# WHAT ECONOMIC TRIGGERS EXIST FOR FNMA HOME MORTGAGE MODIFICATIONS?

by

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A dissertation submitted to the faculty of
The University of North Carolina at Charlotte
in partial fulfillment of the requirements for the
degree of Doctor of Business Administration

Charlotte

2022

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ABSTRACT

MICHAEL A. HOOK. What Economy Triggers Exist For FNMA Home Mortgage Modifications?

(Under the direction of Dr. Tao-Hsien Dolly King)

In this study, I examine the Fannie Mae (FNMA) single-family mortgage loan modification process over the period from 1999 to 2021. Loan modification rates are higher during the period leading up to the bust periods, while first-time home buyers have lower modification rates than the other homeowners. In addition to loan and borrower characteristics, the results suggest that whether the homebuyer is a first-time home buyer, the unemployment rate, interest rate level, and interest rate slope are important factors of loan modifications. The set of determinants of loan modification rates remain the same between the expansionary and contraction periods, but the impacts of determinants are stronger in the contraction periods. I also examine how the 2008-2009 financial crisis and the 2020-2021 pandemic affects the relation between loan modification rates and the determinants. The findings indicate that the determinants are consistent across various sub-periods, however, the loan modification rates exhibit the strongest sensitivity to changes in the factors during the crisis period or the pandemic. The study provides important contributions to the development of preventive mechanisms against mortgage defaults of homeowners and financial distress of lending institutions.

*Keywords: Loan Modification; Mortgage; FNMA; Recession; First Time Home Buyer*

# DEDICATION

I dedicate my dissertation work to my family and many friends. A special feeling of gratitude to my loving parents, Bruce Hook and Jeanette Pankey whose words of encouragement and push for tenacity always ring in my ears. My sister Michelle Cooper who has also just finished her doctoral degree gave me inspiration to never give up and always finish what I start.

I also dedicate this dissertation to my son Michael A. Hook Jr. who I want to always reach as high as possible for your goals and dreams. No matter how tough life gets, you have it in you to overcome any obstacle.

Last but not least, I give thanks to my Lord and savior for carrying me when I couldn't carry myself. I thank you for never leaving my side and always leading me to complete your will.

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to my committee chair, Dr. Tao-Hsien Dolly King, without her guidance and persistent help this dissertation would not have been possible. Thank you for your continuous support, patience, and motivation to guide me through completion of this process that has been incredibly difficult to manage. I never would have imagined that I would have made it this far in achieving my doctoral degree.

Along with my advisor, I would like to thank the rest of my committee: Dr. Gene Lai - Professor and James J. Harris endowed Chair in Risk Management and Insurance, Dr. Weidong Tian – Professor of Finance and Distinguished Professor of Risk Management and Insurance, and Dr. Reginald Silver – DBA Program Director, Clinical Professor of BISOM, Clinical Professor of Data Science and Business Analytics for accepting the request to serve as a member on my committee.

Lastly but not least, I would like to offer my sincere gratitude to my family and friends who encourage me to apply for this amazing DBA program and staying the course to being the first in my family with an advance degree in Business Administration.

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# CHAPTER I

## INTRODUCTION

In the early 2000s, independent lenders made it easy for consumers to obtain a bank loan. The expansion of bank loans increased in the period from 2003 to 2005, making it almost impossible for banks to turn down mortgage applications. As a result, the housing market and buying power accelerated across the country. To no one's surprise, independent lenders had more lenient approval requirements, allowing many first-time homebuyers the ability to purchase homes. Note that many of the first-time homebuyers had unfavorable credits stemming poor payment history of their financial obligations in the past. Independent banks were largely blamed for preying on consumers that lacked financial education, strong credit, and a stable work history, resulting in the housing downturn. During the period from 2003 to 2005, developers were also blamed for preying on homeowners with enticing sales tactics, including hidden fees, kickbacks, and floating interest rates. During the 2008-2009 mortgage crisis, neighborhoods experienced a rapid decline in property values. Banks and independent lenders were facing bankruptcies, causing the government to intervene and bail out certain banks and independent lenders in the sum of around $700 billion. The sentiments among most Americans on government bailouts were certainly not favorable. There was a strong argument that banks were at fault for predatory lending practices. Many industry experts argued that these lenders should not have received a bailout at the expense of the taxpayer.

In response to the faulty lending practices and the increasing instances of mortgage defaults, financial institutions create attractive but strict avenues to assist borrowers in keeping their homes. Banks understand that with millions of homes underwater that a possible alternative to mortgage default is to offer loan modification programs for homeowners. The market observes

that many homeowners facing a foreclosure are in fact first-time homebuyers. Banks evaluated factors triggering homeowners to go into default to design the modification program and make determination on granting a homeowner the option to modify his/her mortgage loan. Both homeowners and lending institutions are vulnerable when default occurs. As a result, the goal of the loan modification programs should aim to achieve a favorable outcome for all parties involved. In particular, homeowners are motivated to make every effort to save their homes from foreclosure or default. Banks, on the other hand, do their best to avoid bankruptcy.

What actually happened during the financial crisis in 2008-2009 was consistent with the above discussion. In particular, the Federal Housing Administration and lending institutions were left scrambling to find a solution in an effort to prevent more banks from having to file bankruptcy and homeowners from going into default. The swift and detrimental decline in the housing market caused various government agencies to formulate aggressive home modification programs. Upon the signing of the American Housing Rescue and Foreclosure Prevention Act (AHRFPA), the Federal Housing Administration offered $300 billion to insure mortgages that were refinanced. The economic crisis caused a domino effect on the other aspects of the economy, such as the unemployment rate that peaked at a high rate of 10% during the crisis. Many homeowners found themselves being reduced to a one-income household, or no income at all, causing them to default on mortgage payments. Modification application rates increased during the crisis while unemployment rates rise. Learning from the experience of the 2008-2009 financial crisis, economists note that the economy is likely to face a recession as a result of the recent pandemic from 2020 to present. We observe a record number of business closing, high unemployment rates, and a large number of foreclosures. Modification rates were extremely high. What was more

alarming is that some homeowners facing foreclosure or default did not applying for modifications as a result of not having a steady income stream amidst the pandemic.

First-time homebuyers that experience the inability to meet mortgage obligations, have applied for modifications. However, risky lending behavior is no longer a major factor, as it was during the early 2000's. Many banks have stricter lending guidelines. Borrowers now go through a very detailed checks and balances process during the loan application process. This requirement holds banks and underwriters accountable to ensure they meet qualifying guidelines for a home mortgage. Economic factors are main drivers of modification applications for all borrowers, even those who are considered responsible and budget-conscientious homeowners. Irresponsible behaviors are not necessarily limited to the first-time homebuyers. In general, the need for a modification can be attributed to various loan, borrower, and economic factors that could lead to homeowners not being able to make mortgage payments on a sustainable basis.

With the rise in the popularity of loan modification programs, the government and lending institutions learn over time that modifications can lead to unexpected negative outcomes for homeowners in the long run. For example, homeowners face taxable events, a larger loan balance at the end of the loan (or called a balloon payment), and the risk of facing re-default. Stricter policies have been developed by the government at the federal and state levels to govern the loan initiation and modification processes. Some industry experts argue that lending institutions and government entities may not have had the homeowner's best interests in mind when the loan modification programs were developed. Some even suggest that homeowners were set up for failure due to the lenient state regulations on modification programs in parts of the country.

In this study, I examine the pattern of loan modification across time and focus on how the pattern varies between boom and bust periods and how the pattern is affected by the financial crisis

or the pandemic. In addition, I analyze using the probit and logit regression models to explore the determinants of loan modification rates for the full sample and the first-time home buyers, respectively. Moreover, I explore how the set of major factors driving the loan modification rates varies between the expansionary and contraction periods, across the pre-crisis, crisis, and post-crisis periods, and between the pre-pandemic and pandemic periods.

Based on a sample of 51,662,118 FNMA single-family loans from 1999 to 2021, I find that the loan count varies significantly over time with a higher loan count in the years around the bust periods. The proportion of first-time home buyer loans is generally lower during the bust years compared to the boom years. Interestingly, loan modification rates are higher during the period leading up to the bust period instead during the bust period. The loan modification rates for first-time home buyers are generally lower than those for the full sample. A typical loan in the FNMA mortgage portfolio has 1.49 borrowers, a debt-to-income ratio of 38.32, a FICO score of 728.61, an original loan term of 322.24 months, and a loan age of 41.81 months. About 12% of the loans are initiated by first-time home buyers.

The probit and logit regression results suggest that the number of borrowers, debt-to-income ratio, borrower FICO score, original loan term, and whether the homeowner is a first-time home buyer are important determinants of loan modification rates. For macroeconomic factors, interest rate level, interest rate slope, and unemployment rate have significant impacts on loan modification. The findings of the major determinants of loan modification for the full sample are similar to those for the first-time home buyers. It is important to note that although the set of determinants of loan modification rates is similar between the boom and bust periods, the impacts of the determinants on loan modification are stronger during the bust periods. The analysis of the impacts of the financial crisis and pandemic on the determinants of loan modification rates yields

intuitive results as well. In particular, I find that the set of determinants of loan modification remains similar across the pre-crisis, crisis, and post-crisis periods. However, the effects of the determinants on loan modifications are strongest during the crisis period of 2008-2009. Similarly, the main determinants for the likelihood of loan modification are similar between the pre-pandemic and the pandemic periods. The effects of the factors on loan modifications are slightly stronger during the pandemic compared to the period before the pandemic.

It is critical to highlight the importance of understanding the patterns and outcomes of mortgage modification and its determinants. The findings of this study provide contributions relating to the development and design of the preventive measures against loan defaults and how these measures should be adjusted on a dynamic manner based on the state of the economy. An active and well-functioning loan market can lead to a healthy real estate market and vice versa. The loan and housing markets are intertwined with the financial markets as a whole. The interactions and co-dependence among the various markets mean that the stability of the financial systems and favorable economic conditions could be easily jeopardized by a fallout of a single market.

The rest of the dissertation is structured as follows. Chapter II presents the literature review. Chapter III presents hypothesis development. Chapter IV describes the data sources and presents the summary statistics. In Chapter V, I present the preliminary results on borrower and loan characteristics and correlation of main variables. Chapter VI discusses the multivariate tests for the loan modification rates. Chapter VII reports the regression results of loan modification rates contingent on economic triggers. Chapter VIII, I present regression results of loan modification rates on their determinants by comparing the results between pre-pandemic and pandemic periods. Chapter IX discussed an extension of analysis for future research. Chapter X concludes.

# CHAPTER II

# LITERATURE REVIEW

## 2.1 The Mortgage Default Crisis

After the 2008 mortgage crisis, mortgage lenders experienced an unprecedented surge of defaults and foreclosures as the housing market downswing interrupted and stopped the U.S. economy. “The potential collapse of house prices, accompanied by widespread mortgage defaults, is a major threat to the American economy” (Feldstein, 2008). This financial disaster is believed to be the worst since the Great Depression. “The mortgage meltdown was an episode of very high defaults and foreclosures on US residential mortgage loans starting in 2007. Aggregate losses on US residential mortgage loans were about $1 trillion from 2007 through 2016” (Adelson, 2020). Ten million American homeowners are believed to have lost their homes and some are still working to regain stability ten years later. “After the Lehman Brothers bankruptcy in September of 2008, the federal government took a much more active role in the financial system in general and in the mortgage market in particular” (Adelino et al., 2013).

## 2.2 Theoretical Explanations for Mortgage Default Events

So why are loan modification programs still important? The mortgage crisis in 2008-2009 had left lenders and borrowers in a financial paralysis. A rapid increase in housing inventory coupled with financial institutions facing foreclosures forced some banks to experience financial distress or bankruptcy. Government bailouts were able to alleviate some of these negative impacts but the damage to the U.S. economy had been catastrophic. Millions of families were left homeless and wondering how they were going to ever recover. Over the following years, experts have

debated over the main determinants for causing borrowers to default on their mortgages. Certain solutions have been suggested as to how the crisis can be avoided and financial stability can be maintained should there be another housing crisis. For example, Thomas Schelkle proposes two hypotheses, the option-theoretic and double-trigger hypothesis, as major contributors to the mortgage crisis. The option-theoretic hypothesis claims that savvy borrowers purposefully default on their loans as a means for financial gains. This model is rationalized and supported by Kau et al. (1994) and Kau et al. (1992), and various surveys conducted by Quercia and Stegman and Kau et al. (1994). The literature suggests that the presence of negative equity alone does not provide sufficient evidence for all defaults. Therefore, the option-theoretic hypothesis can be a partial explanation but not the only or even the primary factor for the mortgage default. As a result, the double-trigger hypothesis is further suggested as another explanation for default.

The double-trigger hypothesis suggests that the presence of negative equity coupled with a life event e.g., job loss or divorce leads to a ripple effect that leaves lenders and borrowers in a substantial housing deficit. This effect not only applies to the subprime borrowers, but also the prime borrowers. Prime borrowers at loan origination likely had a more robust credit profile and income capacity, but that did not necessarily exempt them from defaulting in the future. Factors leading to a default could include income fluctuation or negative equity (Herkenhoff, 2012). Negative equity could occur due to factors outside of the control of the borrowers. For example, negative equity or "underwater" could result from an influx of recent foreclosures within the same or nearby neighborhood. Theoretically, it is more likely for a subprime borrower to be a candidate for mortgage default because of their higher credit risk. Surprisingly enough, Schelkle find that prime borrowers are also susceptible to facing a mortgage default at some point during their loan term. To date, there has been extensive research conducted to support the models: Gerardi et al.

(2007), Foote et al. (2008, 2009), and a survey conducted by Foote and Willen (2018) are examples of studies that support the double-trigger hypothesis and option-theoretic model as major determinants of default events.

In order to gain more direct evidence on what drives the mortgage default crisis in 2008-2009, empirical studies examining the loan behavior from 2002 to 2008 indicate that mortgage default events can mainly be explained by the negative equity and double trigger explanations. Researchers find that fixed-rate mortgages with high original loan-to-value ratios of 95% or above were more likely to default due a low home equity value when facing a large adverse effect on house prices. Based on data on the default percentages from 2003 to 2008, Schelkle find that whether the option-theoretic hypothesis is "frictionless" is highly dependent on the volatility of aggregate house prices, which has a direct and significant effect on the incidence of negative equity and default rates. The rise and fall in housing prices are inevitable and is closely related to the probability and incidences in which negative equity occurs for borrowers.

## 2.3 Possible Solutions for Mortgage Defaults

In the past couple of decades since the mortgage crisis, the U.S. Government has developed several reliefs plans to stabilize the economy by reducing borrower default probability and minimizing the bankruptcy risk of the lenders due to an influx of immovable inventory. Popular programs such as the Troubled Asset Relief Program (TARP) enacted in 2008 was structured to relieve mortgage lenders from default losses by the government purchasing assets from lenders. The Home Affordable Modification Program (HAMP), which reached over 800,000 borrowers, was one of the most popular programs launched by the government to assist lenders and

homeowners in modifying their loans with the hope of lowering the monthly mortgage payments (Bradley, 2012). HAMP was originally planned to allocate $75 Billion to the modification efforts (Collins et al., 2011). “When the Obama Administration first unveiled HAMP in 2009, it made lofty claims that lowering mortgage payments would help up to 4 million homeowners avoid foreclosure” (Berry, 2016). The Homeowners Preserving Equity (HOPE) program is essentially a refinancing program intended to prevent homeowners from defaulting and avoid foreclosure. The Home Affordable Refinance Program (HARP) that was passed in 2009 placed its focus on those homeowners who were current on their mortgages but became underwater and were unable to refinance due to dropping home prices. These government enacted programs, which were more aggressive than previous modification programs in prior years, were designed to assist borrowers in saving their home through another form of loan modifications.

