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Complex Mortgages

Abstract

Complex mortgages became a popular borrowing instrument during the bullish housing market of the early 2000s but vanished rapidly during the subsequent downturn. These non-traditional loans (interest only, negative amortization, and teaser mortgages) enable households to postpone loan repayment compared to traditional mortgages and hence relax borrowing constraints. At the same time, they increase household leverage and heighten dependence on mortgage refinancing to escape changes in contract terms. We document that complex mortgages were chosen by prime borrowers with high income levels seeking to purchase expensive houses relative to their incomes. Borrowers with complex mortgages experience substantially higher ex post default rates than borrowers with traditional mortgages with similar characteristics.

"The availability of these alternative mortgage products proved to be quite important, and, as many have recognized, is likely a key explanation of the housing bubble."
–Ben S. Bernanke

1 Introduction

Over the last decade, the residential mortgage market has experienced a significant increase in product complexity, followed by a rapid reversion back to simple products. In this paper, we study the mortgage contract choice of individual households and their subsequent default behavior.

The menu of household mortgage choices in the United States was dominated for decades by fully-amortizing long-term fixed rate mortgages (FRM) and, to a lesser extent, by adjustable rate mortgages (ARM) that locked in the initial interest rate for the first five to seven years of the contract. From the vantage point of the borrower, FRM contracts preserve contract terms established at origination for the lifetime of the loan. For practical purposes, the same can be said of the prevailing ARM contracts, given the average borrower tenure at a particular house of about seven years. Knowing the monthly servicing costs and amortization schedules simplifies the household budgeting problem.

The mortgage market has experienced a significant increase in product complexity in the early 2000s. The products that gained prominence during the period of rapid house price appreciation featured zero or negative amortization, short interest rate reset periods, and very low introductory teaser interest rates. We term these "complex mortgages" (CM). Figure 1 shows the proportion of fixed rate, adjustable rate, and complex mortgage products originated over the period between 1995 and 2009, as reported by LPS Applied Analytics (our primary data source described in detail below). The share of complex products in the U.S. remained

below 2% until the second half of 2003 before jumping to about 30% of mortgage originations just two years later. In some geographic areas complex mortgages accounted for more than 50% of mortgage originations. The complex products faded almost as quickly, declining to less than 2% of originations in 2008.

Complex mortgages appear to be at the core of the recent rise and decline in housing prices. To obtain an impression of the relation between risk levels and mortgage complexity, we aggregate the loan-level data into 366 Metropolitan Statistical Areas (MSAs) and then sort all MSAs into quintiles according to the proportion of complex mortgage loans in 2004 – the first year of substantial originations of complex loans. Figure 2 summarizes the average quarterly changes in house prices for the bottom, the middle, and the top MSA quintiles. We observe that MSAs in the top complexity quintile experience stronger house appreciation before 2006 and faster depreciation after 2006. This result provides an indication that house price changes were more pronounced in MSAs with high proportion of complex loans. It also suggests the importance of understanding the reasons for CM usage and the drivers of their eventual performance.

The defining feature of complex mortgages is the deferral of principal repayment. As a result, complex mortgages are characterized by low mortgage payments during the first few years of the contract, which relaxes household liquidity and borrowing constraints and enables households to take large exposures in housing assets. The lack of mortgage amortization inevitably produces two effects: a higher loan-to-value (LTV) ratio for any given path of house prices and a greater reliance on refinancing to escape increases in payments once a contract enters the amortization phase.

Complex mortgages can be optimal borrowing instruments if households expect their income levels or housing prices to increase over time, as discussed by Piskorski and Tchistyi (2010). They can also be optimal instruments for lenders concerned with their exposure in

an asset bubble environment (Barlevy and Fisher (2010)). In addition, complex mortgages might also be rationally chosen by households that exhibit relatively high labor income risk and live in areas with volatile house prices. These households have an incentive to minimize the initial mortgage payments and to keep the mortgage balance relatively high because they have the option to default in case of adverse income and house price shocks. These incentives to rationally default should be particularly pronounced in non-recourse states, where lenders do not have access to the non-collateralized assets of households in case of delinquency. In this case, complex mortgages should be a hallmark of sophisticated borrowers keenly aware of the value of the default option.

On the other hand, the low initial payments of complex mortgages might obfuscate the long-term borrowing costs for households, as suggested by Carlin (2009) and Carlin and Manso (2010). Lenders might have an incentive to introduce complex products to hide the actual fees embedded in financial products. Whereas it is relatively easy for a household to compare the costs of plain-vanilla fixed rate mortgages across different lenders, it is more difficult to compare complex loans that often include intricate reset schedules, prepayment penalties, and short-lived teaser interest rates. Lenders might be particularly eager to offer these products if they are confident that they can securitize these loans. In this case, we should observe that complex mortgages are taken out primarily by unsophisticated investors that do not understand the specific features of their mortgage contracts.

To study the mortgage choices of households and the default experiences, we make extensive use of the LPS Analytics data. The database, described in detail in Section 2, contains loan level information for a large sample of mortgages in the United States. Of particular relevance for our analysis is the ability to identify precise contract terms, both at the time of origination and over the lifetime of the loan.

Our main result indicates that complex mortgages are taken out by well-educated house-

holds with relatively high income levels and with prime credit scores. We find that households borrowing complex mortgages earn significantly higher annual incomes ($141,998) than households borrowing fixed rate mortgages ($88,642) or adjustable rates mortgages ($101,005). Furthermore, only 7% of borrowers using complex loans have credit scores below 620 (commonly considered subprime credit scores), whereas 10% of fixed rate borrowers and 23% of adjustable rate borrowers fall into this subprime category. We also find that a higher proportion of the population in neighborhoods with a high propensity of complex loans tend to have a college degree. Finally, complex loans are more prevalent in non-recourse states, where non-collateralized assets of the households are protected. Thus, these results indicate that complex loans are not primarily originated to naive households that are fooled by lenders into inappropriate mortgage contracts.

Nonetheless, these households are stretching to purchase more expensive houses relative to their incomes, as indicated by their higher value-to-income (VTI) ratios. Higher VTI ratios are associated with greater propensity to use complex contracts even after controlling for MSA-level income and VTI measures. This suggests that at least a part of the relationship is due to households using complex mortgages to get more expensive houses within high housing price areas. We also find that areas with higher past house price appreciation and higher population growth have more complex mortgages, whereas areas that experienced sustained house price decreases in the past ten years have fewer complex mortgages. This evidence suggests that the expectation of continued house price appreciation is a likely driving force behind the popularity of complex mortgages.

Next, we study the default behavior of borrowers of complex mortgages. The focus on initial loan affordability might motivate households to borrow too extensively and to underestimate refinancing risk, which is exacerbated by historically short reset periods and recasting of negative amortization loans. After controlling for observable characteristics that include

the FICO credit score and income, we find that households with complex mortgages are more likely to default. This holds true after the set of controls is expanded to include time-varying loan-to-value ratios, which suggests that higher CM defaults are not due exclusively to higher ex post leverage. Since complex mortgages typically have lower monthly payments relative to their fixed rate counterparts during the first years after origination, the higher default rates suggest that either CM households are more likely to default strategically, or that these households have more volatile income streams. Overall, our findings suggest that in addition to the well-documented impact of subprime mortgages, households with complex mortgages might be a significant driving force behind the mounting defaults during the recent crisis.

While the extension of credit to subprime borrowers and mortgage securitization has received much attention following the financial crisis of 2007-2009, the choice and impact of mortgage complexity remains largely unexplored. Mian and Sufi (2009) show that the sharp increase in mortgage defaults in 2007 is significantly amplified in geographic areas with a high density of subprime loans that experienced an unprecedented growth in mortgage credit prior to 2007. Keys, Mukherjee, Seru, and Vig (2010) focus on the role of mortgage securitization process, finding that securitization lowered the screening incentives of loan originators for their subprime borrowers. Jiang, Nelson, and Vytlacil (2010b) study the relation between mortgage securitization and loan performance and find that the lender applies lower screening efforts on loans that have higher ex ante probabilities of being securitized.[1] Our paper contributes to this literature by suggesting an additional and important channel linking mortgage market

[1]Additional papers on securitization and the expansion of credit to subprime borrowers include Adelino, Gerardi, and Willen (2009), Bond, Musto, and Yilmaz (2009), Keys, Mukherjee, Seru, and Vig (2009), Loutskina and Strahan (2009), Mayer, Pence, and Sherlund (2009), Stanton and Wallace (2009), Agarwal, Ambrose, Chomsisengphet, and Sanders (2010), Bajari, Chu, and Park (2010), Barlevy and Fisher (2010), Berndt, Hollifield, and Sandas (2010), Campbell, Giglio, and Pathak (2010), Corbae and Quintin (2010), Demyanyk and Hemert (2010), Garmaise (2010), Gerardi, Rosen, and Willen (2010), Glaeser, Gottleb, and Gyourko (2010), Goetzmann, Peng, and Yen (2010), Jiang, Nelson, and Vytlacil (2010a), Piskorski, Seru, and Vig (2010), Purnanandam (2010), Rajan, Seru, and Vig (2010), Stanton and Wallace (2010), and Woodward and Hall (2010).

innovations to the financial crisis of 2007-2009.

A few recent papers have investigated the role of non-traditional mortgage contracts in the recent crisis. Piskorski and Tchistyi (2010) study optimal mortgage design in an environment with risky privately observable income and costly foreclosure and show that the features of the optimal mortgage contract are consistent with an option adjustable rate mortgage contract. Corbae and Quintin (2010) present a model where heterogeneous households select from a set of mortgage contracts and have a choice of defaulting on their payments. Using their model, they find that the presence of subprime mortgages with low down payments substantially amplifies foreclosure rates in the presence of a large exogenous shock to house prices. In a contemporaneous paper, Barlevy and Fisher (2010) describe a rational expectations model in which both speculators and their lenders use interest-only mortgages when there is a bubble in house prices. They provide evidence that interest only mortgages were used extensively in cities where inelastic housing supply enables pronounced boom-bust cycles. Our paper studies empirically the characteristics and the default experiences of borrowers of complex loans.

The remainder of this paper is structured as follows. Section 2 describes our data sources and reports summary statistics. In Section 3 we study the mortgage choice of households and describe the main features of mortgage contracts. In Section 4 we study the delinquency of different contract types.

2 Data Sources and Summary Statistics

Our study relies on several complementary data sources that cover various aspects of the housing market during the period between 2003 and 2007. In particular, the micro level analysis of mortgage contract choice and performance relies heavily on the proprietary mortgage-level database offered by Lender Processing Services (LPS) Applied Analytics (formerly known as McDash Analytics). LPS collects data from some of the nation's largest mortgage servicers

that report contract and borrower details at the time of loan origination, as well as monthly information on mortgage performance. The LPS data coverage has grown steadily over time, with 9 out of 10 largest servicers reporting to the database by 2003. Our database covers about 10 million mortgages with a total loan value of more than $2 trillion between 2003 and 2007.

For the purposes of our study, the availability of granular information on mortgage contract terms is of particular importance. For each of the loans, LPS provides information on the loan interest rate, the amortization schedule, and the securitization status. For adjustable rate mortgages (ARMs), we know the rate at origination, the frequency of resets, the reference rate, and the associated contractual spread. For loans that do not amortize steadily over their term, we know the horizon of the interest-only period, whether negative amortization is allowed and if so, to what extent and over what period of time. This information allows us to precisely categorize loan contracts.

