American Real Estate and Urban Economics Association Mid-Year Meeting, May 31-June 1, 2005, Washington, DC.

"Revision Bias in Repeat-Sales Home Price Indices" (with Amy Cutts and J. S. Butler) American Real Estate and Urban Economics Association Annual Conference, January 7-9, 2005, Philadelphia, PA.

"Did Changing Rents Explain Changing House Prices During the 1990s? Yes!" (with Amy Cutts and Richard Green) Federal Reserve Bank of Atlanta Conference on Housing, Mortgage Finance and the Macroeconomy, May 19-20, 2005, Atlanta, GA. American Real Estate and Urban Economics Association Annual Conference, January 3-5, 2004, San Diego, CA.

"Determinants of Home Equity and Aggregate Leverage" (with Frank Nothaft) American Real Estate and Urban Economics Association Annual Conference, January 3-5, 2004, San Diego, CA.