## 2.4 Loan Modification Programs: General Background

As a way to combat the payment defaults and foreclosures, lenders worked closely with the U.S. government to design loan modification programs for the purpose of keeping borrowers in their homes. These modification programs are often structured to decrease the borrower’s monthly mortgage payments to 31% of their income and prevent foreclosures (Berry, 2009). “Foreclosure is an expensive and time-consuming process, resulting in significant costs to the borrower and the investor/lender” (Haughwout et al., 2016). Borrowers could go through the loan modification program that usually takes from 4 to 6 months in terms of the length of time. During the modification process, lenders assess the homeowner’s financial ability and offers redefined loan terms if approved. “Alternatively, the lender may modify the loan terms, such as reducing the interest rate, extending the maturity date of the loan, or reducing the principal balance, to facilitate

financial relief for borrowers, enabling them to resume their regularly scheduled payment" (Calem et al., 2018). Loan modification programs, if followed responsibly, can be beneficial to all parties involved. These programs give borrowers an opportunity to stay in their homes, which in return saves taxpayers from being in a financial meltdown. There are huge benefits for the borrower in the long run, as well as the value association with preventing further damages to the mortgage industry and the economy. At the same time, successful loan modification programs can provide a better lender pool and lending power, preventing the occurrences of foreclosure or defaults in the future. Brevoort and Cooper (2013) indicate if a foreclosure takes place, borrowers face an average drop of 150-200 in credit scores and a recovery period of 5 to 7 years. Note that subprime borrowers typically face an even longer recovery period. Some lis pendens (legal notice of foreclosure) could take 2 to 5 years depending on the geographic location (Chan et al., 2013). Without the modification programs, we are likely to find more distressed homes, leading to a greater influx of negative equity and defaults.

### *2.4.1 Outcomes of Loan Modification Programs*

Unfortunately, the HARP and HOPE programs did not turn out to yield a steady success rate, as many of the programs' borrowers re-defaulted on their loans. According to a Fox Business report (2012), the modification programs did not produce the results for which they were designed. 70% of HAMP's program borrowers found themselves re-defaulting about 5 years after the initial modification process. Ironically, the likelihood of re-defaulting seems to be related to the significantly lower mortgage payments. It was believed the reduction in mortgage payments around the 10-30% range would significantly lower the risk of re-default (Chen et al., 2014). However, lower payments did not lead to a lower re-default rate. Researchers find that

irresponsible borrowers regarded the reduction in mortgage payments as an additional source of disposable income that they can spend frivolously. Improper money management is a catalyst to an increased level of debt. Schelkle implies that liquidity is not always to be blamed for a cause for borrower defaults. Having programs in place such as HAMP, HARP, and HOPE is roughly 7-10 times cheaper than a bailout of mortgage lenders. The outcome of these programs deviated from the expected goals of the programs as a result of the irresponsible money management behaviors of certain borrowers triggered by lower mortgage payments. What appeared like a great opportunity for borrowers to get out of a financial constraint did not come to fruition for most of the homeowners. Within 13 months after receiving the modification, 56% of the borrowers who went through the modification program defaulted a second time on their loan. This suggests that the original expectations of the modification programs to save borrowers from losing their home were not fully achieved by the programs.

### *2.4.2 Loan Modification Program and Financial Literacy*

The loan modification process involves multiple steps to assess a borrower's ability to make payments. "The most relevant type of private information that originators collect is knowledge about borrower ability to repay" (Adelino et al., 2019). Lenders review income, credit, debt to income ratio, assets available amongst other financial factors. While there are all important factors, what is not being considered is the borrower's ability to make sound manageable financial decisions. Does the borrower understand the importance of saving and budgeting for the household? Does the borrower understand the effects on his/her credit for not making mortgage and credit card payments in a timely fashion? Introducing financial literacy during the loan modification gives the borrower the necessary tools needed to understand how important saving

and budgeting is for getting him/her back to financial stability. “Financial education can equip consumers with the fundamental knowledge required to choose among the myriad of products and providers in the financial services industry. It can also maximize their longer-term [economic] well-being” (Volpe and Mumaw, 2010). By introducing a financial advisor into the loan modification program, this activates the consumer behavior theory with the hopes of creating a positive effect on the borrower to become financially literate and make informed decisions related to their finances.

Influencing consumer behavior comes with challenges as people are not always predictable and can be indifferent to choices offered to them. The opportunity to have an informed customer benefits all parties. Educating borrowers with financial literacy has been successful in home-buying programs such as the NACA (Neighborhood Assistance Corporation of America) where home buying events and workshops are offered. Offering the same opportunities to current homeowners could mean the difference in a family embracing the American dream of home ownership and a lender having yet another REO (real estate owned) property on the company books after foreclosure.

### *2.4.3 Loan Modification Program and the Role of Financial Advisors*

Financial advisors are equipped to assist clients in every stage of life. During the home purchasing process, if a borrower does not have the foundational knowledge regarding the responsibilities of home ownership, they are at much greater risk to face default. Many borrowers are only concerned about how much they can afford and what their monthly payments will be. Simply reducing the monthly payments alone is unlikely to ensure that the borrower will make

wise financial decisions. Poor money management works against any financial assistance put in place, such as the loan modification programs. Financial advisors play an important role during the modification program. Borrowers benefit greatly from the advice and guidance from a financial advisor during the loan modification process to avoid potential problems due to poor money management, double-trigger, or option-theoretical related factors. With proper advice, borrowers are able to adopt to a new mindset about money management, minimizing his or her chances of re-defaulting in the future.

The idea of having a financial advisor introduced at the beginning the loan modification process with the hopes of impacting the consumers' financial decision-making is well supported by the consumer behavior theory. Every consumer has a conscious or unconscious behavioral reasoning on why they make certain decisions when it comes to spending their money. It could have been developed during their childhood years or recent years. A consumer's openness and willingness to adopt the strategies suggested by a financial advisor depends on how long a consumer has been using their own reasoning to manage finances. Nonetheless, simply having a knowledgeable advisor can help a borrower navigate various financial decisions, increasing the borrower's chances of reaching their financial goals and maintaining financial stability. In the context of the loan modification process, financial advisors are able to guide homeowner to make wise decisions related to the mortgage and other personal finances.

Financial advisors are experts in assisting their clients to see the broad scope of purchasing a home. They are trained to identify the benefits and problems the borrower could face. They provide valuable guidance to borrowers regarding how much income is required and the amount of mortgage debt borrowers can afford. Advisors are able to help borrowers stay within their financial means and provide guidance on budgeting. Carrying too much debt early on in one's life

will have long-term impacts in the future when borrowers need to finance life expenses such as car and mortgage payments and the costs of educations. Borrowers are likely to experience a lower risk of re-default if they had proper borrowing education and guidance during the modification process.

### *2.4.4 Loan Modification Program and Economic Conditions*

It is the American dream to own a home. Never is anyone ever paraded with the importance of becoming financially sound prior to committing to a major financial decision. Financial advice or guidance should be required or at least offered during the loan modification process. When borrowers in the modification phase become educated on what they can do to avoid default in the future, both homeowners and lenders stand to benefit. More educated borrowers possess the ability to make sound financial decisions and timely mortgage payments. This leads to lenders seeing a decrease in recidivism rates. Without the proper financial control in place, the cycle is a healthy one for the economy. On the other hand, only a small portion of borrowers are receiving proper financial education across the U.S. As borrowers are without the needed financial awareness, mortgage lenders tend to experience an increase in modification applications. The trickle-down effect is a deeper economic slump for the financial markets and unfavorable outcomes for the borrowers and mortgage lenders.

In 2008, the U.S. faced a severe economic downturn, unemployment was at an all-time high, similar to the Great Depression during the 1920's. Lenders experienced an influx of modification applications due to the increased unemployment rate. Borrowers who adopt solid financial planning during the home buying process would have been much better prepared for an

unexpected financial hardship such as a reduce in household income or a shock to the housing market. Financial advisors have the responsibility of presenting borrowers with relevant data and advice when educating future homeowners. If this service had been offered in a prevalent manner, it is difficult to imagine that the mortgage industry would have faced such a large scale of loan defaults. The spiraling effects of a cascade of mortgage defaults include a significant drop in house prices, a decrease in the aesthetics of neighborhoods, or even a disproportionate number of homes left being abandoned.

Other actions that increase the amount of mortgage defaults involve the lending practices of loan providers. As a result of the 2008 economic downturn, lenders have navigated towards stricter lending guidelines. Lenders vary significantly on loan type, geographical region, loan size, etc. Regulatory requirements and guidelines play a critical role in governing lending institutions. I see strong evidence that lenient lending guidelines could throw the downturn into an uncontrolled spiral. Lending institutions took advantage of markets with lenient guidelines, to entice borrowers with crafty financing. Predatory lending created a tight rope for banks across the country. In theory, banks were able to entice borrowers that did not have prior knowledge about mortgages. Unfortunately, some lenders who went through a government bailout after the crisis did not learn their lesson. Certain lenders continued to ignore industry standards regulations and failed to offer proper financial education to borrowers during the lending process. In other words, after receiving a bailout, these lending institutions did not come to the aid of its borrowers. There are many factors that caused the economic downturn: Banks focusing on large-size loans and pursuing aggressive lending practices, federal regulators not being timely in terms of its policies and restrictions, lack of financial education and support for borrowers, and others. The lasting effects of a major financial crisis, such as the one in 2008-2009, clearly illustrate that it was difficult for the financial

markets to bounce back. Homeowners continued to suffer from the effects of higher default rates long after the mortgage crisis. Therefore, the understanding of the major determinants of modification rates is critical for the consideration of ways to prevent a similar catastrophic collapse of the financial system in the future.

## 2.5 Loan Modification Programs: Related Literature

A growing number of papers examine the factors driving the booms and busts in the U.S. housing market (Demyanyk and Van Hemert, 2009; Doms et al., 2007; Gabriel and Rosenthal, 2007; Gerardi et al., 2007; Dell'Ariccia et al., 2008; Mayer and Pence, 2008; Keys et al., 2010; Mian and Sufi, 2009a, 2009b, 2010; and Purnanandam, 2010). This study fits in the existing literature by focusing on the drivers of loan modification rate and how the importance of the drivers varies across the type of homeowners and the boom versus bust periods. In addition, I examine the impacts of the financial crisis on the determinants of loan modification by examining the pre-crisis, crisis, and post-crisis periods. Moreover, as a very timely topic, I examine how the loan modification pattern changes from before to during the pandemic, and how the determinants of loan modification are affected by the pandemic. These are topics that have so far received limited attention in the literature.

### *2.5.1 Mortgage Loan Performance and Its Determinants*

There are several streams of literature that are related to this study in terms of the patterns of loan performance and the major drivers. First, several studies explore the performance of FMMA loans at a certain FICO threshold that trigger an extrinsic increase in securitization. The

results suggest that the moral hazard issue intertwined with securitization is harsher for banks. Second, another stream of literature examines the drivers of mortgage performance at the regional or county level (e.g., Mian and Sufi, 2010; Favara and Imbs, 2010). For example, Mian and Sufi (2010) study the impacts of a leverage increase on the loan performance during the crisis. The housing downswing, starting in 2008, was a product of a massive contraction in mortgage credit, a decrease in house prices, and a subsequent increase in unemployment. One of the indicators of the Great Recession was the sharp rise in unemployment. These particular variables and indicators served as useful measures of the severity of the housing downswing, and therefore can be the key variables and indicators in predicting future contraction in the credit and real estate markets and the increase in the unemployment rate.

Third, the focus of studies turns to the lending institutions. Prior to the crisis, U.S. mortgage lenders operated under a wide variety of regulatory structures with differing and inconsistent levels of oversight, especially between banks and non-bank mortgage originators. Banks had to be regulated under strict federal banking laws with close supervision by federal agencies (Belsky and Richardson, 2010). In particular, banks had to comply with a range of federal supervisory controls including the Community Reinvestment Act (CRA), the fair lending practices, and the safety and soundness assessments. Financial institutions are required to obey CRA provisions including the reporting requirements and merger reviews. Depository institutions insured by the Federal Deposit Insurance Corporation (FDIC) are also required comply with the minimum risk-based capital and reserve requirements. Federal agencies routinely examine financial institutions to ensure the comply with the applicable laws related to their mortgage lending such as the CRA, Truth in Lending Act (TILA), and the fair lending laws (Immergluck, 2009).

On the other hand, independent non-bank mortgage lenders (henceforth independents) were not subject to most of the federal regulations, instead, they were regulated and supervised at the state level with much less stringent rules (Belskey and Retsinas, 2008; Immergluck, 2009). Mortgage Bankers Association, a major trade organization representing the independents lenders, has requested the creation of a federal regulator to develop uniform standards around national mortgage and regulate independent mortgage lenders (Belsky and Richardson, 2010). 2005 was the height of the mortgage boom that started in early 2000s, quickly accelerating to an unprecedented level of growth between 2003 and 2005. The patterns of new mortgage originations in the U.S. market exhibit the rise and fall of the mortgage market between 2003 and 2008. The independents contributed a disproportionately number of loans with a large increase in the market share of independents in 2005 compared to that in 2003 across the vast majority of U.S.

### *2.5.2 Loan Modification Programs: Adoption and Success Measures*

The housing market experienced a boom in 2006 and a rapid decline in mid to late 2007, ultimately leading the economy into a financial crisis in 2008-2009. During the crisis, lenders and servicers were forced to offer alternative options for borrowers. Although the Home Affordable Modification Program (HAMP) had been mildly successful in achieving borrower recovery from default, the primary focus at the time of the crisis was to increase the loan modifications over liquidations. Liquidation takes place when homes are sold for a lesser amount, causing the lender to experience a loss. Mortgage affordability is also highlighted during the inception of the HAMP. Thus, the question is how one can measure the success of the modification programs. The three main components used to measure the success of modification programs are: principal reduction, substantial pay relief, and whether the modification is initiated early in the delinquency status.

Based on the three measures, modification programs have generally been regarded to yield a favorable outcome across servicers.

Principal reduction and payment relief are important indicators of the loan modification programs as they measure the extent and potential effectiveness of the modification terms. Principal reduction alleviates the debt burden for borrowers. Payment relief is formulated to extend the loan and recapitalizing delinquent payments. This process creates a reduction in payments, providing payment relief for the borrower. For the timing of modification initiation related to the delinquent months, Goodman et al. (2011) report the modification rate varies by the length of delinquent months at the time of modification for the period from 2008 to 2011. The corresponding graphs are shown in Appendix B-1. Over the period from January 2008 to May 2010, principal reduction was largely successful in part due to the reduction in interest rate by 2%, extending the loan terms and forbearance of the principal balance. Modifying loans early was very effective for borrowers in early in the period from 2008 to 2009: When borrowers were two months or less in default, 41% of loans were modified. When the delinquent months were between three and twelve months, the loan modification was around 22%. And the modification rate dropped to 6% for borrowers who were delinquent for more than twelve months. In 2010, we observe a quite different pattern compared to that in 2008 to 2009. In particular, loans that were two months or less delinquent were modified at 13% rate, loans that were three to six months delinquent had a modification rate of 30%, loans with seven to twelve delinquent months had a 33% modification rate, and the modification rate went up by 24% for borrowers with more than twelve delinquent months. Studies show that in 2010 mortgages that were in default for more than twelve months were more susceptible to re-defaulting and typically not able to survive the 90-day trial period.

### *2.5.3 Loan Modification Programs: Additional Considerations*

In addition to the three aforementioned measures, it is important to point out two other factors that can complicate the execution and success of loan modification programs. First of all, industry experts weigh in possible success factors for the loan modification programs and point out that economic recovery is a key factor. The efficacy of an economic recovery is the unemployment rate. Many borrowers tend to default on their loans or re-default on their modifications due to a reduction in their household income. Empirical studies show when the unemployment rate increases by 1%, the mortgage re-default rate is 2.9% higher. When the unemployment rate falls by 1%, the mortgage re-default rate drops by at least 0.5%. During the peak of the recession in April 2009, 57% of modified loans re-defaulted. Analysts continue to be cautiously optimistic that the various modification options can provide relief to some extent to the borrowers as a whole and consequently lead to a positive force toward a faster economic recovery. A long road ahead lies ahead as economic conditions will inevitably experience unpredictable waves of escalating and deescalating unemployment rates, resulting in modifications and waves of re-defaults. Appendix B-2 shows the GDP-based Recession Indicator Index reported by the St. Louis Fed's Economic Research FRED Data. The pattern shows the unpredictability of the economic state and the boom-and-bust periods. Appendix B-3 presents the strong the extent of the housing bust by showing the change in housing prices from Quarter 2 of 2006 to Quarter 1 2009. The impacts were certainly widely spread across the country, with several major geographical locations/regions bearing the most severe effects. Appendix B-4 reports the drastic jump in delinquency rates (defined as more than 90 days in default or in foreclosure) of Fannie Mae and Freddie Mac loans during the mortgage crisis. The lingering effects of the mortgage bust in 2007 continue on and while we observe the most recent recession in 2020 as a result of the pandemic.