The LPS data also contains key information on borrower and property characteristics at the time of origination. These include the appraised property value, the loan-to-value ratio (LTV), property type (single family or condominium), whether the property was to be occupied by the borrower, and the borrower's creditworthiness as measured by their FICO (Fair Isaac Corporation) credit score.[2]

An important feature of the LPS database is that unlike some other data sources, it is not limited to a particular subset of the loan universe. The LPS data cover prime, subprime, and Alt-A loans,[3] and include loans that are privately securitized, those that are sold to

[2]As Bajari, Chu, and Park (2010) emphasize, an important feature of the FICO score is that it measures a borrower's creditworthiness prior to taking out the mortgage. FICO scores range between 300 and 850 Typically, a FICO score above 800 is considered very good, while a score below 620 is considered poor. As reported on the Fair Isaac Corporation website (www.myfico.com), borrowers with FICO scores above 760 are able to take out 30-year fixed rate mortgages at interest rates that are 160 basis points lower, on average, than those available for borrowers with scores in the 620-639 range.

[3]Alt-A loans are a middle category of loans, more risky than prime and less risky than subprime. They

Government Sponsored Enterprises (GSEs), and loans that held on banks' balance sheets. Although this allows for a broad set of mortgage contracts, the coverage is somewhat skewed in favor of securitized loans that are more likely to be serviced by large corporations reporting to LPS. The relative scarcity of portfolio loans is relevant to us since some of the contracts of interest, such as option ARMs, are commonly held in lenders' portfolios. Still, the large overall size of the data ensures that we have ample coverage of all contract types.

We complement borrower information in LPS with household income data collected under the Home Mortgage Disclosure Act (HMDA). Doing so allows us to compute some of the key measures of loan affordability, such as the ratio of house value to income (VTI). We further augment the loan-level data with information on trends in local home prices. Quarterly data on home prices is available by metropolitan statistical area (MSA) from the Federal Housing Finance Agency (FHFA)-an independent federal agency that is the successor to the Office of Federal Housing Enterprise Oversight (OFHEO) and other government entities.[4] We use the FHFA House Price Index (HPI) including all transactions that is based on repeat sales information. We use a house price index to construct borrower-specific variables on cumulative growth in local house prices.

At the more aggregate level, we utilize zip code level information from the 2000 U.S. Census to control for broad demographic characteristics, such as education levels. We also make use of the annual per capita income and unemployment rate data at the MSA level from the Bureau of Economic Analysis (BEA).

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are generally made to borrowers with good credit scores, but the loans have characteristics that make them ineligible to be sold to the GSEs-for example, limited documentation of the income or assets of the borrower or higher loan-to-value ratios than those specified by GSE limits.

[4]As part of the Housing and Economic Recovery Act of 2008 (HERA), the Federal Housing Finance Regulatory Reform Act of 2008 established a single regulator, the FHFA, for GSEs involved in the home mortgage market, namely, Fannie Mae, Freddie Mac, and the 12 Federal Home Loan Banks. The FHFA was formed by a merger of the Office of Federal Housing Enterprise Oversight (OFHEO), the Federal Housing Finance Board (FHFB), and the U.S. Department of Housing and Urban Development's government-sponsored enterprise mission team (see www.fhfa.gov for additional details).

To determine whether lender recourse has an impact on mortgage choices and mortgage defaults we follow Ghent and Kudlyak (2010) and classify U.S. states as recourse or non-recourse states. In non-recourse states, recourse in residential mortgages is limited to the value of the collateral securing the loan. On the other hand, in recourse states the lender may be able to collect on debt not covered by the proceedings from a foreclosure sale by obtaining a deficiency judgment.[5]

The summary statistics on these variables are presented in Table 1 and we will discuss differences in these variables across mortgage types in more detail in Section 3.2. All of the variables discussed above are summarized in Table 9.

3 Mortgage Choice

This section describes in detail the differences in characteristics of the main mortgage contracts offered in the U.S. during the last decade and the determinants of the mortgage choice.

3.1 Mortgage Contract Design

In this section we illustrate the different payment patterns of some popular U.S. mortgage contracts. We classify all mortgage products into three groups: (1) Fixed Rate Mortgages (FRM); (2) Adjustable Rate Mortgages (ARM); and (3) Complex Mortgages (CM).[6]

Fixed rate mortgages are level-payment fully-amortizing loans with maturities that generally last for 15 or 30 years. For example, a household borrowing $500,000 on a 30-year fixed rate mortgage with a 5% interest rate will be required to make equal monthly payments of $2,684 for 360 months. After 30 years the mortgage will be paid off completely. Borrowers

[5]Ghent and Kudlyak (2010) classify the following states as non-recourse: Alaska, Arizona, California, Iowa, Minnesota, Montana, North Dakota, Oregon, Washington, and Wisconsin.

[6]Additional information on various mortgage contracts can be obtained from the website of Jack M. Guttentag at http://www.mtgprofessor.com.

generally have the option to prepay the mortgage if they sell the property or if they refinance their loan due to a decrease in mortgage interest rates.

Adjustable rate mortgages are fully-amortizing loans where the interest rate changes after an initial period according to a preselected interest rate index. The initial period with a fixed interest rate typically lasts between two and seven years. The mortgages exhibit caps and floors that prevent the interest rates from changing too much over the lifetime of the loan. Interest rates on ARMs generally are lower than those on FRMs due to the increasing term structure of interest rates and the availability of the prepayment option in FRMs.[7] For example, a 5/1 ARM with a 30-year maturity, a $500,000 initial balance, and a 4.5% initial interest rate will have initial mortgage payments of $2,533 per month for the first 60 months. Subsequently, the payments can increase or decrease depending on the level of interest rates. If the interest rate increases to 7%, then the monthly payment in the sixth year will increase to $3,221.[8]

Complex mortgages include a variety of back-loaded mortgage contracts. Most complex mortgages are adjustable rate mortgages and exhibit time-varying payments. The most popular contract is an Interest Only (IO) mortgage. IO borrowers only need to pay the mortgage interest for an initial time period that typically lasts between five and ten years. Subsequently, the mortgage becomes a fully-amortizing loan. For example, a 5-year IO adjustable rate loan with a 30-year maturity, a $500,000 initial balance, and a 4.5% initial interest rate will have initial mortgage payments of $1,875 per month for the first 60 months. Subsequently, the payments reset according to the future interest rates. If the interest rate increases to 7%,

[7]Fixed rate mortgages can be refinanced when interest rates decrease, which is a very valuable option that is priced in the initial interest rate. There are numerous papers on prepayments. See for example, Dunn and McConnell (1981), Schwartz and Torous (1989), Stanton (1995), Dunn and Spatt (1999), Longstaff (2005), Campbell (2006), Amromin, Huang, and Sialm (2007), Gabaix, Krishnamurthy, and Vigneron (2007), and Schwartz (2007).

[8]Several papers study the tradeoff between FRMs and ARMs (e.g., Campbell and Cocco (2003), Vickery (2007), and Koijen, Van Hemert, and Van Nieuwerburgh (2009)).

then the monthly payment in the sixth year will almost double to $3,534. Even if interest rates remain at 4.5%, the mortgage payment will increase to $2,779 per month at the end of the initial interest-only period. The payments increase even more for mortgages with longer interest-only periods.

A second type of a complex mortgage is a Negative Amortization Mortgage (NEGAM), such as an Option ARM. These mortgages give borrowers the option to initially pay even less than the interest due. The difference between the interest due and the actual mortgage payment is added to the loan balance. These mortgages carry the risk of larger increases in mortgage payments, when the mortgage is recast to become a fully amortizing loan after 5-10 years or when the loan balance exceeds the initial balance at origination by more than a certain amount (typically 10-25%).

Finally, a third type of a complex mortgage is a Teaser Rate Mortgage (TRM). For TRMs, the initial interest rate is significantly below the fully indexed rate. Teaser rate loans typically charge investors interest rates of between 1-2% during the first 1-12 months. Most teaser rate mortgages also feature negative amortization.

In sum, complex mortgages are back-loaded products with limited amortization during the first years after origination. As mentioned in the introduction, complex mortgages can be optimal if households expect their income levels or housing prices to increase over time (Piskorski and Tchistyi (2010)). However, the low initial payments of complex mortgages also carry a number of risks, from obfuscating the long-term borrowing costs of households (Carlin (2009), Carlin and Manso (2010)) to greater reliance on refinancing to avoid increases in payments. This obfuscation might be particularly pronounced for teaser rate mortgages, whose low payments only apply for a relatively short initial period.

3.2 Summary Statistics by Mortgage Type

Table 2 reports statistics for our broad mortgage categories – fully-amortizing fixed rate (FRM), fully-amortizing adjustable rate (ARM) and complex (CM) mortgage types. Our data contain in excess of 10 million loan contracts originated between 2003 and 2007. In our sample, 69 percent of mortgages are fixed rate mortgages, 12 percent are adjustable rate mortgages, and the remaining 19 percent are complex mortgages.

Complex mortgages, on average, are associated with higher loan amounts relative to the traditional ARM and FRM mortgages, and are used to finance more expensive houses. For example, the average home value for complex loans is $513,728, whereas the average home values for FRMs and ARMs are $264,878 and $309,465, respectively. Counter to some of the commonly made assertions about complex mortgages, they are extended to borrowers with high income levels. Indeed, the mean income of a complex mortgage borrower is about 60% higher than that of a borrower with a traditional plain-vanilla fixed rate mortgage.

Nevertheless, the average ratio of house value to income (VTI) – a measure of affordability – is considerably higher in complex mortgage contracts, suggesting that complex mortgage borrowers are purchasing more expensive houses relative to their income. Yet, this higher spending on houses is not reflected in the loan-to-value (LTV) ratio, as all mortgage types have similar first lien LTV values.[9] Panel A of Figure 3 depicts the cumulative distribution function of the VTI ratio for borrowers with different mortgage contracts. The figure indicates that CM borrowers tend to have substantially higher VTI ratios than both ARM and FRM borrowers. Median households using FRMs, ARMs, and CMs have value-to-income ratios of 3.0, 3.1, and 3.7, respectively. Put differently, for a given level of income CM borrowers

[9]LPS data is collected at the loan and not property level, which limits one's ability to construct an accurate estimate of the total debt secured by the house. In particular, we are unable to account for second-lien mortgages loans (the so-called "piggyback loans") used to finance the house. Primarily for this reason, we do not emphasize the importance of LTV in our empirical analysis and instead focus on the VTI ratio.

purchased houses valued at about 20% more. The lower initial payments on complex mortgages thus appear to enable households to purchase expensive homes relative to their income levels.

We also find that borrowers of complex mortgages have better credit scores than ARM borrowers and similar credit scores as FRM borrowers. Whereas 23% of ARM borrowers have FICO credit scores below 620, the same can be said of only 10% of FRM and 7% of CM borrowers. Panel B of Figure 3 summarizes the entire distribution of FICO scores for different mortgage contracts. Whereas many borrowers using ARMs tend to have subprime credit scores, the credit quality of borrowers using CMs is fairly similar to that of the FRM borrowers. These results emphasize that the clientele for complex mortgages differs significantly from that for subprime loans.

Several other loan characteristics are different for complex mortgages. CM borrowers are more likely to live in a condominium and are slightly more likely to use the property they are financing for investment purposes. We also find significant differences in the frequency of prepayment penalties across mortgage types. Unlike FRMs, a significant fraction of ARMs and CMs face penalties if the loans are prepaid within the first two or three years. Around 40% of the mortgages in our sample are from refinancing transactions, whereas the remaining proportion is from new home purchases. Complex mortgages have a slightly higher share of refinancings compared to new purchases.

Since complex loans are particularly popular for expensive homes, they are also more likely to exceed the conforming loan limit (i.e be jumbo loans). Hence, although 79% of FRMs are securitized by government-sponsored enterprises (GSEs, such as Fannie Mae, Freddie Mac, amd Ginnie Mae), only 24% of CMs go through the GSEs. Private securitization partially offsets the lack of GSE involvement in the ARM and CM markets.

Complex mortgage borrowers receive significantly lower initial interest rates than FRM or ARM borrowers. The mean initial interest rate on complex mortgages of 5.12% is significantly

lower than the rates on FRMs (6.16%) and ARMs (5.97%). This result is primarily caused by teaser rate mortgages that charge, on average, an initial interest rate of only 1.30%. For each ARM and CM loan we impute the rate such borrowers might have received had they chosen a conventional 30-year fixed rate mortgage instead. We define such hypothetical rate as the average interest rate on all 30 year FRMs originated in the same month, state, with similar loan size (whether or not above the conforming limit), LTV ratio, and FICO score. The hypothetical FRM interest rate is similar across the various contracts.

Whereas the variables above are available at the loan level, we also report some additional variables observed at the MSA or the state level. We find that CM borrowers tend to live in cities with higher income levels and with higher VTI ratios. Thus, some of the variation in income levels and VTI ratios is driven by differences in these characteristics across cities.

From a spatial standpoint, complex mortgages are more common in geographic areas that experienced high house price appreciation. The average 3-year cumulative price appreciation among complex borrowers amounted to a staggering 44%, as compared with 30% among traditional FRM borrowers. We also document that only 12% of complex mortgages were originated in areas that had experienced four quarters of declines in house prices over the preceding 10 years, as opposed to 13% of FRMs and 16% of ARMs.

Unfortunately, we do not observe the education level of borrowers directly. However, we can compute the proportion of people in zip codes with a college education. Households using complex mortgages tend to live in areas with a higher proportion of college graduates. Finally, the population growth rate and the unemployment rate, which capture macroeconomic conditions at the MSA level, are similar in areas with different mortgage compositions.

Complex mortgages were substantially more popular in non-recourse states, where the lender cannot access assets of the defaulting households beyond the value of the collateral securing the loan. Whereas only 22% of FRMs are in non-recourse states, 44% of CMs are

originated in such states.

Table 3 breaks out the key summary characteristics among different complex mortgage types. Teaser loans, on average, appear to be used to finance more expensive homes and are associated with higher loan values. They also display the highest VTI ratios. It is worth noting that few of the teaser contracts are offered to subprime borrowers. As expected, teaser loans commonly carry prepayment penalties. Finally, even among complex products, teaser loans are taken out in areas with higher house price appreciation, often to refinance an existing mortgage obligation. Finally, IO contracts appear to have been subject to stricter underwriting criteria. Whereas only 11% of IOs were underwritten on the basis of less than full documentation, more than 40% of NEGAM and TRM loans were issued in this manner.

3.3 Geographic Distribution of Mortgages

Figure 4 shows the concentration of complex mortgages in different counties across the United States in 2002, 2005, and 2008. Consistent with Figure 1, we find that complex mortgages were fairly uncommon in 2002. The distribution of complex mortgages looks dramatically different in 2005, when multiple counties in California, Colorado, Florida, and Nevada had CM shares in excess of 40%. In some zip codes in these states more than half of mortgage originations were complex loans. While this pattern looks suggestive, numerous areas with high house price appreciation had few complex mortgages even at the peak of the housing boom. For example, CM contracts accounted for only about 5% of loans in the Albany, NY metropolitan area where house prices rose by more than 80% between 2001 and 2007. In contrast, CMs proved to be very popular in the Detroit MSA, where nominal house prices remained flat during this period. It is also worth noting that in some areas rapid price increases preceded

the surge in CM contracts, whereas other areas had the opposite relationship.[10]

3.4 Affordability of Different Mortgage Contracts

Complex mortgage products have relatively low payments during their first years and thereby enable households to purchase more expensive homes. Figure 5 depicts the ratio between the monthly payments of ARMs and CMs relative to fully-amortizing FRMs originated in the same month for borrowers with similar characteristics (i.e., loans originated in the same states with similar FICO scores and loan-to-value ratios). We observe that 64.5% of ARMs and 85.6% of CMs have payments that are less than those of comparable FRMs during the first year. Furthermore, 9.0% of ARMs and 49.8% of CMs have payments that are more than 20% lower. Panels B and C show that the payments on the vast majority of CMs remain lower than those on FRMs even three or five years after the origination. For example, we find that five years after origination the payment ratio is less than one for 87.6% of CMs, and less than 0.8 for 62.5% of CMs. Thus, a relatively small fraction of complex mortgages have substantial resets of mortgage payments during the first five years that cannot be managed by refinancing into a new contract.[11] This result indicates that CM borrowers continued to have relatively low payments throughout the mortgage crisis of 2007-2009. Mortgage defaults during the crisis would likely have been significantly higher if complex mortgages had reset their minimum payments after a shorter introductory time period.

The finding that ARMs and CMs payments were lower than those for comparable FRMs for an extended period of time can be explained by several factors. First, short-term interest rates have decreased over our sample period thereby reducing the payments on ARMs and CMs,

[10] Granger causality tests carried out at the MSA level present mixed evidence of the relationship between changes in house prices and CM shares. The results are also highly sensitive to the choice of evaluation period. This subject is discussed in greater detail in a concurrent paper by Barlevy and Fisher (2010).

[11] Unfortunately we do not have sufficiently long time series available to study the resets in more detail since most of the complex mortgages in our sample are originated between 2004 and 2006.

which are generally tied to such rates. Second, Figure 5 only shows the payments of mortgages that survived and were not previously refinanced. Households that obtain mortgages with lower interest rates and lower total payments are less likely to refinance a loan, resulting in a tendency of the actual payments on surviving ARMs and CMs to decrease over time relative to the FRMs.

By virtue of their amortization structure, complex loans largely maintain a high leverage ratio over time. Figure 6 depicts the distribution of the remaining mortgage balance one, three, and five years after mortgage origination relative to the original balance for the three mortgage contract types. Even five years after origination (Panel C) around 51% of complex mortgages are within 2.5% of their initial loan balance and around 16% of borrowers increased their loan balance by more than 2.5%. This creates a sharp contrast with FRM and ARM borrowers who gradually pay down their mortgages. Thus, CM borrowers tend to keep substantially higher debt levels than households with more traditional mortgage products. This makes CM borrowers more susceptible to economic shocks. This dynamic deterioration in relative leverage ratios becomes particularly dramatic in the event of slower house price appreciation, as experienced during the housing crisis of 2007-2009.[12]

3.5 Determinants of Mortgage Choice

In this section we analyze the determinants of mortgage choice more systematically. In particular, we estimate the likelihood of selection of a particular mortgage contract type (ARM or CM) relative to a baseline contract, which we take to be an FRM. These relative likelihoods are estimated as a function of loan- and borrower-level covariates, as well as MSA-level

[12]The higher long-term loan-to-value ratios of complex loans may have contributed to a further deterioration in housing markets, as suggested by the leverage effect of Stein (1995) and Lamont and Stein (1999). Additional papers that study the macro-economic aspects of housing prices include Lustig and Van Nieuwerburgh (2005), Ortalo-Magne and Rady (2006), Piazzesi, Schneider, and Tuzel (2007), Brunnermeier and Julliard (2008), Favilukis, Ludvigson, and Van Nieuwerburgh (2010), Landvoigt, Piazzesi, and Schneider (2010), and Van Nieuwerburgh and Weill (2010).

aggregates. Formally, we use maximum likelihood to estimate the following multinomial logit regressions:

$$\frac{Prob(Y_i = m)}{Prob(Y_i = FRM)} = e^{\beta_m X_i + FE_i^{State} + FE_i^{Year} + \epsilon_i}, \tag{1}$$

where $Prob(Y_i = m)/Prob(Y_i = FRM)$ is probability of obtaining an ARM or CM relative to a FRM, X is a vector of mortgage-specific covariates, FE^{Year} are indicator variables for the origination years, and FE^{State} are geographic indicator variables.

Table 4 reports the estimated coefficients. The first two columns use only individual household level characteristics to explain the mortgage choice and the last two columns include MSA level aggregates and state fixed effects. All regressions include time fixed effects and the standard errors are clustered by MSA. Since some of the MSA level variables are not available for the full sample, the corresponding specifications include fewer observations than the overall sample summarized in Table 2.

We find that households with higher income levels are significantly more likely to obtain a complex mortgage than to take out a more traditional FRM loan. Despite their higher income, these households are stretching to purchase more expensive homes, as indicated by their higher estimated coefficients on value-to-income (VTI) ratios. Although ARM loans are also more likely in higher VTI transactions, the economic effect of VTI is stronger for CM contracts. Households with lower FICO scores are significantly more likely to choose an ARM or a CM contract, although the coefficient estimate is substantially smaller for CMs than for ARMs.

The theme of complex mortgages as "affordability products" for households with preferences for relatively expensive homes relative to their incomes is reflected in several other coefficients. For instance, we find that CM contracts are much more prevalent for mortgages

above the GSE conforming loan limit. Such mortgages are subject to the so-called jumbo spread, which increases the relative appeal of payment-shrinking CM products. Most strikingly, however, CM borrowers are much more likely to provide incomplete documentation for their loans. The greater reliance of CM contracts on low-documentation underwriting is consistent with borrower effort to inflate their income to qualify for a higher loan amount needed for an expensive house. Overall, there is little evidence that a typical complex mortgage is taken out by a relatively poor and naive household.

We find that the type of property has an impact on mortgage contract choice. Mortgages used to finance condominiums and investment properties are more likely to be ARMs or CMs. Complex mortgages might be particularly attractive for such types of properties, since owners of condominiums and investment properties have potentially fewer indirect costs of strategically defaulting on their properties. They might therefore have an incentive to pay down their mortgage balance relatively slowly to increase the option value of strategic default.

We also find that households in non-recourse states are significantly more likely to obtain a complex mortgage than households in recourse states. This might also be caused by the higher option value of defaulting in non-recourse states. Households in such states have smaller incentives to pay down their mortgages as they can simply walk away in case of default without worrying about the lender accessing their other assets. However, it is interesting that lenders did not curtail to a more significant degree the prevalence of complex loans in non-recourse states.

It is possible that the positive association between CM contract choice and both VTI and income reflects the propensity of CMs to be concentrated in high income and high house price MSAs. However, specifications that incorporate MSA-level controls and state fixed effects preserve these relationships. Although some of the coefficients are attenuated in those specifications, they remain highly significant. This suggests that within individual geographies,

complex mortgage choice is favored by the relatively well-off that are stretching their budget flow constraints to afford more expensive houses.