What we can learn from the past recessions and their drivers remain to be important research questions for understanding the economic and market trends.

Secondly, lenders and servicers handled their own loss mitigation efforts, with no influence from the government prior to 2009. Lenders and servicers had full autonomy to take proper actions in order to recover some of its losses due to borrower default. This led to lenders and servicers following a wide variety of loss mitigation practices. Borrowers entered the loan default process without having a consistent expectation regarding the potential outcome of liquidations, repayment plans, modification terms, and the loss mitigation process. The end result was that borrowers were left even more vulnerable after the initial default event. If mortgage lenders fail to inform borrowers of the tax repercussions, borrowers are forced to face various loss mitigation practices due to the additional tax burdens for their defaulted loan. When homeowners experience a loan default, they can exercise their options to apply for a loan modification or choose a short sale. However, in many instances homeowners are unaware of the tax liabilities as a result of a short sale. Consequently, this common practice is called a taxable event that involves banks taking a loss due to a loan modification, short sale, or foreclosure event. Borrowers are forced to pay taxes on the loss of the distressed property. Generally, those losses can range from 15% to 35%. Many homeowners are blindsided with the tax burden after facing many months of paperwork and communications with the lender. The lack of information from the lending institutions places the borrower in an extremely challenging position. Borrowers are under the assumption that bailouts and debt relief programs will result in loan extension, lower principal value and payments, and the potential of keeping their property. So, the unexpected shock of an extra tax burden adds to the already difficult situation for the borrowers.

HAMP and similar loan modification programs were created after the crisis to ensure borrowers entered home liquidation with proper counseling on its tax burdens. In addition, the government relied on the creation of these programs to curtail mortgage defaults and eliminate inconsistencies in the mitigation process across loan service agencies.

### *2.5.4 Loan Modification Programs: Long-Term Considerations*

While many modification programs are designed to prevent foreclosures, we must examine how effective they will be in the long term. The short-term results are seemingly inconsistent with the expected outcome of lessoning the economic turmoil. In 2008, there was an 81% increase in foreclosure from the previous year. Banks were flooded with modification requests from distressed borrowers who faced reduction in hours, layoffs, or termination, preventing them from meeting their loan obligations. The short-term reliefs including a lower interest rate, lower mortgage payments, principal reduction do not seem to serve as a long-term resolution to the mortgage crisis. Although the main purpose of loan modification is to mitigate foreclosure and provide affordability to the homeowner, the lending institutions would need to consider whether homeowners face a new or continued financial problems that present them from meet their lower monthly obligations even after the modification process. Without long-term considerations, the economy will likely face a vicious cycle in the housing market. Banks and analysts cannot rely on short-term resolutions. Well-structured governmental regulations and support should be in place for homeowners instead of bank bailouts and temporary homeowner relief programs when an influx of liquidations occurs.

## 2.6 Determinants of Loan Modification Rates

As discussed above, this study focuses on the drivers of loan modification rate and how the importance of the drivers varies across the type of homeowners and economic expansions and contractions. I further examine the impacts of the financial crisis on the determinants of loan modification by examining the pre-crisis, crisis, and post-crisis periods. And I explore the very timely topic related to how the loan modification pattern changes from before to during the pandemic, and how the determinants of loan modification are affected by the pandemic. To do so, I discuss the various determinants suggested by the literature so I can empirically test them in the study.

### *2.6.1 Household Assets and Income*

Earlier studies show that assets often help insulate families through emergencies, therefore reducing the probability of them experiencing economic hardship. Most of the evidence in these studies liquid assets while real estate assets play a lesser role. Using a survey of Chicago, Illinois, residents from 1983 to 1985, Mayer and Jencks (1989) observe that with all else being equal, being able to borrow $500 when needed—a measure of liquid assets or access to credit—does as much to reduce the family financial hardship as tripling the family income. Owning a mortgage-free home has the same effect of reducing the likelihood of hardship as does a 33% increase in household income. Mckernan et al. (2009) used the 1996 and 2001 Survey of Income and Program Participation (SIPP) panels to examine the relationship between adverse events and material hardships such as food insecurity or troubles with paying bills. They show that after controlling for income, among families that experience an adverse event and are asset-poor (i.e., families

lacking sufficient liquid assets for three months' expenses at the federal poverty level) are 14% more likely to experience a material hardship than are non-asset-poor families.

Keating (2012) used the 2008 SIPP panel to examine the role of both liquid assets and homeownership in decreasing the probability of material hardship among families that experience the same type of adverse events as those in Mckernan et al. (2009). Keating finds that a higher occurrence of a material hardship is associated with a higher probability of asset-poverty and that this relationship is strongest in families in the bottom third of the income distribution. She also finds that homeownership is associated with a lower probability of hardship. The role of homeownership in protecting against economic hardship becomes especially vague during a housing downturn when home values decline sharply. In a normal economic bust, homeowners with low mortgage payments might be expected to draw from their home equity to become liquid and weather the storm, limiting the chances of a financial hardship. Plus many homeowners who paid off some or all of their mortgages have lower monthly housing costs than renters. However, the substantial decrease in home values that accompanied the Great Recession and the 2008-2009 mortgage crisis erased large amounts of equity leaving many homeowners struggling to keep up their mortgage payments and even basic needs. Additionally, homeowners owing more than the value of their homes cannot withdraw from their equity to become liquid. In analysing income levels, studies find that among low-income individuals, the relationship between homeownership and hardship avoidance is stronger than for individuals in the other income groups.

### *2.6.2 Length of Home Ownership and Loan Age*

Based on the above discussion, we find that liquid and real estate assets, average income, and income variability are important drivers of loan modification rates. Another consideration should be the length of time owning the home or the age of the loan. Owning a home for a longer period (grerater than 10 years) provides more protection over a recently purchased home (within 4 years). Homeownership through a risky mortgage fails to provide substantial protection against a material hardship. As a result, one should consider the length of homeownership or loan age when examining mortgage modification rates.

### *2.6.3 Loan Modification Rate and its Determinants: Economic Booms and Busts*

The findings from this study are foundational to policy discussions around homeownership being a sound strategy during an economic downswing. Homeownership policies partly depend on the timing of potential home purchases in relation to housing prices and mortgage interest rates. Homeownership looked especially favorable after 2006 declines in home prices, along with low interest rates and continuing increases in rents. On the other hand, U.S. unemployment rates experienced a sharp increase during the late 2000s recessions, increasing from 5 percent at the beginning of the economic downturn in December 2007 to 9.5 percent at its official conclusion in June 2009.

The subprime mortgage crisis is widely regarded as one of the main causes of the recession. An analysis using zip code-level data by Mian and Sufi (2009a, 2010) illustrates the growth in mortgage credits between 2002 and 2005 (the period leading up to the recession) in geographical areas with a high share of subprime borrowers. Unfortunately, this growth did not accompany a corresponding growth in household income. The subsequent expansion of household leverage in

the early 2000s proved to be a "powerful predictor" of the gravity of the recession across the counties (Mian and Sufi, 2009b and 2010). The subprime mortgage expansion and the resulting crisis occurred along a 'boom-turned-to-bust' phenomenon in the housing market. This was characterized by a substantial amount of new residential developments during the early 2000s in certain metropolitan areas and a dramatic downturn in housing construction in the years immediately after. According to the 2009 American Community Survey of the U.S. Census Bureau, about 8.5 percent of the U.S. residential housing stock during that time was built between 2000 and 2004 while 4.9 percent of the units were constructed between 2005 and 2009, and about 13.9 percent of the housing stock from the 1990s. These statistics point to sizable increases in new home development in the early 2000s in comparison to residential constructions during the 1990s and the significant reductions in the latter half of the 2000s.

Housing prices followed a similar pattern. Wial and Shearer (2010) reported that 25 of the 100 largest U.S. metropolitan areas saw housing values fall between 25 and 50 percent from 2007 to 2010, with particularly severe declines in cities like Las Vegas, Phoenix, Florida and California. The combined forces of the subprime mortgage crisis and the housing market boom-turned-to-bust phenomenon contributed to the economic downturn in the U.S. lasting, in some locations, well beyond the official end date of the recession. Statistics from the U.S. Bureau of Economic Analysis, released in June 2011 indicate that "construction continued to be a drag on real GDP growth" and that "construction declined for the sixth consecutive year and detracted from growth in most states," hitting Nevada especially hard. Market experts identified the increased development of residential housing, incited by the policies to encourage homeownership, as a form of economic inefficiency (Slivinski, 2008). In a 2008 interview, Edmund Phelps stated that "It used to be said that the business of America was business" but "Now the business of America is

homeownership." Furthermore, Phelps noted, "To grow optimally . . . America needs to get beyond its house passion."

The high levels of residential development provided an employment boost to many regions during the early 2000s housing boom. The U.S. construction industry had a 13.1 percent employment growth rate between 2000 and 2006 and real estate employment increased by 27.3 percent during that period. The robust growth in construction provided a source of jobs for low-skilled laborers, which was especially important given the 6.6 percent decline in the U.S. manufacturing employment between 2000 and 2006. The high levels of residential development in the early 2000s with its corresponding growth in housing-related employment were clearly not sources of sustainable economic growth demonstrated by the ensuing downturn. This housing boom phenomenon came to be known as the "great growth illusion" which is a pattern of growth mainly driven by the new housing development, creating a false economy. The ceremonial ribbon-cuttings showcase that illusion of growth yet without other strong underlying drivers such as income growth, the pattern is unsustainable.

There is a close link between the health of the housing market and economic condition, and the link is shown to vary over time as well. Studies found that the U.S. metropolitan area's share of residential housing units built between 2000 and 2006 did not affect the unemployment rate in the months leading up to the recession. However, residential housing construction in the early 2000s had a positive and statistically significant effect on unemployment in 18 of 30 months during and immediately following the recession. These results indicate that the new housing activity was a key determinant of the recession's impact on U.S. metropolitan areas. Furthermore, regions with high rates of growth between 2001 and 2006 in construction, retail trade, and hospitality industry employment, indicators of a false economy supported up by housing growth,

were hit especially hard by the recession. Therefore, I examine how the boom-turned-to-bust nature of the U.S. economy affects the loan modification rate and its determinants using a long sample period from 1999 to 2021.

### *2.6.4 Loan Modification Rate and its Determinants: Recent Developments in the Housing Market*

There are widespread concerns about recent increases in housing prices. Despite the reduction of the stop-go mortgage flow cycle in a nationwide securitized market, one can argue that the free flow of financing may lead to a housing bubble. Nationwide housing prices are 50 percent up over the past five years, with metropolitan and regional markets rising even higher. While some of the gains reflect a catch-up of the slower than expected appreciation in previous years, the increases in recent years have been particularly rapid and may have exceeded the fundamental values. Several indicators suggest there are speculative pressures on prices. There has been a rise in purchases of second homes as investment properties. The incidences of using interest-only mortgages to allow more expensive purchases has also increased. Market surveys and anecdotal evidence indicate that home buyers extrapolate past gains into the expectations for future appreciation. The price-to-rent ratio has also risen, suggesting that in some markets these valuations can only be justified by anticipation of future rapid appreciation. These are warning signs that predict a decline in prices or an adjustment through a long period of slow gains until actual valuations align with fundamentals.

A closer examination of the recent developments in the housing market reflects certain underlying factors that need to be take into consideration. Estimated pricing errors between the market and intrinsic prices are not particularly significant, suggesting that a lot of the recent

increases can be justified by rising incomes, greater employment rates, and low interest rates. Also, the positive surprises in housing prices in the last five years are a welcome relief after a decade of negative surprises, especially on the east and west coasts. These patterns suggest that much of the recent gains may be due to a protracted period of prices trailing fundamentals.

There have been other changes in homebuilders' behavior since the 1980s including the referencing housing starts and accumulating inventories of new homes moderating the risk of a possible housing bubble. Speculative homebuilding represents a major indicator of the housing activity. The power of using data of the completion status of the new home sales cannot be overstated. This data helps identify speculative building (sales of houses already completed or under construction) versus nonspeculative building (construction not yet started at the time of sale). From the 1960s through the 1980s, builders engaged in speculative stats to build an inventory of homes for sale in advance of a relatively short "hot" market. Speculative construction has declined since the 1980s. Given that the builders' demand is no longer subject to the stop-go cycles, their incentives to maintain an inventory of new homes for hopes of a surge in demand are significantly diminished, resulting a smaller likelihood of the overhang of new homes for sale. Inventories of new homes are rising to the levels of the early 1970s despite the doubling of home sales. During the previous boom-bust cycles, a buildup of inventories came before price collapse when demand inevitably subsided. New home inventories divided by the monthly sales pace (referred to as the months' supply) measures the vulnerability of housing markets when there is a drop in demand and the length of time for developers to shed excess inventories. A normal real estate cycle begins with a sharp increase in housing prices triggering a swift increase in construction of new development and the inevitable rise in supply. As demands subside, housing prices decline to absorb the excess supply. An example during the 1980s had new home inventories

reaching almost 10 months' supply on the west coast and 15 months' supply during northeast boom. Prices subsequently fell by 10 percent in order to absorb the excess supply. Once the supply leveled off to 6 months or less, prices began their inevitable rise again. However, in the current boom the months' supply remain near the historic lows even in regions where housing markets are very strong. The northeast has current inventories of about 4 months' supply and the west coast has 3 months' supply. The fact that these levels are below the rates at which housing prices stabilized during previous bust cycles indicate that housing supply is not far ahead of demand.

Based on the above discussion, I examine how major shocks influence the loan modification rate and its determinants. The shocks include the financial crisis during the period from 2008 to 2009 and the pandemic in the period from 2020 to 2021.

## Chapter III

## Hypothesis Development

### Hypothesis 1

As discussed above, borrower characteristics are very common factors for mortgage loan initiation and loan modification process. These characteristics pertain to borrower's financial status including the debt-to-income ratio and credit score. The number of borrowers should also be considered. For loan characteristics, the literature suggests that the original loan term, loan age, and remaining time to maturity are important factors to include in the analysis of loan modification rate. In addition, I conjecture that unemployment rate and whether the loan is initiated by a first-time home buyer should be considered. More specifically, loan modification rate should be closely related to the unemployment rate. This can be explained by the fact that when homeowners are out of work and their income is reduced, borrowers are more likely seek out alternatives to help them remain in their home. For example, homeowners may contact the loan servicer to request for a reduction in monthly mortgage payments so as to avoid delinquency. Correspondingly, delinquencies in mortgage payments in 2007 was at the beginning stages of a rise, especially for borrowers carrying an unconventional loan (Prassas, 2011). This period was also the beginning of the 2008 recession where loan modifications were becoming popular with the government-driven foreclosure prevention policies such as Home Affordable Modification Program (HAMP) (Kim 2015). First-time home buyer may exhibit behaviors that are different from the other home buyers. Thus, I conjecture that whether the loan is initiated by a first-time home buyer is a factor of modification rate.

$H_0$: In addition to the major borrower and loan characteristics that drive loan initiation and loan performance, I hypothesize that unemployment rate and whether the borrower is a first-time homebuyer are not important drivers of loan modification rate of residential mortgage loans.

$H_1$: In addition to the major borrower and loan characteristics that drive loan initiation and loan performance, I hypothesize that unemployment rate and whether the borrower is a first-time homebuyer are important drivers of loan modification rate of residential mortgage loans.

**Hypothesis 2**

Prior to the pandemic, the economy was beginning to experience growth and recovering from the 2008 market crash that left millions of Americans without homes. Also, during this expansionary period, FNMA loan modifications were on a steady decrease from 2014 to 2022. I observe that the housing crisis has gradually subsided as the economy continues to bounce back since the 2008-2009 recession. The creation of HAMP and other government programs are designed to modify loans to prevent homeowner defaults and bailouts of lending banks. It is predicted during economic busts; modification applications will increase tremendously. Business closures, layoffs, and other life events will be the root cause of an influx of modification applications for the next several years. In addition, I conjecture that the effects of the determinants on loan modification rate vary between the expansionary and contraction periods.