Complex mortgages are backloaded contracts in which reduced mortgage payments are followed by higher payments needed to catch up on the delayed principal repayment. There are several explanations justifying this preference for an increasing payment path. First, individual households might anticipate future income growth, due either to favorable local economic conditions or to their personal wage profile, especially for younger households. For these households it makes sense to purchase expensive homes relative to their incomes under the permanent income hypothesis (Gerardi, Rosen, and Willen (2010) and Cocco (2010)). Second, households might expect house prices to appreciate in the future, which enables them to refinance their loans to meet the higher future payments (Barlevy and Fisher (2010)). Third, the popularity of these backloaded products might be an outcome of lax lending standards due to agency issues, in which lenders care only about the fees generated from originating the loans and not about future defaults when they sell the loans via securitization (Carlin (2009), Keys, Mukherjee, Seru, and Vig (2010) and Jiang, Nelson, and Vytlacil (2010a)).

We cannot perfectly separate these three explanations. However, results in Table 4 shed some light on their relative importance in the choice of mortgage contracts. Since we cannot observe household expectations for their income and house price growth, we use the prior three years' house price appreciation and an indicator variable for whether the area experienced an annual decline over the prior ten years as proxies for expected income and house price growth rates. These two variables capture the extent to which households extrapolate past local experiences to build their expectations about future house price dynamics. Borrowers and lenders in areas which experienced a recent decline in house prices might have been more cautious in choosing instruments that exhibit low or even negative amortization. On the other hand, borrowers and lenders in geographic areas where appreciation was substantial

might have been more willing to accept non-amortizing loans if they expected the appreciation to continue in the future. In addition, we include the prior one-year population growth rate in the MSA as a proxy for expected income and house price growth. Geographic areas with significant population growth might be areas where households expect significant house price and income growth.

We find that the price decline indicator variable and the population growth rate significantly affect the choice of CM. In particular, CM contracts are more popular in areas that did not experience an annual house price decline over the prior ten years and in areas with high population growth. This evidence suggests that the expectations of continued house price and income growth are likely a driving force behind the popularity of complex mortgages.

Finally, if complex mortgages are affected by agency conflicts and are pushed to naive households to maximize the commissions for loan officers, then we might expect these loans to be concentrated in low income areas with poorly educated households. We do not find support for this hypothesis. Cities with lower proportions of college educated households and with lower median incomes do not exhibit higher proportions of complex loans.

Table 5 reports the coefficients of multinomial logit regressions that further differentiate between various types of complex contracts. The estimates are consistent with the univariate results in Table 2. In particular, we see that NEGAM and especially TRM contracts were used by high-income borrowers to refinance their high-priced primary residences, often on the basis of only limited income and asset documentation. It is likely that such refinancings were serial in nature, which would further underscore the fragility of such contracts in environments where the refinancing markets freeze up.

4 Mortgage Delinquencies

In this section we study the delinquency of different types of mortgages. A mortgage is delinquent if the borrower is at least 60 days late in making the mortgage payments.

4.1 Reasons for Mortgage Delinquencies

Delinquencies might differ across mortgage types for various reasons. First, ARMs and CMs are generally adjusted according to short-term interest rates and might have higher delinquency rates because their mortgage payments increase in a rising interest rate environment. Over our sample period the interest rates have not risen substantially, suggesting that this channel is likely not of significant importance.

Second, CMs generally exhibit an increasing payment trend over the life of the loan since the initial payments are not fully amortizing as described previously. Mortgage delinquencies might become more likely after the various resets when the payments suddenly increase. On the other hand, CMs might exhibit lower delinquency rates during the initial period when mortgage payments are relatively low. Some complex mortgage contracts (e.g., Option ARMs) give borrowers the flexibility to adjust their mortgage payments as their income levels fluctuate, which might reduce the probability of defaults. As we observe in Figure 5, most complex mortgages have lower mortgage payments than corresponding FRMs or ARMs over the first five years since origination.

Third, CMs pay down their mortgage balance at a slower rate than FRMs and ARMs as summarized in Figure 6. Therefore, borrowers of complex loans have a bigger incentive to default on their loans in case of cash flow difficulties or for strategic reasons. Whereas a borrower with a complex mortgage might just walk away from their mortgage contract if they experience financial difficulties, a borrower with a FRM or an ARM might be more likely to

sell their home since the embedded equity is higher for fully amortizing mortgage contracts.

Fourth, borrowers that are attracted to ARMs and CMs might differ in their preferences. Borrowers that are willing to bear interest-rate risk might be more risk-tolerant as shown by Campbell and Cocco (2003). Finally, borrowers using traditional mortgage products might be more influenced by ethical norms that motivate them to pay back their debt even if it would be more economical to default on a mortgage contract, as discussed by Guiso, Sapienza, and Zingales (2009).

4.2 Summary of Mortgage Delinquency

Panel A of Table 6 reports the proportion of mortgages that are delinquent after one, three, and five years by mortgage type. We observe that FRMs have the lowest delinquency rates at all horizons, CMs have lower delinquency rates than ARMs at a one year horizon but higher delinquency rates at longer horizons. For example, 22.75% of CMs, 18.48% of ARMs, and 11.95% of FRMs are delinquent at a 5-year horizon. Thus, at longer horizons the probability of delinquency increases for CMs.

Figure 7 shows the proportion of mortgage delinquencies for FRMs, ARMs, and CMs for the first five years after origination. In each month we depict the proportion of remaining mortgages that become delinquent for the first time. We observe that complex mortgages have strictly higher delinquency rates than fixed rate mortgages at all horizons. Mortgage delinquencies of complex loans reach peaks of 1.3% and 1.2% of surviving loans after 27 and 39 months since origination. These peaks occur three months after common reset intervals, since delinquency begins when a mortgage payment is at least 60 days late. We observe a similar peak for ARMs after a horizon of 27 months.

Whereas ARMs have slightly higher rates of delinquency at short horizons, CMs have substantially higher rates at longer horizons. It must be kept in mind that borrowers of

complex loans have relatively high delinquency propensities despite having significantly higher credit scores than ARM borrowers, as summarized in Table 2. It is also insightful that the delinquency rate increases substantially even before the minimum loan payments are reset after two or three years, indicating that some borrowers of complex loans do not even make the relatively low initial mortgage payments.

4.3 Hazard Rate Model

To investigate the determinants of mortgage delinquencies, we run the following Cox proportional hazard model:

$$h(i,t) = h_0(t)e^{\beta X_{i,t} + FE_i^{Year} + FE_t^{Year} + FE_i^{State} + \epsilon}, \tag{2}$$

where the hazard rate $h(t)$ is the estimated probability of first time 60 day delinquency at time t conditional on surviving to time t_-, $h_0(t)$ is the baseline hazard rate, X is a vector of household-specific covariates, and FE_i^{Year} and FE_t^{Year} are two indicator variables for the origination year and calendar years to control for different vintage effects and macroeconomic conditions. In some specifications, we also include FE^{State} to control for state fixed effects. The loan sample is expanded to a loan-year level so that time-varying covariates can be included. Also, time is scaled so that the first observation date is the calendar year of origination (time 0), and subsequent calendar years are measured relative to the year of origination. Implicitly, loans of different vintages are compared with each other, so that the baseline hazard represents the probability of delinquency for a borrower with covariates of 0 at t years after origination. In some specification we split up complex mortgages into the three sub-types (IO, NEGAM, and TRM).

Table 7 reports the estimated coefficients of the propensity of first time 60 day delinquency,

so that the change in probability of delinquency can be read as odds ratios. For example, in column 1, the coefficient of 0.792 for CM means that the ratio of the probability of delinquency for a borrower with a complex mortgage and the probability of delinquency for a borrower with similar characteristics but a fixed rate mortgage is $e^{1\times 0.792}/e^{0\times 0.792} = 2.2$; or the complex borrower is about 2.2 times more likely to be delinquent.

In the first two columns, we use only borrower characteristics at the time of loan origination to estimate the delinquency probability. In last two columns, we include time-varying characteristics and state fixed effects. The current LTV ratio is defined as the mortgage loan amount at the end of the prior period divided by the current home value. The current home value is estimated by adjusting the home value at origination by the house price appreciation at the MSA level since the origination. Households with complex loans will pay down their mortgages at a slower pace (as illustrated in Figure 6) and will have higher current LTV ratios. In addition, areas with house price declines will have higher current LTV ratios. Households with LTV ratios exceeding 100% will have higher incentives to default on their loans since they do not have any home equity at stake. Thus, including the current LTV ratio in the hazard model controls for dynamic leverage levels, which differ across mortgage types. Finally, the unemployment level captures the proportion of unemployed in an MSA and the income growth is defined as the growth rate of income at the MSA level since the mortgage was originated.

We find that CMs have significantly higher delinquency rates than FRMs in all specifications. Delinquency rates are particularly high for teaser rate mortgages, which are presumably the least transparent mortgage contract we analyze. Households that borrow using ARMs also have significantly higher propensities to be delinquent, although the coefficient estimate is substantially smaller than the coefficient on complex mortgages. The propensity to be delinquent decreases with the income level at origination. Furthermore, borrowers with lower credit scores, subprime borrowers, loans originated with low or no documentation, loans above the

conforming limit, and investment properties are significantly more likely to be delinquent.

The last two columns consider the impact of the additional MSA level variables and state fixed effects. We find that households in areas with high unemployment and depressed income growth since the origination of the loan are more likely to be delinquent, suggesting that the difficulty to meet cash flow payment is certainly a driver of mortgage delinquency. However, local income shocks are likely to affect borrowers of different mortgages similarly. To investigate the impact of house price appreciation and different amortization schedules, we include the current LTV ratio. We find that households with higher current LTV ratios are significantly more likely to default, suggesting that strategic default is likely a contributor to mortgage delinquency as well. This source of delinquency is also likely to explain the significantly higher delinquency rate for CMs over time, since the LTV for CMs increases significantly over time relative to ARMs or FRMs due to the low or even negative amortization in the first few years.

It is also remarkable that the coefficients on CMs remain highly statistically significant even after controlling for the current LTV ratio, the local income growth rate, the local unemployment rate, and state fixed effects, suggesting that CM borrowers might be fundamentally different from FRM borrowers. They might be more risk seeking in general, as revealed by their choices for CM contracts. They might have riskier income or might be more receptive to the idea of strategic default. Additional work is needed to fully disentangle the various sources of delinquency. These results are consistent with the structural model of Corbae and Quintin (2010), who find that the presence of nontraditional mortgages amplified the foreclosure crisis between the first quarter of 2007 and the first quarter of 2009.

4.4 Bankruptcy

The decision to default on a mortgage is related to the decision to declare bankruptcy. Contrasting the determinants of personal bankruptcy with the determinants of mortgage delinquency gives us important insights about the motivation of the delinquency behavior. It is not necessary that households that default on their mortgages are also declaring bankruptcy. Nor is it necessary that households that declare bankruptcy default on their mortgages. For example, in our sample only 13% of households that are delinquent on their mortgage also declare bankruptcy. Furthermore, only 29% of households that declare bankruptcy also default on their mortgage loans.[13] Bankruptcy is significantly less common than mortgage defaults. In our sample, 13% of mortgages become delinquent at any time during their life, whereas only 2% of mortgage borrowers also declare bankruptcy.

Panel B of Table 6 shows the proportion of households with different mortgage types that declare bankruptcy. We observe that FRMs have the lowest bankruptcy rate at all horizons. Households borrowing using CMs have higher bankruptcy rates than ARMs at a five year horizon. For example, 3.18% of CMs, 2.94% of ARMs, and 2.15% of FRMs households declare bankruptcy within a five year horizon after they originate a mortgage.

Table 8 reports the propensity of households to declare personal bankruptcy and contrasts it with those that are delinquent on their mortgage. Not surprisingly, most coefficients have the same signs in both regressions. For example, higher income and higher FICO scores reduce the propensities of both delinquency and bankruptcy.

It is interesting that some variables show up with different signs in the two regressions. For example, although investment properties have higher mortgage delinquency rates, households with investment properties are less likely to file for personal bankruptcy. This evidence

[13]See Li, White, and Zhu (2010) for a discussion of the relationship between bankruptcy laws and mortgage defaults.

suggests that owners of investment properties are more likely to walk away from the property when it is economical to do so, even if they can afford to continue the mortgage payment. Moreover, loans with low documentation are more likely to be delinquent, but that variable does not predict personal bankruptcy, suggesting that these households might be more likely to strategically default.

4.5 Prepayment

Another reason that households go into delinquency is that they cannot refinance their previous mortgage when they have a high LTV ratio or experience a bad income shock. Panel C of Table 6 summarizes the proportion of mortgages that are prepaid. Mortgages are prepaid if the borrowers pay-off their loan before maturity either by refinancing the loan or by paying off the mortgage using the proceeds from selling the house or through other means. We find that ARMs are more likely to be prepaid than FRMs, while CMs have intermediate levels of prepayments. Unfortunately, we do not observe whether households prepay their mortgages to refinance their loan or whether they prepay their mortgages because they sold their homes.

The last column of Table 8 reports the propensity of households to prepay. Many variables have the opposite sign for the delinquency and the prepayment regressions, since variables that increase the probability of prepayment likely will decrease the probability of delinquency. For example, loans with high current LTV are less likely to be prepaid and more likely to go into delinquency. However, there are some exceptions. For example, CMs and ARMs are both more likely to be prepaid and more likely to go into delinquency. Loans that were used to refinance another loan are both less likely to be prepaid and less likely be delinquent.

5 Conclusions

The recent housing crisis brought the extension of credit to subprime borrowers and agency problems inherent in mortgage securitization to the forefront of academic research. This paper focuses on a different aspect of credit markets during this time – namely, the proliferation of non-amortizing mortgages. In addition to variable interest rates, such mortgages also featured changes in amortization schedules set off by a variety of triggers. These complex mortgage contracts became extremely popular during the mid 2000s and vanished almost completely after the housing crisis of 2007-2009.

We find that complex mortgages were the contract of choice for relatively high credit quality and high-income households seeking to purchase houses that were expensive relative to their incomes. We further find that CM contracts were not simply an inevitable outcome of high house prices. Even within high house price areas these contracts are associated with households stretching to afford more expensive houses, often on the basis of stated income alone. We document that complex mortgages experienced substantially higher defaults, controlling for a variety of borrower and loan characteristics, as well as macroeconomic shocks. Higher default rates cannot be attributed solely to greater leverage of complex mortgages and the onset of amortization resets brought about by inability to refinance complex loans. That complex loans were more likely to be underwritten using stated income may also indicate greater inherent earnings variability of CM borrowers, which would make them more susceptible to economic shocks.

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Table 1: **Summary Statistics**
This table reports means, standard deviations, medians, and first and third quartiles for our data sample.

	Mean	Std. Dev.	1st Quart.	Median	3rd Quart.
Loan Amount	218,065	181,464	108,300	168,000	268,918
House Value	317,294	297,950	145,000	234,000	388,000
Income	100,211	88,251	50,000	75,000	117,000
VTI	3.54	1.94	2.22	3.18	4.41
First Lien LTV	0.75	0.18	0.67	0.79	0.86
FICO	707	67	662	715	762
FICO less than 620	0.11	0.31	0	0	0
Subprime	0.07	0.26	0	0	0
Low Documentation	0.14	0.34	0	0	0
Condo	0.13	0.34	0	0	0
Investment Property	0.10	0.30	0	0	0
Refinance	0.41	0.49	0	0	1
With Prepayment Penalty	0.13	0.34	0	0	0
Prepayment Penalty Term (in Months)	30.17	13.48	24.00	36.00	36.00
Above Conforming Limit	0.11	0.31	0	0	0
Government Securitized	0.64	0.48	0	1	1
Private Securitized	0.25	0.43	0	0	1
Initial Interest Rate (in %)	5.94	1.44	5.50	6.00	6.50
Hypothetical FRM Interest Rate (in %)	6.19	0.45	5.88	6.13	6.50
MSA level variables					
Median Income	77,641	20,689	62,000	74,000	88,000
Median VTI	3.28	0.82	2.60	3.15	3.80
House Price Change Prior 3 Years	0.33	0.21	0.14	0.29	0.46
Decrease in House Prices Prior 10 Years	0.13	0.34	0	0	0
College or More	0.35	0.16	0.22	0.32	0.45
Population Growth (in %)	1.10	1.43	0.29	0.82	1.74
Unemployment Rate (in %)	5.03	1.40	4.10	4.80	5.70
Non-Recourse State	0.27	0.44	0	0	1
Number of Observations	10,208,522				

Table 2: **Summary Statistics by Mortgage Type**
This table reports summary statistics for Fixed Rate Mortgages (FRM), Adjustable Rate Mortgages (ARM), and Complex Mortgages (CM).

	All	FRM	ARM	CM
Loan Amount	218,065	179,415	220,374	357,887
House Value	317,294	264,878	309,465	513,728
Income	100,211	88,642	101,005	141,998
VTI	3.54	3.40	3.46	4.07
First Lien LTV	74.17	73.88	77.01	73.45
FICO Credit Score	707	710	684	710
FICO less than 620	0.11	0.10	0.23	0.07
Subprime	0.07	0.03	0.24	0.10
Low Documentation	0.14	0.11	0.09	0.26
Condo	0.13	0.11	0.17	0.18
Investment Property	0.10	0.09	0.11	0.11
Prepayment Penalty	0.13	0.06	0.25	0.33
Prepayment Penalty Term (in Months)	30.17	37.39	27.57	27.85
Refinance	0.41	0.41	0.34	0.45
Above Conforming limit	0.11	0.05	0.13	0.33
Government Securitized	0.64	0.79	0.43	0.24
Private Securitized	0.25	0.15	0.41	0.54
Initial Interest Rate (in %)	5.94	6.16	5.97	5.12
Hypothetical FRM Interest Rate (in %)	6.19	6.17	6.20	6.23
MSA level variables				
Median Income	77,641	74,105	76,530	91,254
Median VTI	3.28	3.13	3.28	3.84
House Price Change Prior 3 Years	0.33	0.30	0.32	0.44
Decrease in House Prices Prior 10 Years	0.13	0.13	0.16	0.12
College or More	0.35	0.33	0.36	0.39
Population Growth (in %)	1.10	1.11	1.12	1.08
Unemployment Rate (in %)	5.03	5.04	5.21	4.87
Non-Recourse State	0.27	0.22	0.26	0.44
Number of Observations	10,208,522	7,071,317	1,202,383	1,934,822

Table 3: **Summary Statistics of Complex Loans by Mortgage Type**
This table reports summary statistics for different types of complex mortgages including Interest-Only Mortgages (IO), Negative Amortization Mortgages (NEGAM), and Teaser Rate Mortgages (TRM).

	All CM	IO	NEGAM	TRM
Loan Amount	357,887	352,757	343,059	393,023
House Value	513,728	501,394	497,894	571,770
Income	141,998	141,348	135,024	153,249
VTI	4.07	4.03	4.02	4.27
First Lien LTV	73.45	74.05	74.18	70.67
FICO Credit Score	710	720	689	710
FICO less than 620	0.07	0.05	0.16	0.03
Subprime	0.10	0.08	0.23	0.00
Low Documentation	0.26	0.11	0.42	0.49
Condo	0.18	0.20	0.17	0.15
Investment Property	0.11	0.14	0.06	0.08
Prepayment Penalty	0.33	0.14	0.39	0.83
Prepayment Penalty Term (in Months)	27.85	28.01	28.28	27.38
Refinance	0.45	0.34	0.54	0.64
Above Conforming limit	0.33	0.32	0.29	0.42
Government Securitized	0.24	0.31	0.22	0.06
Private Securitized	0.54	0.53	0.51	0.57
Initial Interest Rate (in %)	5.12	5.99	6.03	1.30
Hypothetical FRM Interest Rate (in %)	6.23	6.24	6.31	6.10
MSA level variables				
Median Income	91,254	89,390	92,525	95,133
Median VTI	3.84	3.75	3.86	4.07
House Price Change Prior 3 Years	0.44	0.43	0.43	0.49
Decrease in House Prices Prior 10 Years	0.12	0.11	0.11	0.16
College or More	0.39	0.40	0.36	0.39
Population Growth (in %)	1.08	1.18	0.98	0.93
Unemployment Rate (in %)	4.87	4.72	5.03	5.08
Non-Recourse State	0.44	0.39	0.49	0.55
Number of Observations	1,934,822	1,087,058	484,574	363,190

Table 4: **Mortgage Choice Multinomial Logit Regressions**
This table reports the coefficients of multinomial logit regressions for mortgage choice. The coefficients are measured relative to FRM. The significance levels are abbreviated with asterisks: One, two, and three asterisks denote significance at the 10, 5, and 1% level, respectively.

	Individual-level Covariates		State Fixed Effects	
	ARM	CM	ARM	CM
Log(Income)	0.440***	0.773***	0.274***	0.507***
	(0.024)	(0.034)	(0.015)	(0.028)
Value-to-Income	0.080***	0.126***	0.028***	0.041***
	(0.013)	(0.016)	(0.006)	(0.009)
FICO/100	−0.379***	−0.054***	−0.405***	−0.053**
	(0.013)	(0.020)	(0.014)	(0.022)
Subprime	2.304***	1.481***	2.306***	1.448***
	(0.040)	(0.069)	(0.040)	(0.077)
Low Documentation	−0.006	0.892***	0.036	0.914***
	(0.037)	(0.047)	(0.031)	(0.043)
Above Loan Limit	0.718***	1.382***	0.707***	1.306***
	(0.053)	(0.064)	(0.041)	(0.044)
Condo	0.664***	0.742***	0.483***	0.453***
	(0.054)	(0.049)	(0.037)	(0.027)
Investment Property	0.283***	0.110***	0.346***	0.072**
	(0.025)	(0.040)	(0.017)	(0.029)
Refinance	−0.535***	−0.021	−0.560***	−0.116**
	(0.022)	(0.043)	(0.020)	(0.050)
Non-Recourse States	0.153**	0.720***		
	(0.078)	(0.090)		
College or More			0.871***	0.110
			(0.058)	(0.086)
House Price Change			−0.152	0.317
			(0.152)	(0.194)
Decrease in House Prices			−0.072**	−0.212***
			(0.036)	(0.036)
MSA Median Income			0.276**	1.006***
			(0.120)	(0.161)
MSA Median VTI			0.264***	0.248***
			(0.050)	(0.058)
MSA Population Growth			2.673	4.398**
			(1.650)	(1.852)
Origination Year Dummies	Yes		Yes	
State Dummies	No		Yes	
Observations	10,166,582		8,944,872	

Table 5: **Mortgage Choice Multinomial Logit Regressions for Detailed Classification**

This table reports the coefficients of multinomial logit regressions for mortgage choice. The coefficients are measured relative to FRM. The significance levels are abbreviated with asterisks: One, two, and three asterisks denote significance at the 10, 5, and 1% level, respectively.