$H_0$: Loan modification patterns and factors driving the loan modification rate are not significantly different across the business cycles containing the expansionary and recessionary periods.

$H_1$: Loan modification patterns and factors driving the loan modification rate are significantly different across the business cycles containing the expansionary and recessionary periods.

**Hypothesis 3**

The home mortgage financial crisis of 2008 sent the U.S. economy into a devastating downturn that affected millions of American homeowners, investors, financial institutions, and the private sectors. Prior to the crisis, modifications remained at a very low rate. As a result of the crisis, the number of loan modifications skyrocketed with the goal of helping homeowners remain in their home and prevent foreclosure. What caused homeowners to experience a default event came from a number of factors. Job loss being one of the major factors as many industries was forced to lay off employees due to the crisis. In addition, millions of mortgages experienced a ballooned payment involving a monthly mortgage payment that was low or affordable doubling or tripling as a result of the crisis, resulting in homeowners not being able to make payments. Given the above discussion, I conjecture that loan modification rates should vary across the pre-crisis, crisis, and post-crisis periods. In addition, the impacts of the determinants on modification rates are likely to differ across these pre-crisis, crisis, and post-crisis periods.

$H_0$: I hypothesize that the 2008-2009 financial crisis does not have a strong impact on loan modification patterns and factors driving the loan modification rate. As a result, I

expect that loan modification patterns and factors driving the loan modification rate do not differ significantly across the pre-crisis, crisis, and post-crisis period.

$H_1$: I hypothesize that the 2008-2009 financial crisis has a profound impact on loan modification patterns and factors driving the loan modification rate. As a result, I expect that loan modification patterns and factors driving the loan modification rate differ significantly across the pre-crisis, crisis, and post-crisis period.

**Hypothesis 4**

Modifications are typically down when the country is in a healthy business cycle. When there is a strong workforce, companies have an increase in demand, thus causing an increase in hours for hourly workers. Salaried and hourly workers contribute to the economic spending and borrowers' ability to meet the monthly mortgage obligations. Recessionary periods are associated with an increase in modification applications and a trickle-down effect on economic spending patterns. The pandemic in recent years from 2020 to 2021 mirror in scale and pattern to the 2008-2009 crisis. As a result, I expect that pandemic has a strong impact on the loan modification rate and the factors driving modifications.

$H_0$: Loan modification patterns and their factors are not expected to be significantly different before and during the pandemic.

$H_1$: Loan modification patterns and their factors are expected to be significantly different before and during the pandemic.

**Hypothesis 5**

First-time homebuyers may face factors that are unique in triggering a default or modification. Risky lending behavior becomes less prominent in recent years. However, first-time home buyers may exhibit behaviors that are different from those buyers who are more experienced home buyers. I first acknowledge that given stricter requirements on information disclosures, first-time home buyers have the same information as all other home buyers in the market. However, there may be factors and patterns that drive loan modification rates for the first-time buyers that are different from those for the experienced home buyers. For example, the knowledge of the real estate and loan markets as a result of going through the loan initiation process in the past may lead to the experienced home buyers to behave differently in the loan initiation and modification process. The experienced home buyers are more likely to realize the importance of income level, income stability, budgeting, savings, and other financial means in maintaining a mortgage and preventing possible defaults.

$H_0$: Loan modification patterns and factors driving the loan modification rate are not significantly different between first-time homebuyers and the other homeowners.

$H_1$: Loan modification patterns and factors driving the loan modification rate are significantly different between first-time homebuyers and the other homeowners.

# Chapter IV

## Data Sources and Summary Statistics

### 4.1 FNMA Single-Family Loan Data

The data for this research is from the FNMA mortgage portfolio. With Fannie Mae as a front runner in the mortgage industry, they exhibit the monopolistic power in most markets. Thus, the use of their loan portfolios as the main data source is fitting for this research. Fannie Mae's top priority is to make homeownership and rental housing affordable for millions of Americans. Fannie Mae is committed to promoting equal and sustainable gateways to homeownership and quality rental housing throughout the United States. Fannie Mae is continuously seeking to create and conduct a stronger more viable, safer, and effective housing finance strategy, providing a trusting resource to homeowners and renters in neighborhoods and communities throughout the nation. Fannie Mae was chartered by U.S. Congress in 1938 to provide a reliable source of affordable mortgage financing across the country. Today, their mission continues to provide a stable source of liquidity to support low- and moderate-income mortgage borrowers and renters. One of the ways they do this is by enabling greater access to affordable home and rental housing finance in all markets and at all times.

Since the 1950s, Fannie Mae has focused on offering 30-year fixed rate loans to homeowners. This lending option makes it easier for homeowners to purchase a home. With this loan product as an available option, consumers are not surprised throughout the life of the loan. With the monthly payments being predictable, homeowners have a peace of mind as they are able to focus on meeting their monthly obligations and future goals. Fannie Mae neither originates mortgage loans nor lends money directly to borrowers. As a leading source of financing for mortgages in the United States, Fannie Mae purchases mortgages from lenders and helps facilitate

the flow of capital into the housing market by issuing and guaranteeing mortgage-related securities. Fannie Mae has made a huge commit to a leadership role within the housing finance industry as well as working with the industry partners to create opportunities for more people to buy, refinance, or rent a home.

## 4.2 Federal Reserve Economic Data (FRED)

The Federal Reserve Economic Data, FRED is an online database consisting of economic data time series from national, international, public, and private sources. FRED, created and maintained by the Research Department at the Federal Reserve Bank of St. Louis, goes far beyond simply providing data: It combines data with a powerful mix of tools that help the user understand, interact with, display, and disseminate the data. In essence, FRED helps users tell their data stories.

FRED began in the early 1990s as an offshoot of the long-running legacy at the Federal Reserve Bank of St. Louis of providing monetary data to help better understand the Fed's policy decisions. The data were organized into categories containing roughly 300 data series and expanded from there. Perhaps surprisingly, FRED did not begin as part of a grand scheme or strategic objective. Rather, it grew over time in a very organic way. Since its inception, FRED has contained many of the more popular figures reported by the Board of Governors, Bureau of Economic Analysis, Bureau of Labor Statistics, and Census - among others. Throughout time, FRED has expanded its collection to include more international, national, and regional data series. More recently, it has become clear that data relevant to other topics and geographies must also be included if FRED to best serve its users. As a result, the data content will continue to grow and evolve.

Certain data, as it travels through time, is subject to revision. The FRED database always contains and displays the most recent revision—or vintage—of the data available. FRED's real-time relative, the aforementioned ALFRED (Archival Federal Reserve Economic Database), captures all of the individual revisions to a data series. This means that collectively, FRED and ALFRED data can be used as a data time machine, allowing users access to the precise data that their predecessors used. Researchers often attempt to replicate results of previous academic papers or use data to train or test economic models; in these instances, the relevance of these FRED tools becomes clear.

### 4.3 Sample Construction

I collect data from the FNMA data source detailing loans from the periods of 1999 to 2021. This accounted for a total of 51,662,118 single family loans within the FNMA portfolio during this time period. This included an indicator for us to distinguish between the first-time home buyers and non-first-time home buyers. The variables I focus on include the FICO score, Loan-to-value (LTV) ratio, debt-to-income (DTI) ratio, and modification rates. For each year between 1999 and 2020, I gather the average FICO score, LTV, and DTI for all loans in the FNMA portfolio. I then divide the sample by whether the loan was initiated by the first-time home buyers and whether the loan is modified. Examining these breakouts allows me to view how many first-time homebuyers make up the FNMA portfolio as well as how many modifications took place during this time period. I can also explore how many of the first-time homebuyers receive a modification during the sample period.

From FRED, I pull economic data on various macroeconomic variables including the unemployment rates, GDP, Inflation rates, interest rate level, interest rate slope, and interest

volatility. These economic variables provide important indicators for the state of the economy, for example, whether the economy is experiencing a boom or bust. During the boom periods, the economy is operating at a high positive rate in all major sectors. Bust periods, on the other hand, are essentially the complete opposite. The economy is suffering, and many industries are struggling to survive. During each of these periods, the unemployment rate aligns with the progression of the country's economy. During the boom periods, unemployment rates are low. Americans are working and the economy is adding more jobs each quarter. During the bust periods, unemployment is high and job creation is low. GDP and inflation rates are additional economic indicators to consider. The interest rate variables including the level, slope and volatility are important factors to include as they are tied closely to the state of the economy, the housing market, and the mortgage market.

### 4.4 Descriptive Statistics

In Table 1, the single-family FNMA loans I are providing for each year the amount of loans exist within the portfolio. For each year you see the average FICO score for that year. Along with the average FICO score, is the average loan-to-value ratio and the average debt-to-income ratio. Each table displayed shows a highlighted area in orange which indicate a year classified as a bust year according to FRED. These are years I experienced an economic recession.

Table 2 provides a look at the single-family FNMA loans that are first time homebuyers. As defined first time homebuyers are homeowners that have purchased a home for the first time. I provide a percent look at of the overall single family FNMA population how many where first time homebuyers. The other indicators for FICO, LTV and DTI also are provided. Table 3 allows us to take a look at the single family modified FNMA loan count. This table shows of the overall

loan count, how many of those loans received a loan modification. I also take a look at what is the percentage of how many of the overall loan count received a modification during this time period.

Table 4 labeled First time Home Buyers Modified FNMA Loan count breaks down for each year how many first-time home buyers received a modification. This helps us determine if there again is a strong relationship between first time home buyers having to go through the modification program early on in home ownership. Table 5 reveals the full sample of single-family FNMA loans against the first-time home buyers. I first show the loan count comparison for both overall count and first-time home buyers. I then provide the comparison between the overall modified rate versus the first-time home buyer modified rate.

In Figure 1, which exhibits the number of FNMA single-family loans for the full sample, provides a look at the loan trends from 1999 through the end of 2021. In this figure you can see FNMA's largest loan count occur in 2003 with over 5 million single family loans on the books, then quickly decline the following 2004 year to just over 1.5 million loans. The trend fluctuations under 3 million until the next huge spike in loans in 2020.

Figure 2 delivers a look into the FNMA Single-Family First-Time Home Buyers population of the FNMA portfolio. The chart shows a steady increase in first-time homebuyers from 2011 through 2020. FNMA's definition of a first-time homebuyer has 3 requirements. First, the buyer is an individual that's buying the property. Secondly, the individual must live in the property. Thirdly, the individual has had no ownership interest in a residential property during the prior three years of purchase.

In Figure 3, labeled Number of FNMA Modified Loans: Full Sample, provides an overview of all FNMA loans that received a loan modification within the time period of 1999 – 2020. Leading up to the 2008 mortgage crisis, the prior 6 years modifications were well over 15,000 per

year for FNMA, then dramatically shifting under 10,000 per year. I was not able to include 2021 modifications in the data collection as FNMA data dynamics website has not been refreshed to include this information. Finally, Figure 4 provides the modified loan counts of the first-time homebuyers for FNMA and shows there was a significant dip in modifications from 2008 to 2012. Then 2013 lead a rebound of modifications for the next 5 years. Along with the full sample of modified loans, the first-time homebuyer data collection does not include 2021.

# Chapter V

# Preliminary Results

## 5.1 Borrower and Loan Characteristics

For the preliminary results I have complied the list of mortgage loans from the FNMA single family home dataset. The final loan sample is compiled over the time-period of 1999 through 2020. This dataset includes a detailed analysis of the loan characteristics including number of borrowers for loans, debt to income ratio, borrower credit score, first time buying dummy, original loan term, loan age, remaining months to maturity, and other loan terms. The expectations are to use these characteristics to have an in-inclusive view of the population's performance and which group of first-time buyers versus non-first-time buyers are affecting the modification rate over the period of time. In particular, I explore and present the planned Table 6 presents the descriptive statistics of 7 key variables in the data collection. Those variables are as follows: Number of borrowers, Debt-to-Income ratio, borrower FICO score at loan origination, original loan terms in months, loan age in months, remaining time to maturity in months, and the FTHB dummy variable. FTHB equals one if the loan is a first-time home buyer loan and zero otherwise. The descriptive statistics results show that the average Debt-to-Income ratio for FNMA single family is around

38% and holds an average FICO score of 728. The average original loan term is 322 months with an average of 276 months remaining until maturity.

As a subset of the full sample of the data population, the following preliminary results focus on the first-time homebuyer's mortgage loans from the FNMA single family home dataset. The final loan sample is compiled over the time-period of 1999 through 2020. This dataset includes a detailed analysis of the loan characteristics including number of borrowers for loans, debt to income ratio, borrower credit score, first time buying dummy, original loan term, loan age, remaining months to maturity, and other loan terms. I use these characteristics to have an in-inclusive view of the population's performance and which group of first-time buyer's vs non-first-time buyers are affecting the modification rate over the period of time. I explore and present the planned Table 7 that contains the descriptive statistics for the single-family first-time homebuyers. As seen in Table 7, the average number of borrowers per loan sits at 1.37, while the debt-to-income ratio hovers just shy of 39%. Similar to the overall population sample, the mean FICO score at origination for the first-time homebuyers is 731.76. The average age in months of the loans are 40.34 months old with 302.13 remaining time until maturity.

## 5.2 Correlations of Borrower and Loan Characteristics

Table 8 presents the variable correlation matrix of the loan variables that important to borrower qualification, such as loan term, credit score, DTI, and loan age. I also include the number of borrowers. In Table 8, I show the Pearson Correlation of the FNMA single-family loan characteristics of the full sample of 76,933,527 FNMA single-family loan-year observations and first-time home buyer sample of 8,877,484 loan years, respectively. The sample period is from 1999 to 2021. For each sample, I report the correlation estimates of the following variables:

Number of borrowers, Debt-to-Income ratio, borrower FICO score at loan origination, original loan terms, loan age, and remaining time to maturity. The results within the overall sample population are showing there is a positive correlation with the number of borrowers per loan and the average FICO score at origination with 0.046. While a negative correlation exists between the number of borrowers per loan and loan age at -0.065. One of the strongest positive correlations within this metric occurs with debt-to-income and the remaining time to maturity at 0.192. The first-time homebuyer sample results continue to hold a positive correlation between number of borrowers and FICO score at origination but at a much smaller amount of 0.007. The original loan term and remaining time to maturity holds the highest positive correlation with 0.658.

## Chapter VI

## Baseline Regressions

### 6.1 Baseline Regressions of Loan Modification Rate on Borrower and Loan Characteristics: Full Sample

In the regressions, I explore the major factors of the loan modification rates. I include as the dependent variable the modification dummy variable and the right-side variables the explanatory variables, control variables, and the macroeconomic controls such as interest rates. Table 5 list the overall modification rate which includes the full sample of data. Using the regression model for this question provides us the insight on basic trending for modification rates for each population. In particular, I explore and present Table 9 that contains the following information of baseline regression of loan modifications for the full sample population. Panel A represents the probit model regression results and significance level for each variable. The number of borrowers shows to have a high significant level at 0.041, while original loan term has a relatively low significant level of 0.001. Panel B represents the logit model regression results for the same variables. The unemployment rate significant level sits at 0.021 which is significant compared Borrower FICO Score at origination significance of 0.011. Remaining Time to Maturity has a significance level of 0.000.

### 6.2 Baseline Regressions of Loan Modification Rate on Borrower and Loan Characteristics: First-Time Home Buyers

I perform the Table 10 regression analysis which follows the same format as the Table 9 analysis, though only including the population of the first-time homebuyers. I continue the regression testing viewing how the factors impact the loan modification rates. I include as the

dependent variable the modification dummy variable and the right-side variables the explanatory variables, control variables, and the macroeconomic controls such as interest rates. I have a comparison on the overall population compared to the first-time homebuyer's sample of data. Using the regression model for this question provides us the insight on basic trending for modification rates for each population. Table 10 present the following information of baseline regression of loan modifications for first-time homebuyers. In Panel A, I observe the probit model regression results and significance level for each variable. The debt-to-income indicates a significant level at 0.024, while remaining time to maturity has a relatively low significant level of 0.009. Panel B displays the logit model regression results for the same variables. The number of borrowers significance level is relatively high at 0.060, which Borrower FICO Score at origination also shares a high significance of 0.056. Remaining Time to Maturity has a significance level of 0.015.