	State Fixed Effects			
	ARM	IO	NEGAM	TRM
Log(Income)	0.277***	0.433***	0.520***	0.725***
	(0.015)	(0.029)	(0.022)	(0.038)
Value-to-Income	0.029***	0.056***	0.007	0.016**
	(0.006)	(0.010)	(0.006)	(0.007)
FICO/100	−0.410***	0.113***	−0.303***	−0.304***
	(0.014)	(0.020)	(0.018)	(0.035)
Subprime	2.291***	1.316***	2.213***	−2.771***
	(0.041)	(0.052)	(0.097)	(0.204)
Low Documentation	0.082**	−0.067	1.742***	1.901***
	(0.032)	(0.041)	(0.060)	(0.049)
Above Loan Limit	0.699***	1.362***	1.114***	1.376***
	(0.042)	(0.047)	(0.040)	(0.053)
Condo	0.481***	0.473***	0.472***	0.306***
	(0.036)	(0.032)	(0.031)	(0.048)
Investment Property	0.340***	0.243***	−0.330***	−0.120**
	(0.017)	(0.032)	(0.038)	(0.048)
Refinance	−0.548***	−0.435***	0.166***	0.685***
	(0.020)	(0.057)	(0.042)	(0.076)
College or More	0.853***	0.439***	−0.342***	−0.640***
	(0.057)	(0.098)	(0.076)	(0.097)
House Price Change	−0.192	0.331*	−0.300	0.712**
	(0.153)	(0.183)	(0.256)	(0.285)
Decrease in House Prices	−0.072**	−0.185***	−0.292***	−0.298***
	(0.036)	(0.051)	(0.049)	(0.046)
MSA Median Income	0.312***	0.761***	1.699***	1.677***
	(0.120)	(0.176)	(0.209)	(0.247)
MSA Median VTI	0.253***	0.277***	0.082	0.133*
	(0.050)	(0.058)	(0.099)	(0.076)
MSA Population Growth	2.560	4.882**	1.807	4.677*
	(1.610)	(2.031)	(1.708)	(2.729)
Origination Year Dummies	Yes			
State Dummies	Yes			
Observations	8,944,873			

Table 6: **Mortgage Delinquencies, Household Bankruptcies, and Prepayment Decisions**

This table reports the proportion of mortgages that are at least 60 days delinquent, the proportion of households with mortgages that declare bankruptcy, and the proportion of mortgages that are prepaid after one, three, and five years. Mortgages are prepaid if a borrower refinances the loan or pays back the loan completely before maturity.

Panel A: Proportion of Mortgages that are Delinquent			
	FRM	ARM	CM
1 Year	2.65	6.43	4.02
3 Years	9.31	15.63	17.56
5 Years	11.95	18.48	22.75
Number of Loans	6,895,047	1,174,328	1,917,719

Panel B: Proportion of Households Declaring Bankruptcy			
	FRM	ARM	CM
1 Year	0.25	0.52	0.26
3 Years	1.51	2.28	2.20
5 Years	2.15	2.94	3.18
Number of Loans	6,895,047	1,174,328	1,917,719

Panel C: Proportion of Mortgages that are Prepaid			
	FRM	ARM	CM
1 Year	7.66	15.10	12.05
3 Years	28.32	47.12	38.33
5 Years	37.29	59.98	45.34
Number of Loans	6,895,047	1,174,328	1,917,719

Table 7: **Hazard Model of Mortgage Delinquency**
This table reports the hazard rate for mortgage delinquency. The significance levels are abbreviated with asterisks: One, two, and three asterisks denote significance at the 10, 5, and 1% level, respectively.

	Individual-level Covariates		State Fixed Effects	
CM	0.792***		0.689***	
	(0.020)		(0.014)	
IO		0.761***		0.664***
		(0.026)		(0.019)
NEGAM		0.774***		0.687***
		(0.021)		(0.014)
TRM		0.964***		0.800***
		(0.027)		(0.022)
ARM	0.346***	0.343***	0.326***	0.324***
	(0.013)	(0.013)	(0.012)	(0.012)
Log Income	−0.249***	−0.250***	−0.164***	−0.165***
	(0.018)	(0.018)	(0.017)	(0.016)
Value to Income (VTI)	−0.030***	−0.030***	−0.014*	−0.014*
	(0.008)	(0.008)	(0.008)	(0.008)
FICO/100	−1.108***	−1.106***	−1.058***	−1.057***
	(0.016)	(0.016)	(0.018)	(0.018)
Subprime	0.408***	0.422***	0.421***	0.430***
	(0.016)	(0.016)	(0.011)	(0.011)
Low Documentation	0.052***	0.039***	0.053***	0.043***
	(0.015)	(0.013)	(0.012)	(0.010)
Above Loan Limit	0.403***	0.395***	0.442***	0.438***
	(0.038)	(0.038)	(0.026)	(0.026)
Condo	−0.086**	−0.084**	−0.064**	−0.063**
	(0.041)	(0.041)	(0.026)	(0.026)
Investment Property	0.289***	0.290***	0.283***	0.284***
	(0.033)	(0.033)	(0.030)	(0.030)
Refinance	−0.152***	−0.160***	−0.164***	−0.170***
	(0.009)	(0.009)	(0.013)	(0.013)
Non-Recourse State	0.112*	0.108*		
	(0.061)	(0.061)		
College or More			−1.415***	−1.411***
			(0.061)	(0.062)
Current LTV			0.762***	0.761***
			(0.066)	(0.066)
Unemployment Level			0.037***	0.037***
			(0.008)	(0.008)
Income Growth since Origination			−0.040***	−0.040***
			(0.004)	(0.004)
Calendar Dummies	Yes	Yes	Yes	Yes
Orig. Year Dummies	Yes	Yes	Yes	Yes
State Dummies	No	No	Yes	Yes
Observations	32,960,513	32,960,513	26,019,616	26,019,616

Table 8: **Hazard Models of Mortgage Delinquency, Personal Bankruptcy, and Mortgage Prepayment**
This table reports the hazard rate for mortgage delinquency, personal bankruptcy, and prepayment decisions. The significance levels are abbreviated with asterisks: One, two, and three asterisks denote significance at the 10, 5, and 1% level, respectively.

	Delinquency	Bankruptcy	Prepayment
CM	0.689***	0.631***	0.372***
	(0.014)	(0.017)	(0.019)
ARM	0.326***	0.208***	0.545***
	(0.012)	(0.013)	(0.011)
Log Income	−0.164***	−0.358***	0.079***
	(0.017)	(0.024)	(0.012)
Value to Income (VTI)	−0.014*	−0.171***	0.001
	(0.008)	(0.011)	(0.002)
FICO/100	−1.058***	−0.763***	−0.091***
	(0.018)	(0.012)	(0.013)
Subprime	0.421***	0.075***	0.289***
	(0.011)	(0.022)	(0.017)
Low Documentation	0.053***	−0.006	−0.008
	(0.012)	(0.011)	(0.008)
Above Loan Limit	0.442***	0.408***	−0.099***
	(0.026)	(0.040)	(0.020)
Condo	−0.064**	−0.193***	−0.051***
	(0.026)	(0.030)	(0.011)
Investment Property	0.283***	−0.200***	−0.270***
	(0.030)	(0.023)	(0.011)
Refinance	−0.164***	0.232***	−0.116***
	(0.013)	(0.015)	(0.010)
College or More	−1.415***	−1.373***	0.123***
	(0.061)	(0.070)	(0.045)
Current LTV	0.762***	0.707***	−0.634***
	(0.066)	(0.062)	(0.063)
Unemployment Level	0.037***	0.046***	−0.037***
	(0.008)	(0.010)	(0.008)
Income Growth from Origination	−0.040***	−0.032***	0.012***
	(0.004)	(0.004)	(0.004)
Calendar and Orig. Year Dummies	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes
Observations	26,019,616	25,851,519	25,989,417

Table 9: **Variable Descriptions**
This table reports the description of the variables used and the corresponding data sources.

Variable	Data Source	Aggregation	Description
Loan Amount	LPS	Individual	Loan amount
Home Value	LPS	Individual	Appraised home value at origination
Income	HMDA	Individual	Reported Income from loan application
FICO	LPS	Individual	FICO at origination
VTI	LPS	Individual	Appraisal value divided by income from loan application
First Lien LTV	LPS	Individual	Loan amount divided by appraised value of home
Hypothetical FRM Interest Rate	LPS	Individual	Average interest rate on 30-yr FRM within month, state, conforming, LTV, and FICO buckets
Refinance	LPS	Individual	Refi or not
Condo	LPS	Individual	Condo property or not
Investment Property	LPS	Individual	2nd home or investment
Subprime	LPS	Individual	Subprime indicator as the servicer believes; does not include Alt-A
Prepayment Penalty	LPS	Individual	Flag for prepayment penalty along
Prepayment Penalty Term	LPS	Individual	Length in months of prepayment penalty
Percentage above Conforming	LPS	Individual	Flag for conforming loan.
Share Government Securitized	LPS	Individual	Securitization flag after 1yr of loan life
Share Private Securitized	LPS	Individual	Securitization flag after 1yr of loan life
House Price Change Prior 3 Years	FHFA	CBSA-Qtr	House price change in the past 3 years
Decrease in House Prices Prior 10 Years	FHFA	CBSA-Qtr	Indicator variable for whether there were 4 quarters of house price depreciation in the past 10 years
Share College or More	Census	Zip (static)	Proportion of 2000 population with college education or better
Non-Recourse	Ghent and Kudlyak (2010)	State	States where recourse in residential mortgages is limited by the value of the collateral securing the loan.
Current LTV	LPS and FHFA	Individual	The mortgage loan amount at the end of the prior period divided by the current home value. The current home value is estimated by adjusting the home value at origination by the house price appreciation at the MSA level since the origination.
Unemployment Level	BLS	CBSA-Qtr	Unemployment rate
Income Growth from Origination	BEA	CBSA-Qtr	Growth rate of per capita personal income

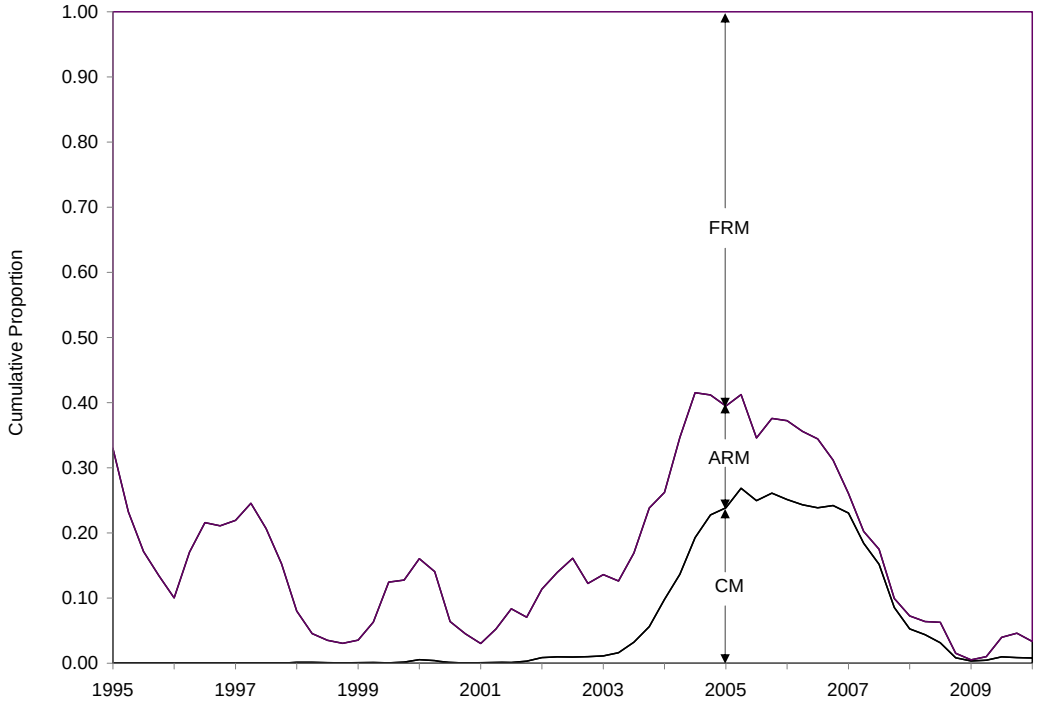


Figure 1: **Composition of Mortgage Products.**
The figure depicts the composition between Fixed Rate Mortgages (FRM), Adjustable Rate Mortgages (ARM), and Complex Mortgages (CM) over the period between 1995 and 2009.

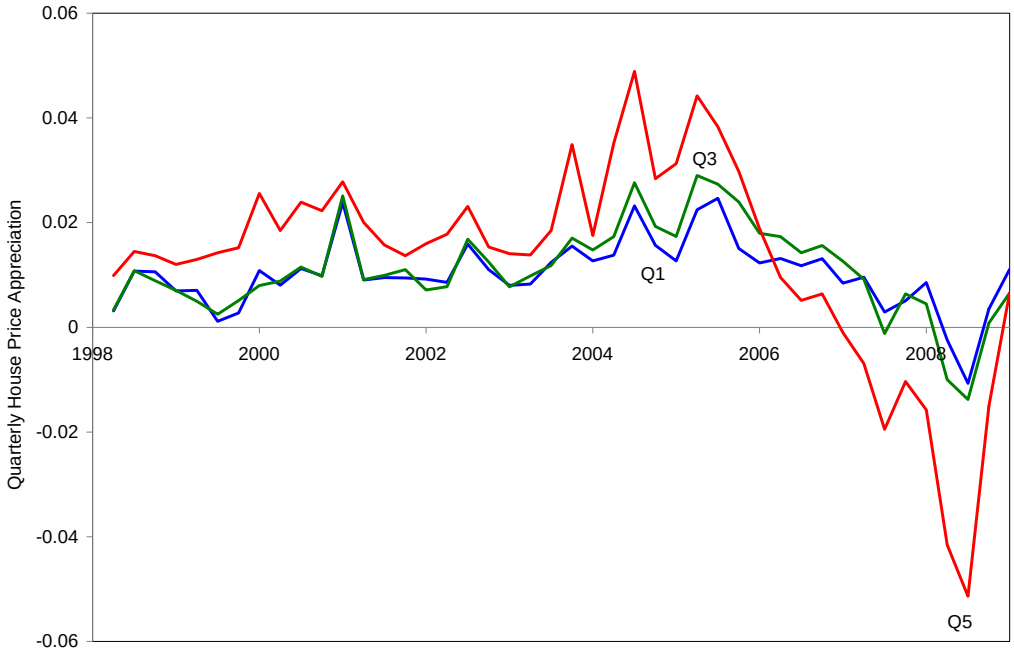
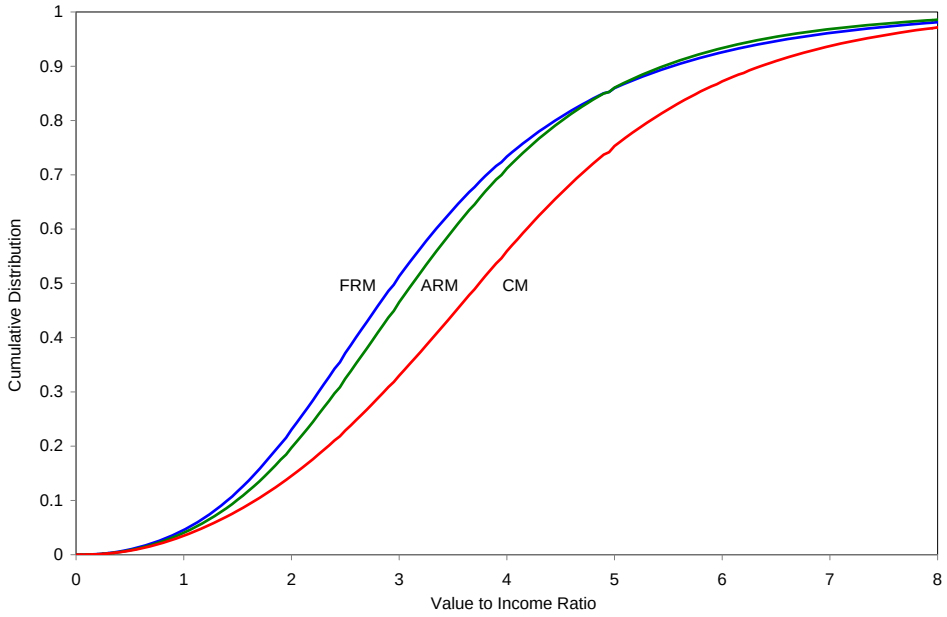


Figure 2: **Quarterly House Price Changes by Complexity Quintile**
This figure depicts the quarterly house price changes of MSAs quintiles sorted according to the proportion of complex mortgages in 2004. Q1, Q3, and Q5 correspond to the mean appreciation levels of MSA in the first, third, and fifth quintile according to the complex share.

Panel A: Value-to-Income Ratio



Panel B: FICO Credit Score

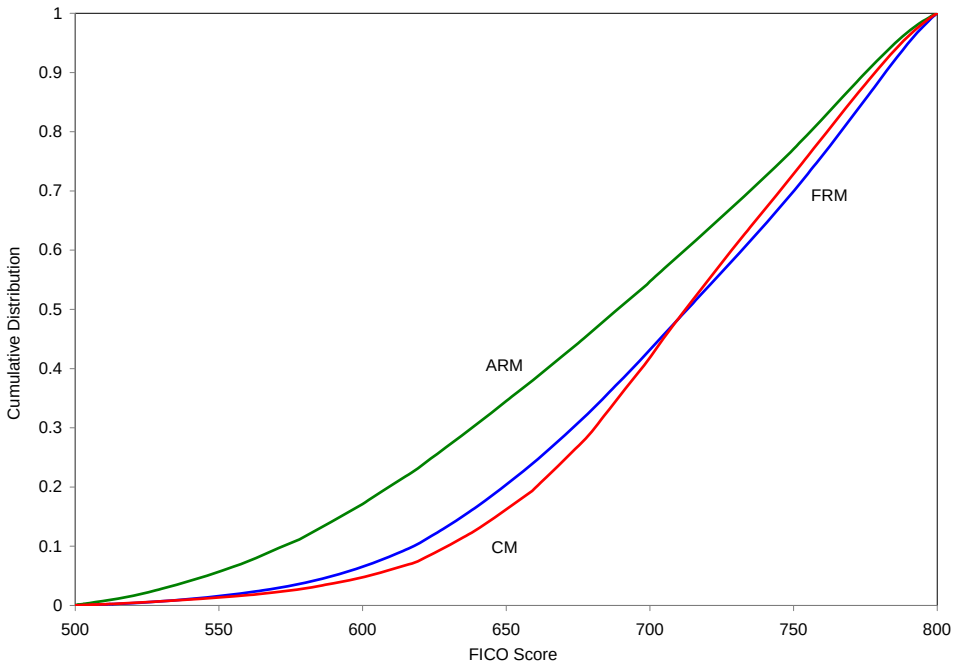
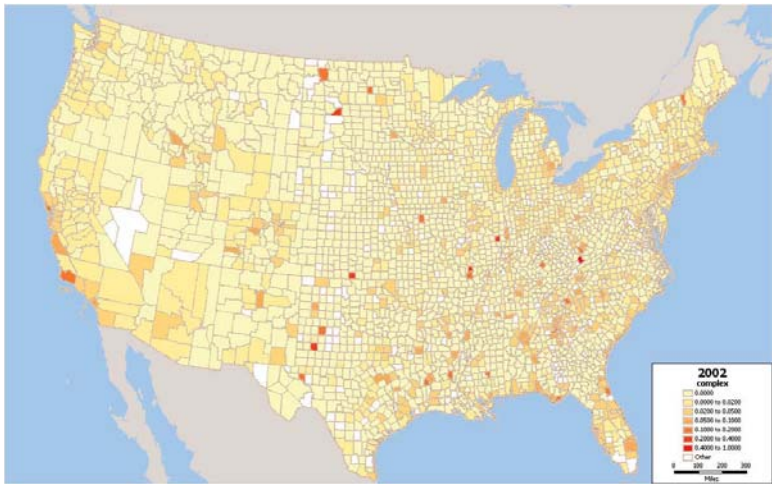
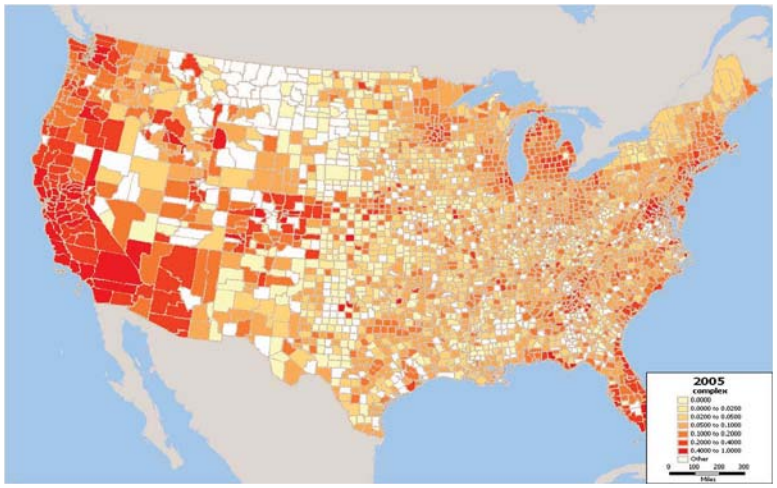


Figure 3: **Cumulative Distribution Functions by Mortgage Type**
These figures depict the cumulative distribution functions of the value-to-income ratio (VTI) and FICO credit scores for Fixed Rate Mortgages (FRM), Adjustable Rate Mortgages (ARM), and Complex Mortgages (CM) over the period between 1995 and 2009.