## Chapter VII

## Loan Modification and Economic Triggers

### 7.1 Boom versus Bust Periods

The focus for the economic trigger analysis provides the insight on what roles the economy plays in the modification rate. During boom-and-bust periods a regression model shows the impact these time periods have on the modification performance for many homeowners. The period (boom-and-bust) is broken out separately in sets in the baseline regression models. For the boom period, I expect to view how modification rates remain low during the period when the economy is doing well and is on the rise. While bust periods I anticipate seeing an increase in modification rates from homeowners considering economic drivers such as unemployment's rates are higher. In Table 11, I perform a set of subsample analysis by running the baseline regressions shown in Table 9 with one panel presenting the boom years and one panel presenting the regression results for the bust years. In particular, Table 11 contains the results for the full sample. Table 12 contains the results for the first-time home buyer sample.

Beginning with Table 11 Panel A1, the chart displays a probit regression model of the boom years for the full sample population and showing the significance level for each variable. The interest rate level significantly rate sits at 0.033 which closely mirrors Borrower FICO Score at origination significance of 0.032. Inflation rates exist with a significant of 0.895. In Table 11 Panel A2, the probit regression model of the bust years also showing the significance level for each variable. The number of borrowers significantly rate sits at 0.043. The borrower FICO Score at origination significance of 0.014. Inflation rates exist with the highest significant level of the variables with 0.869. Original Loan Term has a significance rate of 0.003.

In addition, Table 11 Panel B1 presents the logit regression model of the boom years. The original loan term significant rate is 0.028. The unemployment rate significance of 0.028. Inflation

rates exist with the highest significant level of the variables with 0.881. Original Loan Term has a significance rate of 0.028. Lastly in Table 11 Panel B2, the logit regression model of the bust years also showing the significance level for each variable share some similar results to the boom years. The borrower FICO Score at origination significant rate is 0.060. The unemployment rate significance of 0.050. Inflation rates exist with the highest significant level of the variables with 0.901. Original Loan Term has a high significance rate of 0.040.

In Table 12 Panel A1, the results display a probit regression model of the boom years for the full sample population and showing the significance level for each variable. The interest rate level significantly rate sits at 0.021 and interest rate slope has a low significance of 0.008. Inflation rate exist with the highest significant level of the variables with 0.884. Panel A2 shows the probit regression model of the bust years. The number of borrowers significantly rate sits at 0.040. The borrower FICO Score at origination significance of 0.015. Inflation rates exist with the highest significant level of the variables with 0.885. Original Loan Term has a fairly low significance rate of 0.006.

In Table 12 Panel B1, the logit regression model of the boom years also showing the significance level for each variable share some similar results to the boom years. The original loan term significant rate is 0.030. The unemployment rate significance of 0.039. Inflation rates exist with the highest significant level of the variables with 0.890. Original Loan Term has a significance rate of 0.030. Lastly in table 12 Panel B2, the logit regression model of the bust years shares some similar results to the logit regression model for the boom years. The borrower FICO Score at origination significant rate is 0.045. The unemployment rate significance of 0.034. Inflation rates exist with the highest significant level of the variables with 0.885. Original Loan Term has a significance rate of 0.025.

## 7.2 Impacts of Financial Crisis

The crisis periods analysis consists of pre-crisis, crisis, and post-crisis periods. For crisis I identify these periods as the 2008 mortgage crisis and lastly the COVID19 crisis that affect the global economy. Pre-Crisis periods represents the period before the country enters the 2008 mortgage crisis that sent the country into a recession and the COVID19 pandemic. The crisis period regression analysis of course demonstrates during the recession/COVID19 pandemic and post-crisis period is the time following. With each regression analysis, I demonstrate how the modification rates are impacted based on the economic triggers and after the crisis time period passes, how long does it take for the modification rates to return to pre-crisis levels. In the planned Table 13, I plan to perform a set of subsample analysis by running the baseline regressions shown in Table 9 with three panels: one panel for the pre-crisis period, one panel for the crisis period, and one panel for the post-crisis period. In particular, Table 13 Panel A probit model contains the following significance level for each variable (number of borrowers, debt-to-income, borrower FICO Score at Origination, Original Loan Term, Loan Age, Remaining Time to Maturity, FTHB, Interest Rate Volatility, Interest Rate Slope, Interest Rate Level, Inflation Rate, GDP, and Unemployment Rate) comparing by pre-crisis, crisis period, and post-crisis. The number of borrowers holds consistent across the first two periods with .006 for 1999-2007 and .008 for 2008-2009 then increase to .014 for 2010-2021. The Borrower FICO Score at Origination shares a similar pattern as the number of borrowers with .007 for 1999-2007 and .009 for 2008-2009 then increase to .017 for 2010-2021.

For Table 13 Panel B logit model contains the following significance level for each variable (number of borrowers, debt-to-income, borrower FICO Score at Origination, Original Loan Term, Loan Age, Remaining Time to Maturity, FTHB, Interest Rate Volatility, Interest Rate Slope,

Interest Rate Level, Inflation Rate, GDP, and Unemployment Rate) comparing by pre-crisis, crisis period, and post-crisis. The original loan term holds consistent across all periods with 1.125 for 1999-2007 and 1.125 for 2008-2009 then increase to 1.129 for 2010-2021. The Borrower FICO Score at Origination has a consistent significance across all periods .005 for 1999-2007 and .005 for 2008-2009 then increase to .009 for 2010-2021

Table 14, which contains the First-Time Homebuyer population, displays in Panel A the probit model contains the following significance level for each variable (number of borrowers, debt-to-income, borrower FICO Score at Origination, Original Loan Term, Loan Age, Remaining Time to Maturity, FTHB, Interest Rate Volatility, Interest Rate Slope, Interest Rate Level, Inflation Rate, GDP, and Unemployment Rate) comparing by pre-crisis, crisis period, and post-crisis. The number of borrowers holds consistent across the first two periods with .003 for 1999-2007 and .002 for 2008-2009 then increase to .012 for 2010-2021. The Borrower FICO Score at Origination begins with .025 for 1999-2007 and .214 for 2008-2009 then decrease to .013 for 2010-2021.

For Table 14, which contains the First-Time Homebuyer population, displays in Panel B logit model contains the following significance level for each variable (number of borrowers, debt-to-income, borrower FICO Score at Origination, Original Loan Term, Loan Age, Remaining Time to Maturity, FTHB, Interest Rate Volatility, Interest Rate Slope, Interest Rate Level, Inflation Rate, GDP, and Unemployment Rate) comparing by pre-crisis, crisis period, and post-crisis. The remaining time to maturity holds consistent across all periods with 0.169 for 1999-2007 and 0.166 for 2008-2009 then increase to 0.173 for 2010-2021. The Borrower FICO Score at Origination has a consistent significance across all periods .040 for 1999-2007 and .006 for 2008-2009 then increase to .013 for 2010-2021.

# Chapter VIII

# Pandemic Impacts

## 8.1 Pandemic Impacts: Full Sample

The COVID19 pandemic has had significant impact on the global economy and forced many industries to come to a halt in production. With such an effect, this also effect the employment rate for many Americans. During the pandemic jobs lost began to increase, this causes many homeowners to find themselves unable to make mortgage payment, which has had significant influence on the mortgage modification rate. The analysis gathered is used to show what role the pandemic in the economy downturn, and from using previous crisis recovery such as the 2008 mortgage crisis, I expect to observe possible patterns from the COVID19 effects. UB Table 15, I perform a set of subsample analysis by running the baseline regressions similar to those in Table 9 with two panels: one panel for the pre-pandemic period and one panel for pandemic period. In particular, Table 15 contains the following information of comparing the significance level of each variable (number of borrowers, debt-to-income, borrower FICO Score at Origination, Original Loan Term, Loan Age, Remaining Time to Maturity, FTHB, Interest Rate Volatility, Interest Rate Slope, Interest Rate Level, Inflation Rate, GDP, and Unemployment Rate) before the pandemic and during the pandemic. Beginning with Panel A probit model, the debt-to-income holds consistent across both periods with 0.857 for 1999-2019 and 0.860 for 2020-2021. The Borrower FICO Score at Origination has a relatively low significance between the two periods .005 for 1999-2019 and .008 for 2020-2021. The number of borrowers mirrors the Borrower FICO Score at Origination significance level between the two periods .004 for 1999-2019 and .007 for 2020-2021. Lastly, in Panel B logit model, the debt-to-income holds consistent across both periods with 0.915 for 1999-2019 and 0.918 for 2020-2021. The Borrower FICO Score at Origination has

a relatively low significance between the two periods .005 for 1999-2019 and .008 for 2020-2021. The number of borrowers mirrors the Borrower FICO Score at Origination significance level between the two periods .008 for 1999-2019 and .011 for 2020-2021.

## 8.2 Pandemic Impacts: First-Time Home Buyers

As most global citizens experienced a tremendous impact from the pandemic, first-time homebuyers were no spared during the economic downtown. In Table 16, I analyze the pandemic impacts for the first-time homebuyers using the same comparison as the full sample presented in Table 15, which contains the following information of comparing the significance level of each variable (number of borrowers, debt-to-income, borrower FICO Score at Origination, Original Loan Term, Loan Age, Remaining Time to Maturity, FTHB, Interest Rate Volatility, Interest Rate Slope, Interest Rate Level, Inflation Rate, GDP, and Unemployment Rate) before the pandemic and during the pandemic. Beginning with Panel A probit model, the remaining time to maturity holds consistent across both periods with 0.124 for 1999-2019 and 0.126 for 2020-2021. The Borrower FICO Score at Origination has a relatively low significance between the two periods .032 for 1999 2019 and .013 for 2020-2021. The number of borrowers mirrors the Borrower FICO Score at Origination significance level between the two periods .010 for 1999-2019 and .012 for 2020 2021. Lastly, in Panel B logit model for first-time homebuyers, the debt-to-income holds consistent across both periods with 0.915 for 1999-2019 and 0.921 for 2020-2021. The Borrower FICO Score at Origination has a relatively low significance between the two periods .005 for 1999-2019 and .011 for 2020-2021. The number of borrowers mirrors the Borrower FICO Score at Origination significance level between the two periods .008 for 1999-2019 and .014 for 2020-2021.

## Chapter IX

## Future Research

I would like to incorporate the modification loss amount to measure the impact of homeowners going through the modification process. Providing this analysis, I anticipate providing the impacts a modification has on the financial institutions. Whenever a borrower completes a modification, the mortgage companies most likely experience a significant financial loss. Considering this loss is much smaller than a homeowner forced to foreclose on their home, it is still a measure worth examining. The cumulative modification loss amount can shed additional light to the loan modification outcomes and the determinants of modification rates beyond what can be discerned from the modification rate as shown above. The analysis should include a set of subsample analysis by running the baseline regressions shown in Table 9 through Table 16 using the modification loss amount as the new dependent variable. I note that the FNMA loan portfolio data has very limited information on the modification loss amount variable. The majority of the observations for this variable is missing. As a result, this analysis should be considered for future research using an alternative data source with valid data on the modification loss amount.

## Chapter X

## Conclusion

This study examined the FNMA home loan mortgage modification process over the most recent time period of 21 years from 1999-2021. I examine the pattern of loan modification rates over time and the main determinants leading to a homeowner to modify his/her home mortgage loan. Sample loan count experiences rises and falls and seems to exhibit waves with heights near the recessionary periods. Interestingly, the proportion of loans initiated by the first-time home buyer loans is generally lower in the contraction periods. The modification rate remains steady over time but seems to show a run-up during the period leading up to a recession. I find a similar pattern in modification rate over time for the first-time home buyer loans.

The recessionary periods that occurred in the US deeply affected the economy and each financial sector. I first hypothesize that economic indicators such as the unemployment rate and being the first-time homebuyer are important drivers of loan modification rate on residential mortgage loans. The results suggest that unemployment rate has a positive and significant impact on loan modification rate, while first time home buyers are more likely to experience a loan modification process. When looking at the first-time home buyer loans only, I observe that the set of determinants of loan modification for the first-time home buyer loans is similar to that for the full sample. I also hypothesize that loan modification patterns and factors driving the loan modification rate are significantly different across the business cycles containing the expansionary and recessionary periods. The results suggest that the loan modification rates do differ between boom and bust periods. The set of drivers of loan modification rates is not significantly different between the boom and bust periods. However, the impacts of the drivers on loan modification are stronger in the bust periods than in the boom periods.

Moreover, I explore if the loan modification rates differ across the pre-crisis, crisis, and post-crisis periods. Similarly, the set of drivers of loan modification rates is not significantly different among the three periods. However, the impacts of the drivers on loan modification are strongest during the crisis period, which is intuitive and makes economic sense. Lastly, I examine whether the loan modification rate and its factors are significantly different before and during the pandemic. The results show that the set of determinants and their impacts on loan modification remain similar before and during the pandemic. A clear understanding of the mortgage modification rates and outcomes is important to shed light on the preventive measures against loan defaults and how these measures should be revised dynamically based on the state of the economy. A healthy loan market is closely tied to the housing market, with both having a strong interlocking relation with the stability of the financial system.

## Figures

### Figure 1. FNMA Single-Family Loans: Full Sample

This figure represents the number of FNMA single-family loans for the full sample during the time periods of 1999 – 2021. Loan counts are displayed on the vertical axis and represents the number of loans in the FNMA mortgage loan portfolio. Year appears on the horizontal axis and indicates the beginning year of 1999 and the ending year of 2021 for the sample period.

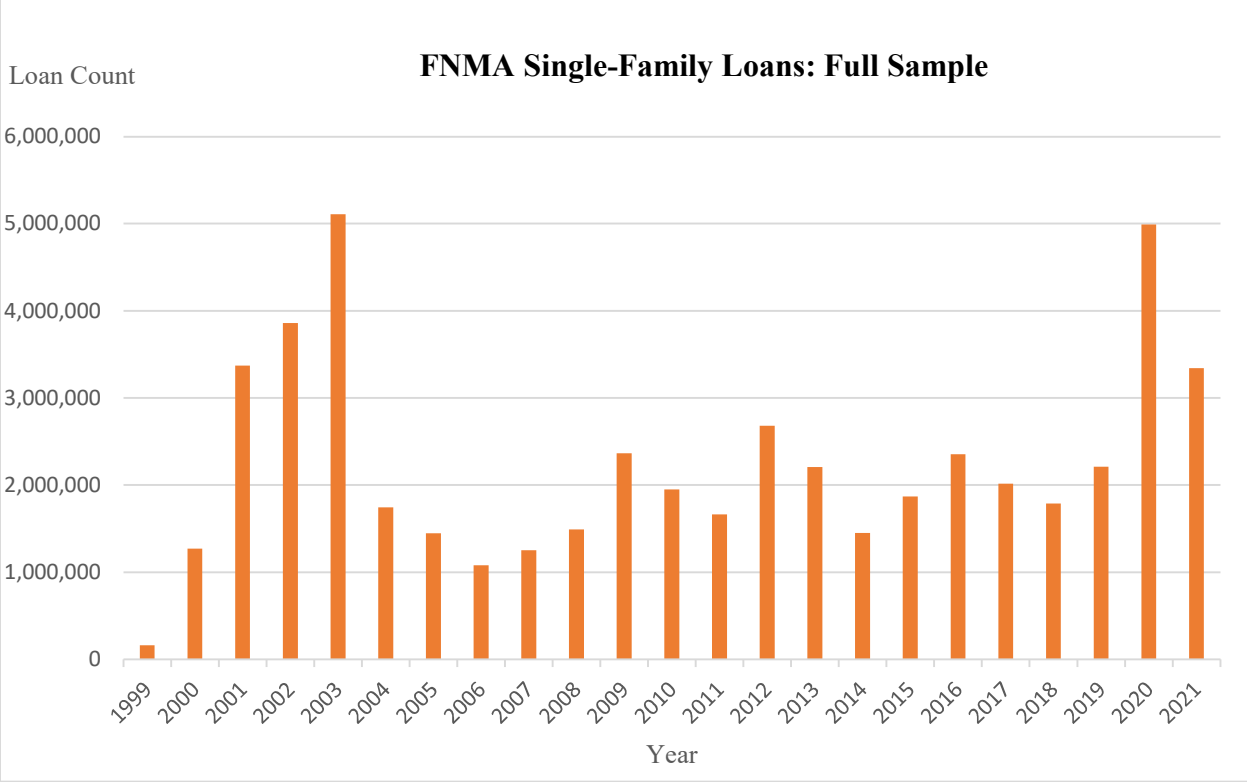


**Figure 2. FNMA Single-Family Loans: First-Time Home Buyers**

This figure represents the number of FNMA single-family loans for the first-time home buyers during the time periods of 1999 – 2021. Loan counts are displayed on the vertical axis and represents the number of loans in the FNMA mortgage loan portfolio. Year appears on the horizontal axis and indicates the beginning year of 1999 and the ending year of 2021 for the sample period.