Panel A: Complex Mortgages in 2002



Panel B: Complex Mortgages in 2005



Panel C: Complex Mortgages in 2008

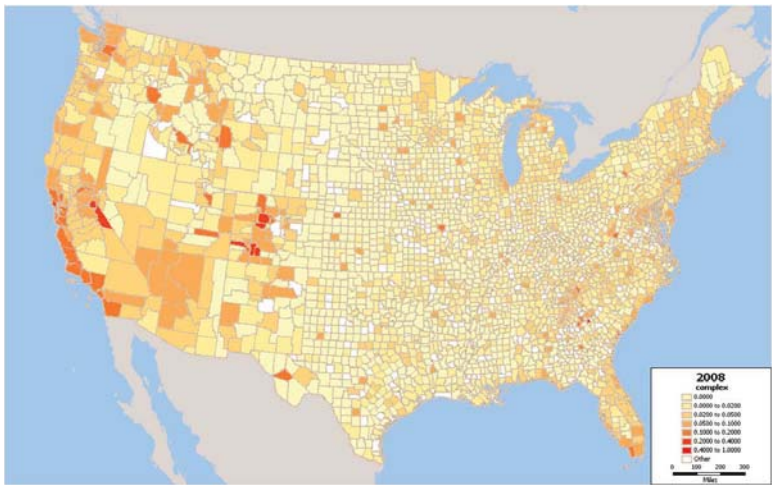
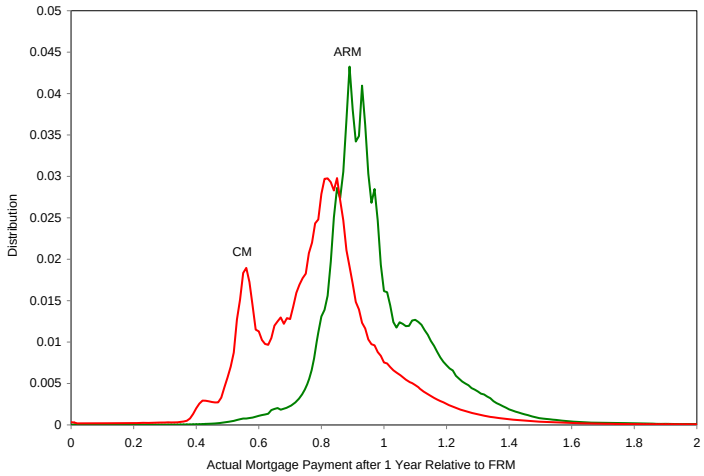
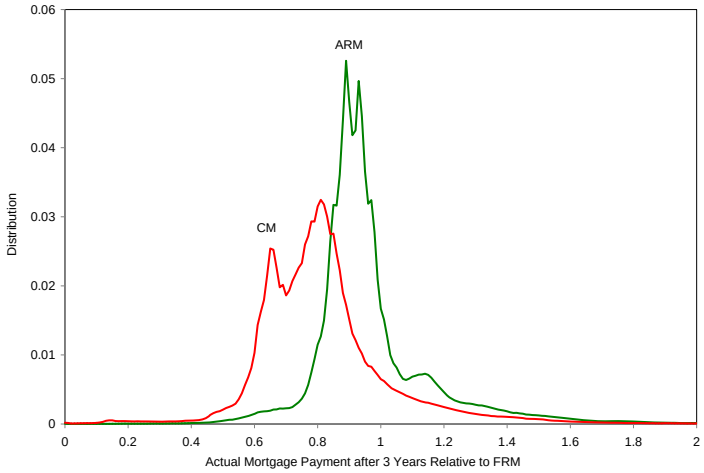


Figure 4: **Geographic Distribution of Complex Mortgages**
These figures depict the geographic distribution of complex mortgages in 2002, 2005, and 2008.

Panel A: Mortgage Payment After One Year Relative to FRM



Panel B: Mortgage Payment After Three Years Relative to FRM



Panel C: Mortgage Payment After Five Years Relative to FRM

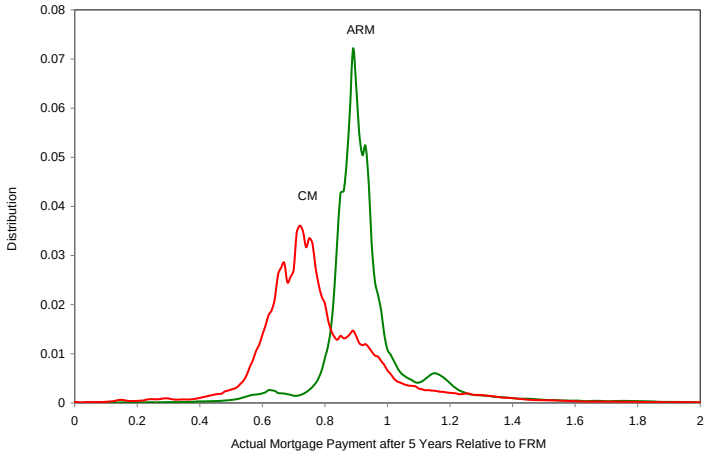
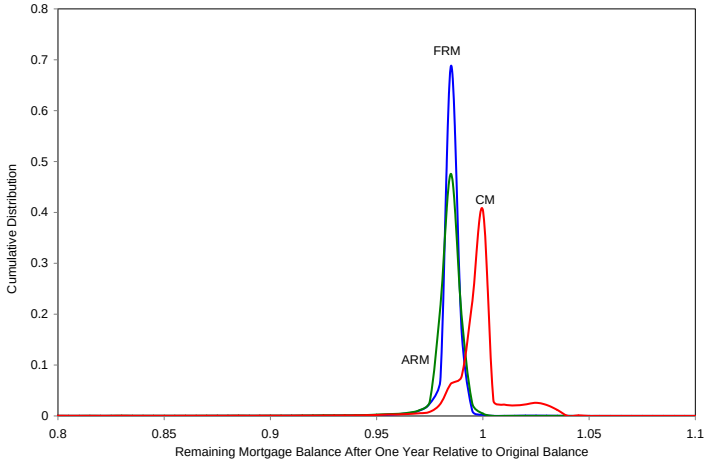
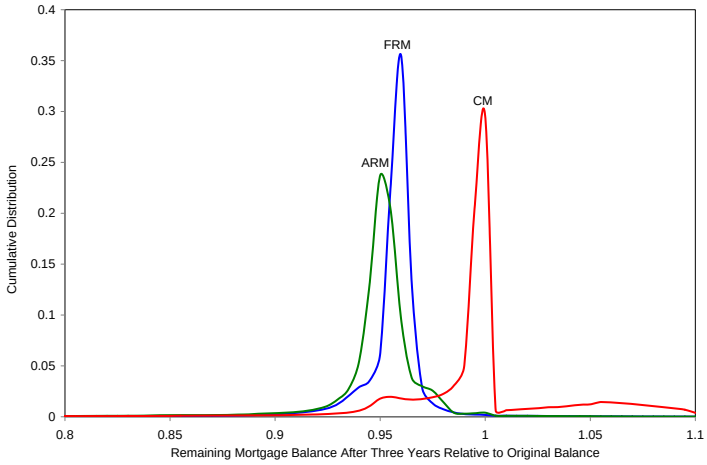


Figure 5: **Mortgage Payment Relative to FRM**
These figures depict the actual mortgage payments for Adjustable Rate Mortgages (ARM) and for Complex Mortgages (CM) one, three, and five years after origination relative to the mortgage payments of a Fixed Rate Mortgages (FRM) with similar borrower characteristics.

Panel A: Remaining Balance After One Year



Panel B: Remaining Balance After Three Years



Panel C: Remaining Balance After Five Years

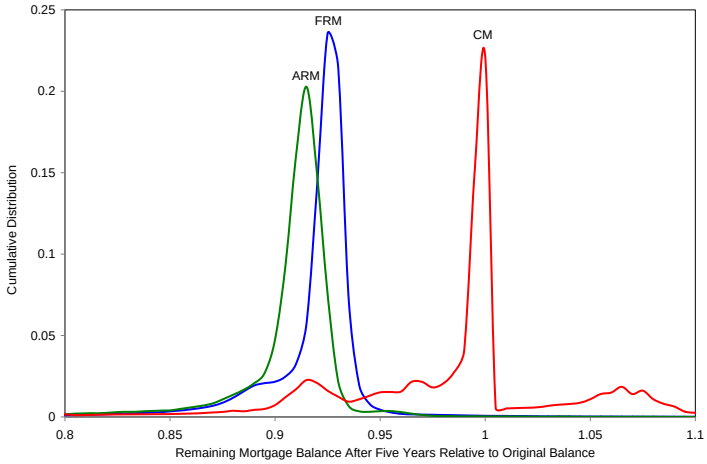


Figure 6: **Remaining Mortgage Balances**
These figures depict the remaining mortgage balances after one, three, and five years relative to the initial balances for Fixed Rate Mortgages (FRM), Adjustable Rate Mortgages (ARM), and Complex Mortgages (CM).

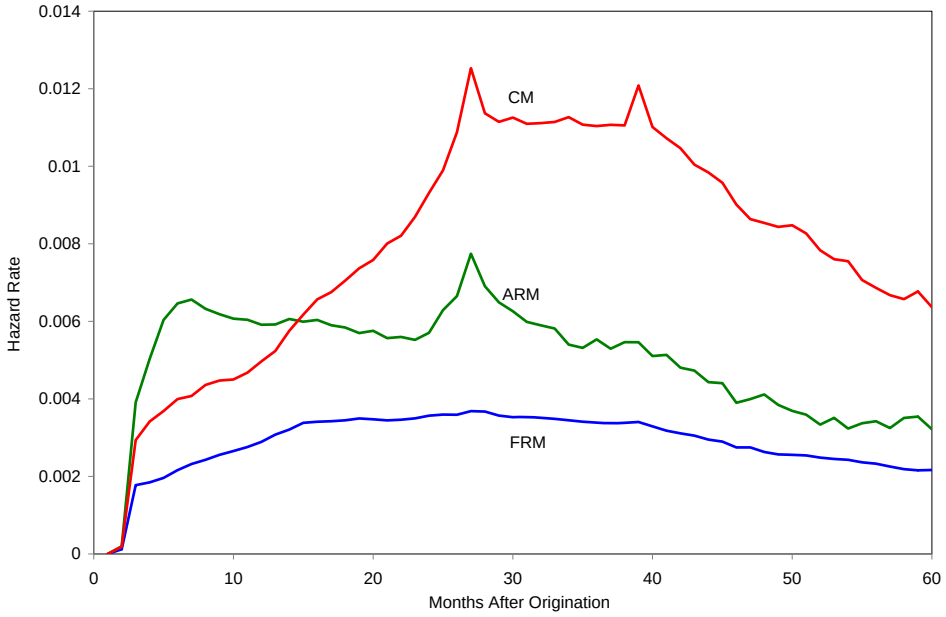


Figure 7: **Proportion of Mortgage Delinquencies by Month After Origination**
The figure depicts the proportion of surviving loans that are delinquent by month after origination for Fixed Rate Mortgages (FRM), Adjustable Rate Mortgages (ARM), and Complex Mortgages (CM) over the period between 2003 and 2009.

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