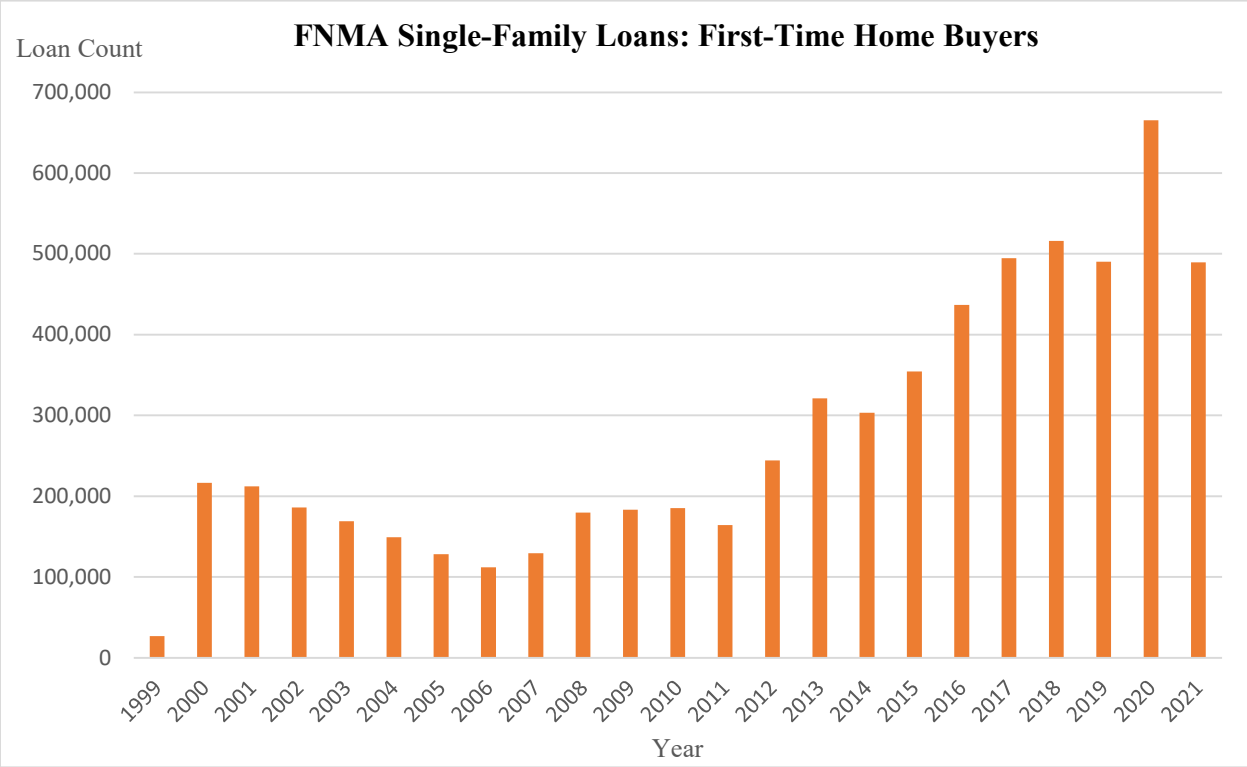


**Figure 3. Number of FNMA Modified Loans: Full Sample**

This figure represents the number of FNMA single-family loans that were modified during the time periods of 1999 – 2020. Loan counts are displayed on the vertical axis and represents the number of loans in the FNMA mortgage loan portfolio. Year appears on the horizontal axis and indicates the beginning year of 1999 and the ending year of 2020 for the sample period.

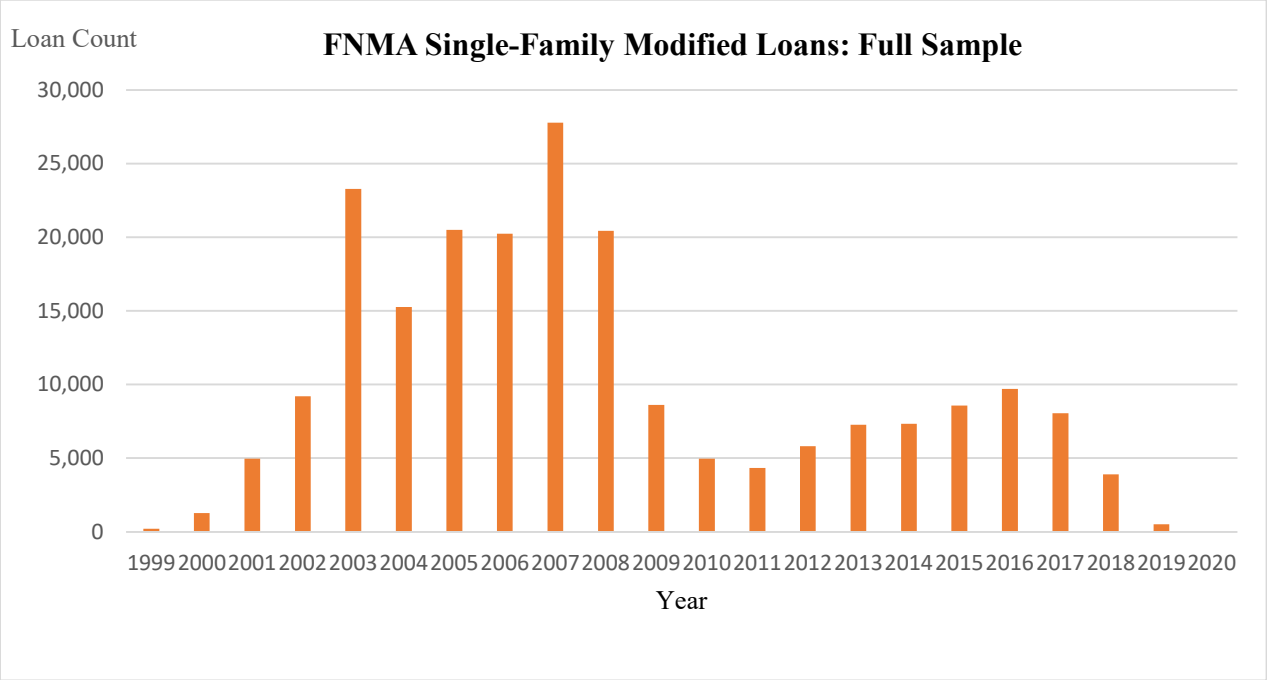
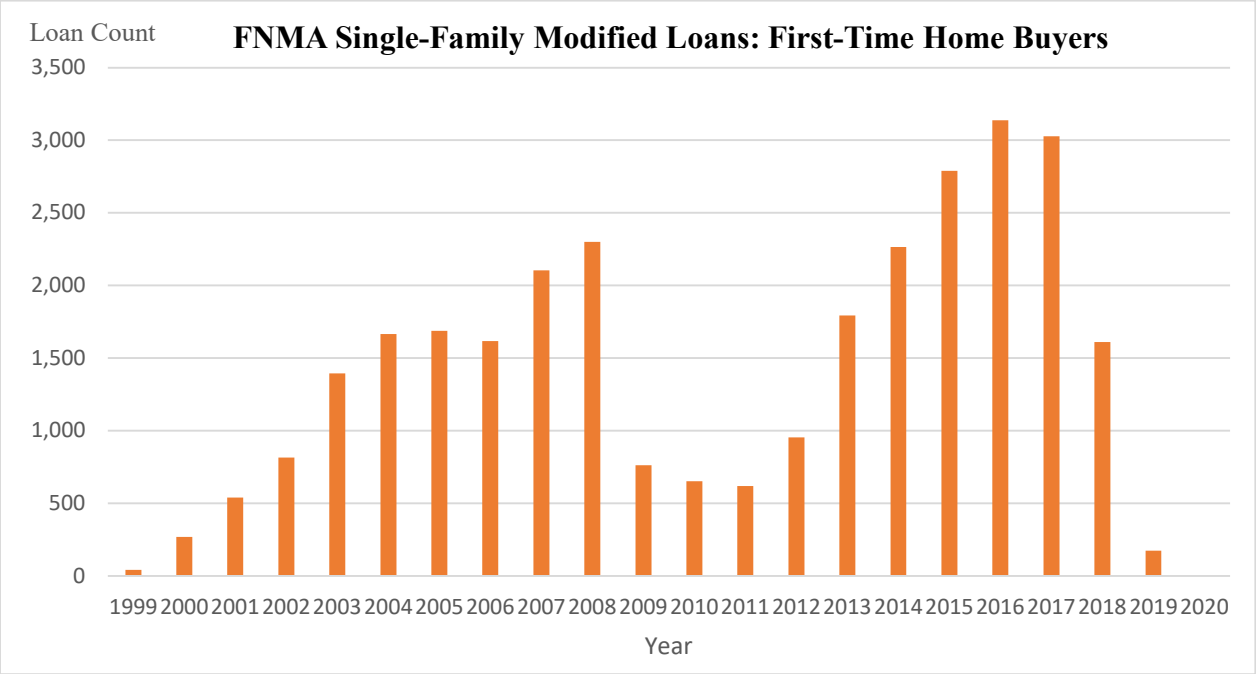


**Figure 4. Number of FNMA Modified Loans: First-Time Homebuyers**

This figure represents the number of FNMA single-family first-time home buyer loans that were modified during the time periods of 1999 – 2020. Loan counts are displayed on the vertical axis and represents the number of loans in the FNMA mortgage loan portfolio. Year appears on the horizontal axis and indicates the beginning year of 1999 and the ending year of 2020 for the sample period.



## Tables

### Table 1. FNMA Single-Family Loans: Full Sample

In this table, I provide the loan count by year of the FNMA single-family loans from the time-period of 1999 – 2021. I also report the average borrower FICO score, average borrower LTV (Loan-to-Value), and average borrower DTI. Highlighted are the years defined as bust or recessionary years as defined by the National Bureau of Economics (NBER).

| Year | Full Sample Loan Count | Average FICO | Average LTV | Average DTI |
|---|---|---|---|---|
| 1999 | 160,138 | 717 | 77.5% | 34.4% |
| 2000 | 1,268,238 | 719 | 77.7% | 35.4% |
| 2001 | 3,371,992 | 722 | 72.8% | 33.3% |
| 2002 | 3,857,380 | 727 | 69.4% | 32.9% |
| 2003 | 5,107,654 | 729 | 67.1% | 32.6% |
| 2004 | 1,744,573 | 723 | 69.3% | 35.7% |
| 2005 | 1,446,029 | 726 | 69.7% | 37.6% |
| 2006 | 1,080,688 | 725 | 70.5% | 38.8% |
| 2007 | 1,252,482 | 725 | 72.2% | 38.9% |
| 2008 | 1,491,789 | 745 | 71.7% | 37.9% |
| 2009 | 2,363,088 | 764 | 66.3% | 33.6% |
| 2010 | 1,951,208 | 769 | 66.7% | 31.8% |
| 2011 | 1,661,838 | 769 | 68.3% | 32.1% |
| 2012 | 2,680,124 | 772 | 68.9% | 31.1% |
| 2013 | 2,207,361 | 764 | 72.4% | 32.6% |
| 2014 | 1,449,702 | 753 | 76.4% | 34.2% |
| 2015 | 1,869,437 | 755 | 75.0% | 33.7% |
| 2016 | 2,353,813 | 758 | 73.6% | 33.5% |
| 2017 | 2,014,548 | 751 | 76.2% | 35.4% |
| 2018 | 1,787,446 | 749 | 77.8% | 37.6% |
| 2019 | 2,211,117 | 756 | 75.9% | 35.8% |
| 2020 | 4,990,333 | 766 | 71.1% | 33.5% |
| 2021 | 3,341,140 | 762 | 69.3% | 34.0% |
| **Total** | **51,662,118** | **750** | **71.5%** | **34.1%** |

Bust Year

**Table 2. FNMA Single-Family Loans: First-Time Home Buyers**

In this table, I provide the loan count by year of the single-family FNMA loans for first-time home buyers (FTHB) from the time-period of 1999 – 2021. I also report the percentage of first-time home buyer loan count out of the full sample loan count, average borrower FICO score, average borrower LTV (Loan-to-Value), and average borrower DTI. Highlighted are the years defined as bust or recessionary years as defined by the National Bureau of Economics (NBER).

| Year | FTHB Loan Count | % Of Full Sample | Average FICO | Average LTV | Average DTI |
|---|---|---|---|---|---|
| 1999 | 26,555 | 17% | 715 | 85.1% | 34.6% |
| 2000 | 216,544 | 17% | 717 | 84.8% | 35.4% |
| 2001 | 212,046 | 6% | 718 | 84.6% | 34.5% |
| 2002 | 186,051 | 5% | 720 | 83.7% | 34.8% |
| 2003 | 168,862 | 3% | 722 | 83.3% | 35.1% |
| 2004 | 149,056 | 9% | 725 | 81.5% | 36.7% |
| 2005 | 127,949 | 9% | 731 | 79.5% | 37.3% |
| 2006 | 111,884 | 10% | 731 | 79.3% | 37.9% |
| 2007 | 129,180 | 10% | 731 | 80.3% | 38.4% |
| 2008 | 179,569 | 12% | 746 | 81.3% | 38.5% |
| 2009 | 183,255 | 8% | 758 | 78.0% | 35.4% |
| 2010 | 185,211 | 9% | 762 | 77.5% | 33.6% |
| 2011 | 164,143 | 10% | 760 | 80.4% | 33.3% |
| 2012 | 244,284 | 9% | 760 | 82.5% | 32.4% |
| 2013 | 321,102 | 15% | 755 | 84.4% | 32.4% |
| 2014 | 303,385 | 21% | 748 | 85.3% | 34.0% |
| 2015 | 354,233 | 19% | 749 | 86.4% | 33.9% |
| 2016 | 436,804 | 19% | 750 | 86.6% | 33.9% |
| 2017 | 494,583 | 25% | 748 | 86.9% | 35.3% |
| 2018 | 515,924 | 29% | 747 | 87.9% | 37.4% |
| 2019 | 490,348 | 22% | 750 | 88.2% | 36.4% |
| 2020 | 665,291 | 13% | 755 | 87.9% | 34.9% |
| 2021 | 489,468 | 15% | 755 | 87.3% | 35.2% |
| **Total** | **5,809,685** | **12%** | **747** | **85.1%** | **35.2%** |

Bust Year

**Table 3. FNMA Single-Family Modified Loans: Full Sample**

In this table, I provide the loan count for the FNMA single-family loans that received a modification during the time-period of 1999 – 2020. I also report the percent of the modified loan count out of the full sample loan count, average borrower FICO score, average borrower LTV (Loan-to-Value), and average borrower DTI. Highlighted are the years defined as bust or recessionary years as defined by the National Bureau of Economics (NBER).

| Year | Modified Loan Count | % Of Full Sample | Average FICO | Average LTV | Average DTI |
|---|---|---|---|---|---|
| 1999 | 206 | 0.13% | 654 | 80.6% | 36.8% |
| 2000 | 1,268 | 0.10% | 654 | 82.0% | 36.6% |
| 2001 | 4,972 | 0.15% | 667 | 79.9% | 36.4% |
| 2002 | 9,204 | 0.24% | 673 | 77.5% | 37.4% |
| 2003 | 23,277 | 0.46% | 680 | 74.9% | 37.8% |
| 2004 | 15,266 | 0.88% | 678 | 74.9% | 40.6% |
| 2005 | 20,498 | 1.42% | 680 | 73.4% | 42.3% |
| 2006 | 20,247 | 1.87% | 676 | 72.9% | 43.2% |
| 2007 | 27,782 | 2.22% | 675 | 75.1% | 43.8% |
| 2008 | 20,436 | 1.37% | 692 | 76.2% | 44.9% |
| 2009 | 8,626 | 0.37% | 714 | 72.8% | 42.0% |
| 2010 | 4,970 | 0.25% | 718 | 73.7% | 37.6% |
| 2011 | 4,334 | 0.26% | 715 | 75.4% | 37.4% |
| 2012 | 5,818 | 0.22% | 718 | 77.6% | 36.9% |
| 2013 | 7,265 | 0.33% | 710 | 80.3% | 37.2% |
| 2014 | 7,339 | 0.51% | 698 | 82.8% | 38.1% |
| 2015 | 8,576 | 0.46% | 697 | 82.6% | 38.1% |
| 2016 | 9,708 | 0.41% | 700 | 82.6% | 38.4% |
| 2017 | 8,051 | 0.40% | 695 | 83.4% | 39.8% |
| 2018 | 3,907 | 0.22% | 689 | 84.8% | 41.9% |
| 2019 | 524 | 0.02% | 716 | 82.1% | 40.4% |
| 2020 | 29 | 0.00% | 731 | 76.3% | 40.3% |
| **Total** | **212,303** | **0.44%** | **688** | **76.8%** | **40.9%** |

Bust Year

**Table 4. FNMA Single-Family Modified Loans: First-Time Home Buyers**

In this table, I provide the loan count for the FNMA single-family first-time home buyer (FTHB) loans that received a modification during the time-period of 1999 – 2020. I also report the percent of the modified loan count out of the full sample loan count, average borrower FICO score, average borrower LTV (Loan-to-Value), and average borrower DTI. Highlighted are the years defined as bust or recessionary years as defined by the National Bureau of Economics (NBER).

| Year | FTHB Modified Loan Count | % Of FTHB Loans | Average FICO | Average LTV | Average DTI |
|---|---|---|---|---|---|
| 1999 | 40 | 0.02% | 658 | 86.0% | 34.1% |
| 2000 | 268 | 0.02% | 662 | 87.8% | 36.0% |
| 2001 | 538 | 0.02% | 663 | 87.6% | 35.6% |
| 2002 | 815 | 0.02% | 674 | 88.2% | 36.7% |
| 2003 | 1,394 | 0.03% | 682 | 87.9% | 38.3% |
| 2004 | 1,664 | 0.10% | 685 | 86.3% | 40.8% |
| 2005 | 1,687 | 0.12% | 691 | 83.7% | 41.9% |
| 2006 | 1,617 | 0.15% | 686 | 83.5% | 43.5% |
| 2007 | 2,103 | 0.17% | 683 | 84.4% | 44.5% |
| 2008 | 2,299 | 0.15% | 701 | 86.2% | 45.1% |
| 2009 | 761 | 0.03% | 713 | 79.6% | 42.2% |
| 2010 | 651 | 0.03% | 716 | 80.2% | 38.1% |
| 2011 | 617 | 0.04% | 710 | 82.6% | 37.9% |
| 2012 | 952 | 0.04% | 715 | 85.4% | 36.9% |
| 2013 | 1,793 | 0.08% | 709 | 87.4% | 37.4% |
| 2014 | 2,264 | 0.16% | 699 | 88.8% | 37.9% |
| 2015 | 2,789 | 0.15% | 697 | 89.4% | 37.8% |
| 2016 | 3,138 | 0.13% | 701 | 90.8% | 38.5% |
| 2017 | 3,027 | 0.15% | 697 | 91.5% | 39.7% |
| 2018 | 1,609 | 0.09% | 693 | 92.4% | 41.7% |
| 2019 | 173 | 0.01% | 711 | 92.2% | 41.3% |
| 2020 | 1 | 0.00% | 747 | 92.0% | 49.0% |
| **Total** | **30,200** | **0.06%** | **696** | **87.7%** | **40.1%** |

Bust Year

**Table 5. FNMA Single-Family Loans and Modification Rate: Full Sample versus First-Time Home Buyers**

In this table, I provide the comparison of the full sample loans with the first-time home buyer loans. I report the loan count, modification loan count, and the modification rate for the full sample loans and the first-time home buyer loans, respectively. Highlighted are the years defined as bust or recessionary years as defined by the National Bureau of Economics (NBER).

| Year | Full Sample Loan Count | Modified Loan Count | Modification Rate | FTHB Loan Count | FTHB Modified Loan Count | FTHB Modification Rate |
|---|---|---|---|---|---|---|
| 1999 | 160,138 | 206 | 0.13% | 26,555 | 40 | 0.02% |
| 2000 | 1,268,238 | 1,268 | 0.10% | 216,544 | 268 | 0.02% |
| 2001 | 3,371,992 | 4,972 | 0.15% | 212,046 | 538 | 0.02% |
| 2002 | 3,857,380 | 9,204 | 0.24% | 186,051 | 815 | 0.02% |
| 2003 | 5,107,654 | 23,277 | 0.46% | 168,862 | 1,394 | 0.03% |
| 2004 | 1,744,573 | 15,266 | 0.88% | 149,056 | 1,664 | 0.10% |
| 2005 | 1,446,029 | 20,498 | 1.42% | 127,949 | 1,687 | 0.12% |
| 2006 | 1,080,688 | 20,247 | 1.87% | 111,884 | 1,617 | 0.15% |
| 2007 | 1,252,482 | 27,782 | 2.22% | 129,180 | 2,103 | 0.17% |
| 2008 | 1,491,789 | 20,436 | 1.37% | 179,569 | 2,299 | 0.15% |
| 2009 | 2,363,088 | 8,626 | 0.37% | 183,255 | 761 | 0.03% |
| 2010 | 1,951,208 | 4,970 | 0.25% | 185,211 | 651 | 0.03% |
| 2011 | 1,661,838 | 4,334 | 0.26% | 164,143 | 617 | 0.04% |
| 2012 | 2,680,124 | 5,818 | 0.22% | 244,284 | 952 | 0.04% |
| 2013 | 2,207,361 | 7,265 | 0.33% | 321,102 | 1,793 | 0.08% |
| 2014 | 1,449,702 | 7,339 | 0.51% | 303,385 | 2,264 | 0.16% |
| 2015 | 1,869,437 | 8,576 | 0.46% | 354,233 | 2,789 | 0.15% |
| 2016 | 2,353,813 | 9,708 | 0.41% | 436,804 | 3,138 | 0.13% |
| 2017 | 2,014,548 | 8,051 | 0.40% | 494,583 | 3,027 | 0.15% |
| 2018 | 1,787,446 | 3,907 | 0.22% | 515,924 | 1,609 | 0.09% |
| 2019 | 2,211,117 | 524 | 0.02% | 490,348 | 173 | 0.01% |
| 2020 | 4,563,123 | 29 | 0.00% | 608,717 | 1 | 0.00% |
| **Total** | **47,893,768** | **212,303** | 0.44% | **5,809,685** | **30,200** | 0.06% |

Bust Year

**Table 6. Characteristics of FNMA Single-Family Loans: Full Sample**

In this table, I provide the characteristics of the full sample of 76,933,527 FNMA single-family loan-year observations for the time period of 1999 – 2021. I report the descriptive statistics of each of the following variables: Number of borrowers, Debt-to-Income ratio, borrower FICO score at loan origination, original loan terms in months, loan age in months, remaining time to maturity in months, and the FTHB dummy variable. FTHB equals one if the loan is a first-time home buyer loan and zero otherwise.

| | Mean | Median | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| No of Borrowers | 1.49 | 1.00 | 0.52 | 1.00 | 10.00 |
| Debt-to-Income Ratio | 38.32 | 39.00 | 12.72 | 0.00 | 64.00 |
| FICO Score at Origination | 728.61 | 736.00 | 57.04 | 340.00 | 850.00 |
| Original Loan Term (months) | 322.24 | 360.00 | 72.81 | 60.00 | 360.00 |
| Loan Age (months) | 41.81 | 30.00 | 37.29 | 0.00 | 232.00 |
| Remaining Time to Maturity (months) | 276.58 | 317.00 | 87.86 | 0.00 | 480.00 |
| FTHB | 0.12 | 0.00 | 0.32 | 0.00 | 1.00 |

**Table 7. Characteristics of FNMA Single-Family Loans: First-Time Home Buyers**

In this table, I provide the characteristics of the full sample of 8,877,484 FNMA single-family loan-year observations for the first-time home buyers for the time period of 1999 – 2021. I report the descriptive statistics of each of the following variables: Number of borrowers, Debt-to-Income ratio, borrower FICO score at loan origination, original loan terms in months, loan age in months, remaining time to maturity in months, and the FTHB dummy variable. FTHB equals one if the loan is a first-time home buyer loan and zero otherwise.

| | Mean | Median | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| No of Borrowers | 1.37 | 1.00 | 0.51 | 1.00 | 10.00 |
| Debt-to-Income Ratio | 38.77 | 39.00 | 11.76 | 1.00 | 64.00 |
| FICO Score at Origination | 731.76 | 739.00 | 53.13 | 340.00 | 850.00 |
| Original Loan Term (months) | 347.27 | 360.00 | 45.71 | 60.00 | 360.00 |
| Loan Age (months) | 40.34 | 29.00 | 36.31 | 0.00 | 193.00 |
| Remaining Time To Maturity (months) | 302.13 | 327.00 | 68.02 | 0.00 | 459.00 |
| FTHB | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 |

**Table 8. Variable Correlation of FNMA Single-Family Loan Characteristics**

In this table, I provide the Pearson Correlation of the FNMA single-family loan characteristics of the full sample of 76,933,527 FNMA single-family loan-year observations and first-time home buyer sample of 8,877,484 loan years, respectively. The sample period is from 1999 to 2021. For each sample, I report the correlation estimates of the following variables: Number of borrowers, Debt-to-Income ratio, borrower FICO score at loan origination, original loan terms, loan age, and remaining time to maturity.

**Panel A: Full Sample**

| | No of Borrowers | Debt-to-Income | FICO Score at Origination | Original Loan Term | Loan Age | Remaining Time To Maturity |
|---|---|---|---|---|---|---|
| No of Borrowers | 1.000 | -0.116** | 0.046** | -0.078** | -0.065** | -0.036** |
| Debt-to-Income | -0.145 | 1.000 | -0.160** | 0.159** | -0.074** | 0.192** |
| FICO Score at Origination | 0.046** | -0.160** | 1.000 | 0.019** | -0.230** | 0.084** |
| Original Loan Term | -0.078** | 0.159** | 0.019** | 1.000 | -0.034** | 0.793** |
| Loan Age | -0.065** | -0.074** | -0.230** | -0.034** | 1.000 | -0.573** |
| Remaining Time To Maturity | -0.036** | 0.192** | 0.084** | 0.793** | -0.573** | 1.000 |

**Panel B: First-Time Home Buyer Sample**

| | No of Borrowers | Debt-to-Income | FICO Score at Origination | Original Loan Term | Loan Age | Remaining Time To Maturity |
|---|---|---|---|---|---|---|
| No of Borrowers | 1.000 | -0.075** | 0.007** | 0.003** | -0.095** | 0.071** |
| Debt-to-Income | -0.075** | 1.000 | -0.079** | 0.106** | -0.060** | 0.143** |
| FICO Score at Origination | 0.007** | -0.079** | 1.000 | -0.072** | -0.115** | -0.015** |
| Original Loan Term | 0.003** | 0.106** | -0.072** | 1.000 | -0.005** | 0.658** |
| Loan Age | -0.095** | -0.060** | -0.115** | -0.005** | 1.000 | -0.686** |
| Remaining Time To Maturity | 0.071** | 0.143** | -0.015** | 0.658** | -0.686** | 1.000 |

**Table 9. Baseline Regressions of Loan Modification on Loan Characteristics and Macroeconomic Factors: Full Sample**

The table presents the baseline regression of loan modification on loan characteristics and macroeconomic factors for the full sample of 76,933,527 FNMA single-family loan-year observations from 1999 to 2021. Panel A presents the Probit regression results and Panel B reports the Logit regression results. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

**Panel A: Probit Model**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.002 | 0.001 | 0.041 | ** |
| Debt-To-Income | 0.874 | 0.332 | 0.015 | ** |
| Borrower FICO Score at Origination | 0.023 | 0.418 | 0.011 | ** |
| Original Loan Term | 1.745 | 0.367 | 0.001 | *** |
| Loan Age | 0.589 | 0.393 | 0.170 | |
| Remaining Time To Maturity | 0.111 | 1.138 | 0.000 | *** |
| FTHB | 0.152 | 0.418 | 0.012 | ** |
| Interest Rate Volatility | 0.001 | 0.001 | 0.591 | |
| Interest Rate Slope | 0.002 | 0.255 | 0.000 | *** |
| Interest Rate Level | 0.141 | 0.638 | 0.012 | ** |
| Inflation Rate | 0.022 | 0.687 | 0.874 | |
| GDP | 0.010 | 0.001 | 0.542 | |
| Unemployment Rate | 0.010 | 0.358 | 0.021 | ** |

*Adjusted R square: 0.41*

**Table 9. Baseline Regressions of Loan Modification on Loan Characteristics and Macroeconomic Factors: Full Sample**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.002 | 0.001 | 0.038 | ** |
| Debt-To-Income | 0.804 | 0.332 | 0.015 | ** |
| Borrower FICO Score at Origination | 0.001 | 0.418 | 0.011 | ** |
| Original Loan Term | 1.120 | 0.367 | 0.001 | *** |
| Loan Age | 0.211 | 0.393 | 0.170 | |
| Remaining Time To Maturity | 0.111 | 1.138 | 0.000 | *** |
| FTHB | 0.152 | 0.418 | 0.012 | ** |
| Interest Rate Volatility | 0.001 | 0.001 | 0.591 | |
| Interest Rate Slope | 0.002 | 0.255 | 0.000 | *** |
| Interest Rate Level | 0.141 | 0.638 | 0.012 | ** |
| Inflation Rate | 0.022 | 0.687 | 0.874 | |
| GDP | 0.010 | 0.001 | 0.542 | |
| Unemployment Rate | 0.010 | 0.358 | 0.021 | ** |

**(Continued)**

**Table 10. Baseline Regressions of Loan Modification on Loan Characteristics and Macroeconomic Factors: First-Time Home Buyer Sample**

The table presents the baseline regression of loan modification on loan characteristics and macroeconomic factors for the first-time home buyer sample of 8,877,484 FNMA single-family loan years observations from 1999 to 2021. Panel A presents the Probit regression results and Panel B reports the Logit regression results. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

**Panel A: Probit Model**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.020 | 0.013 | 0.047 | ** |
| Debt-To-Income | 0.872 | 0.344 | 0.024 | ** |
| Borrower FICO Score at Origination | 0.019 | 0.497 | 0.020 | ** |
| Original Loan Term | 1.138 | 0.379 | 0.010 | *** |
| Loan Age | 0.229 | 0.405 | 0.179 | |
| Remaining Time to Maturity | 0.129 | 1.150 | 0.009 | *** |
| Interest Rate Volatility | 0.229 | 0.405 | 0.600 | |
| Interest Rate Slope | 0.020 | 0.267 | 0.009 | *** |
| Interest Rate Level | 0.192 | 0.650 | 0.021 | ** |
| Inflation Rate | 0.040 | 0.699 | 0.883 | |
| GDP | 0.028 | 0.013 | 0.551 | |
| Unemployment Rate | 0.028 | 0.857 | 0.030 | ** |

*Adjusted R square: 0.48*

**Table 10. Baseline Regressions of Loan Modification on Loan Characteristics and Macroeconomic Factors: First-Time Home Buyer Sample (Continued)**

**Panel B: Logit Model**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.014 | 0.054 | 0.060 | * |
| Debt-To-Income | 0.920 | 0.348 | 0.105 | |
| Borrower FICO Score at Origination | 0.009 | 0.967 | 0.056 | * |
| Original Loan Term | 1.128 | 0.152 | 0.035 | ** |
| Loan Age | 0.219 | 0.358 | 0.204 | |
| Remaining Time to Maturity | 0.166 | 1.145 | 0.015 | ** |
| Interest Rate Volatility | 0.371 | 0.013 | 0.667 | |
| Interest Rate Slope | 0.010 | 0.264 | 0.015 | ** |
| Interest Rate Level | 0.149 | 0.648 | 0.027 | ** |
| Inflation Rate | 0.040 | 0.698 | 0.889 | |
| GDP | 0.018 | 0.013 | 0.557 | |
| Unemployment Rate | 0.018 | 0.371 | 0.036 | ** |

**Table 11. Loan Modification and Its Determinants:**
**A Comparison between Boom and Bust Years using the Full Sample**

The table presents a comparison of the regression results of loan modification on loan characteristics and macroeconomic factors between the Boom and Bust periods. The sample used is the full sample of 76,933,527 FNMA single-family loan-year observations from 1999 to 2021. Bust or recessionary years as defined by the National Bureau of Economics (NBER) include 2001, 2008, 2009, 2020, and 2021. The remaining years are regarded as Boom years. Panel A presents the Probit regression results and Panel B reports the Logit regression results. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

**Panel A1: Probit Model – Boom Years**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.052 | 0.061 | 0.059 | * |
| Debt-To-Income | 0.905 | 0.393 | 0.036 | ** |
| Borrower FICO Score at Origination | 0.053 | 0.547 | 0.032 | ** |
| Original Loan Term | 1.173 | 0.430 | 0.022 | ** |
| Loan Age | 0.265 | 0.457 | 0.191 | |
| Remaining Time to Maturity | 0.166 | 1.203 | 0.021 | ** |
| FTHB | 0.208 | 0.484 | 0.033 | ** |
| Interest Rate Volatility | 0.057 | 0.067 | 0.612 | |
| Interest Rate Slope | 0.060 | 0.323 | 0.021 | ** |
| Interest Rate Level | 0.233 | 0.707 | 0.033 | ** |
| Inflation Rate | 0.082 | 0.757 | 0.895 | |
| GDP | 0.071 | 0.072 | 0.563 | |
| Unemployment Rate | 0.072 | 0.917 | 0.042 | ** |

*Adjusted R square: 0.42*

**Table 11. Loan Modification and Its Determinants:**
**A Comparison between Boom and Bust Years using the Full Sample**
**(Continued)**

**Panel A2: Probit Model – Bust Years**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.007 | 0.006 | 0.043 | ** |
| Debt-To-Income | 0.860 | 0.338 | 0.021 | ** |
| Borrower FICO Score at Origination | 0.004 | 0.488 | 0.014 | ** |
| Original Loan Term | 1.122 | 0.369 | 0.003 | *** |
| Loan Age | 0.212 | 0.394 | 0.171 | |
| Remaining Time to Maturity | 0.111 | 1.138 | 0.000 | *** |
| FTHB | 0.151 | 0.417 | 0.011 | ** |
| Interest Rate Volatility | 0.004 | 0.488 | 0.589 | |
| Interest Rate Slope | 0.001 | 0.252 | 0.003 | *** |
| Interest Rate Level | 0.170 | 0.634 | 0.008 | *** |
| Inflation Rate | 0.017 | 0.682 | 0.869 | |
| GDP | 0.004 | -0.005 | 0.536 | |
| Unemployment Rate | 0.003 | 0.838 | 0.014 | ** |

*Adjusted R square: 0.31*

**Table 11. Loan Modification and Its Determinants:**
**A Comparison between Boom and Bust Years using the Full Sample**
**(Continued)**

**Panel B1: Logit Model – Boom Years**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.008 | 0.054 | 0.053 | * |
| Debt-To-Income | 0.922 | 0.347 | 0.098 | * |
| Borrower FICO Score at Origination | 0.019 | 0.966 | 0.049 | ** |
| Original Loan Term | 1.146 | 0.150 | 0.028 | ** |
| Loan Age | 0.245 | 0.355 | 0.197 | |
| Remaining Time to Maturity | 0.200 | 1.141 | 0.007 | *** |
| FTHB | 0.235 | 0.421 | 0.048 | ** |
| Interest Rate Volatility | 0.058 | 0.003 | 0.659 | |
| Interest Rate Slope | 0.068 | 0.258 | 0.007 | *** |
| Interest Rate Level | 0.215 | 0.641 | 0.019 | ** |
| Inflation Rate | 0.114 | 0.690 | 0.881 | |
| GDP | 0.100 | 0.004 | 0.549 | |
| Unemployment Rate | 0.108 | 0.362 | 0.028 | ** |

**Table 11. Loan Modification and Its Determinants:**
**A Comparison between Boom and Bust Years using the Full Sample**
**(Continued)**

**Panel B2: Logit Model – Bust Years**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.026 | 0.061 | 0.062 | * |
| Debt-To-Income | 0.932 | 0.355 | 0.108 | |
| Borrower FICO Score at Origination | 0.004 | 0.974 | 0.060 | * |
| Original Loan Term | 1.124 | 0.159 | 0.040 | ** |
| Loan Age | 0.216 | 0.365 | 0.210 | |
| Remaining Time to Maturity | 0.164 | 1.152 | 0.022 | ** |
| FTHB | 0.192 | 0.433 | 0.064 | * |
| Interest Rate Volatility | 0.008 | 0.016 | 0.676 | |
| Interest Rate Slope | 0.011 | 0.272 | 0.025 | ** |
| Interest Rate Level | 0.151 | 0.656 | 0.038 | ** |
| Inflation Rate | 0.043 | 0.706 | 0.901 | |
| GDP | 0.022 | 0.021 | 0.570 | |
| Unemployment Rate | 0.023 | 0.379 | 0.050 | ** |

**Table 12. Loan Modification and Its Determinants:**
**A Comparison between Boom and Bust Years using the First-Time Home Buyer Sample**

The table presents a comparison of the regression results of loan modification on loan characteristics and macroeconomic factors between the Boom and Bust periods. The sample used is the first-time home buyer sample of 8,877,484 FNMA single-family loan years observations from 1999 to 2021. Bust or recessionary years as defined by the National Bureau of Economics (NBER) include 2001, 2008, 2009, 2020, and 2021. The remaining years are regarded as Boom years. Panel A presents the Probit regression results and Panel B reports the Logit regression results. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

**Panel A1: Probit Model – Boom Years**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.004 | 0.005 | 0.039 | ** |
| Debt-To-Income | 0.857 | 0.337 | 0.017 | ** |
| Borrower FICO Score at Origination | 0.005 | 0.491 | 0.014 | ** |
| Original Loan Term | 1.125 | 0.374 | 0.005 | *** |
| Loan Age | 0.217 | 0.401 | 0.175 | |
| Remaining Time to Maturity | 0.118 | 1.147 | 0.006 | *** |
| Interest Rate Volatility | 0.217 | 0.401 | 0.591 | |
| Interest Rate Slope | 0.011 | 0.266 | 0.008 | *** |
| Interest Rate Level | 0.184 | 0.650 | 0.021 | ** |
| Inflation Rate | 0.033 | 0.700 | 0.884 | |
| GDP | 0.022 | 0.015 | 0.553 | |
| Unemployment Rate | 0.023 | 0.860 | 0.033 | ** |

*Adjusted R square: 0.42*

**Table 12. Loan Modification and Its Determinants:**
**A Comparison between Boom and Bust Years using the First-Time Home Buyer Sample**
**(Continued)**

**Panel A2: Probit Model – Bust Years**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.008 | 0.004 | 0.040 | ** |
| Debt-To-Income | 0.861 | 0.336 | 0.018 | ** |
| Borrower FICO Score at Origination | 0.009 | 0.490 | 0.015 | ** |
| Original Loan Term | 1.129 | 0.373 | 0.006 | *** |
| Loan Age | 0.221 | 0.400 | 0.176 | |
| Remaining Time to Maturity | 0.122 | 1.146 | 0.007 | *** |
| Interest Rate Volatility | 0.012 | 0.009 | 0.599 | |
| Interest Rate Slope | 0.015 | 0.265 | 0.009 | *** |
| Interest Rate Level | 0.188 | 0.649 | 0.022 | ** |
| Inflation Rate | 0.037 | 0.699 | 0.885 | |
| GDP | 0.026 | 0.014 | 0.554 | |
| Unemployment Rate | 0.027 | 0.859 | 0.034 | ** |

*Adjusted R square: 0.39*

**Table 12. Loan Modification and Its Determinants:**
**A Comparison between Boom and Bust Years using the First-Time Home Buyer Sample**
**(Continued)**

**Panel B1: Logit Model – Boom Years**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.010 | 0.055 | 0.052 | * |
| Debt-To-Income | 0.917 | 0.349 | 0.098 | * |
| Borrower FICO Score at Origination | 0.007 | 0.968 | 0.050 | ** |
| Original Loan Term | 1.127 | 0.153 | 0.030 | ** |
| Loan Age | 0.219 | 0.359 | 0.200 | |
| Remaining Time to Maturity | 0.167 | 1.146 | 0.012 | ** |
| Interest Rate Volatility | 0.010 | 0.009 | 0.665 | |
| Interest Rate Slope | 0.013 | 0.265 | 0.014 | ** |
| Interest Rate Level | 0.153 | 0.649 | 0.027 | ** |
| Inflation Rate | 0.045 | 0.699 | 0.890 | |
| GDP | 0.024 | 0.014 | 0.559 | |
| Unemployment Rate | 0.025 | 0.372 | 0.039 | ** |

**Table 12. Loan Modification and Its Determinants:**
**A Comparison between Boom and Bust Years using the First-Time Home Buyer Sample**
**(Continued)**

**Panel B2: Logit Model – Bust Years**

| | Coefficient Estimate | Standard Error | Significance | Significance Level (*/**/***) |
|---|---|---|---|---|
| Number of Borrowers | 0.008 | 0.055 | 0.047 | ** |
| Debt-To-Income | 0.915 | 0.349 | 0.093 | * |
| Borrower FICO Score at Origination | 0.005 | 0.968 | 0.045 | ** |
| Original Loan Term | 1.125 | 0.153 | 0.025 | ** |
| Loan Age | 0.217 | 0.359 | 0.195 | |
| Remaining Time to Maturity | 0.165 | 1.146 | 0.007 | *** |
| Interest Rate Volatility | 0.008 | 0.009 | 0.660 | |
| Interest Rate Slope | 0.011 | 0.265 | 0.009 | *** |
| Interest Rate Level | 0.151 | 0.649 | 0.022 | ** |
| Inflation Rate | 0.043 | 0.699 | 0.885 | |
| GDP | 0.022 | 0.014 | 0.554 | |
| Unemployment Rate | 0.023 | 0.372 | 0.034 | ** |

**Table 13. Loan Modification and Its Determinants:**
**The Impacts of Financial Crisis using the Full Sample**

The table presents a comparison of the regression results of loan modification on loan characteristics and macroeconomic factors across the pre-, during, and post-financial crisis periods. The sample used is the full sample of 76,933,527 FNMA single-family loan-year observations from 1999 to 2021. Pre-crisis period is defined as the period from 1999 to 2007. The financial crisis period is from 2008 to 2009. The post-crisis period is from 2010 to 2021. Panel A presents the Probit regression results and Panel B reports the Logit regression results. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

**Panel A: Probit Model**

| | **1999-2007** | | **2008-2009** | | **2010-2021** | |
|---|---|---|---|---|---|---|
| | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) |
| Number of Borrowers | 0.006 | ** | 0.008 | ** | 0.014 | ** |
| Debt-To-Income | 0.859 | ** | 0.861 | ** | 0.868 | ** |
| Borrower FICO Score at Origination | 0.007 | ** | 0.009 | ** | 0.017 | ** |
| Original Loan Term | 1.127 | *** | 1.129 | *** | 1.138 | ** |
| Loan Age | 0.219 | | 0.221 | | 0.231 | |
| Remaining Time to Maturity | 0.120 | *** | 0.122 | *** | 0.133 | ** |
| FTHB | 0.162 | ** | 0.164 | ** | 0.176 | ** |
| Interest Rate Volatility | 0.011 | | 0.013 | | 0.026 | |
| Interest Rate Slope | 0.014 | *** | 0.016 | ** | 0.030 | ** |
| Interest Rate Level | 0.187 | ** | 0.189 | ** | 0.204 | ** |
| Inflation Rate | 0.036 | | 0.038 | | 0.054 | |
| GDP | 0.025 | | 0.027 | | 0.044 | |
| Unemployment Rate | 0.026 | ** | 0.028 | ** | 0.046 | ** |
| *Adjusted R square:* | *0.40* | | *0.59* | | *0.60* | |

**Table 13. Loan Modification and Its Determinants:**
**The Impacts of Financial Crisis using the Full Sample**
**(Continued)**

**Panel B: Logit Model**

| | 1999-2007 | | 2008-2009 | | 2010-2021 | |
|---|---|---|---|---|---|---|
| | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) |
| Number of Borrowers | 0.008 | ** | 0.008 | ** | 0.012 | ** |
| Debt-To-Income | 0.915 | * | 0.915 | | 0.919 | |
| Borrower FICO Score at Origination | 0.005 | ** | 0.005 | ** | 0.009 | ** |
| Original Loan Term | 1.125 | ** | 1.125 | ** | 1.129 | ** |
| Loan Age | 0.217 | | 0.217 | | 0.221 | |
| Remaining Time to Maturity | 0.165 | *** | 0.165 | *** | 0.169 | *** |
| FTHB | 0.193 | ** | 0.193 | ** | 0.197 | * |
| Interest Rate Volatility | 0.009 | | 0.009 | | 0.013 | |
| Interest Rate Slope | 0.012 | *** | 0.012 | *** | 0.016 | ** |
| Interest Rate Level | 0.152 | ** | 0.152 | ** | 0.156 | ** |
| Inflation Rate | 0.044 | | 0.044 | | 0.048 | |
| GDP | 0.023 | | 0.023 | | 0.027 | |
| Unemployment Rate | 0.024 | ** | 0.024 | ** | 0.028 | ** |

**Table 14. Loan Modification and Its Determinants:**
**The Impacts of Financial Crisis using the First-Time Home Buyer Sample**

The table presents a comparison of the regression results of loan modification on loan characteristics and macroeconomic factors across the pre-, during, and post-financial crisis periods. The sample used is the first-time home buyer sample of 8,877,484 FNMA single-family loan-year observations from 1999 to 2021. Pre-crisis period is defined as the period from 1999 to 2007. The financial crisis period is from 2008 to 2009. The post-crisis period is from 2010 to 2021. Panel A presents the Probit regression results and Panel B reports the Logit regression results. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

**Panel A: Probit Model**

| | **1999-2007** | | **2008-2009** | | **2010-2021** | |
|---|---|---|---|---|---|---|
| | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) |
| Number of Borrowers | 0.003 | ** | 0.002 | ** | 0.012 | ** |
| Debt-To-Income | 0.176 | | 1.122 | ** | 0.865 | ** |
| Borrower FICO Score at Origination | 0.025 | | 0.214 | *** | 0.013 | ** |
| Original Loan Term | 0.014 | *** | 0.115 | | 1.133 | ** |
| Loan Age | 0.216 | | 0.157 | *** | 0.225 | |
| Remaining Time to Maturity | 0.117 | *** | 0.117 | *** | 0.126 | ** |
| Interest Rate Volatility | 0.007 | | 0.007 | | 0.016 | |
| Interest Rate Slope | 0.010 | *** | 0.010 | *** | 0.019 | ** |
| Interest Rate Level | 0.183 | ** | 0.183 | ** | 0.192 | ** |
| Inflation Rate | 0.032 | | 0.032 | | 0.041 | |
| GDP | 0.021 | | 0.021 | | 0.030 | |
| Unemployment Rate | 0.022 | ** | 0.022 | ** | 0.031 | ** |
| *Adjusted R square:* | *0.45* | | *0.48* | | *0.42* | |

**Table 14. Loan Modification and Its Determinants:**
**The Impacts of Financial Crisis using the First-Time Home Buyer Sample**
**(Continued)**

**Panel B: Logit Model**

| | 1999-2007 | | 2008-2009 | | 2010-2021 | |
|---|---|---|---|---|---|---|
| | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) |
| Number of Borrowers | 0.008 | ** | 0.009 | * | 0.016 | * |
| Debt-To-Income | 0.148 | * | 0.916 | | 0.923 | |
| Borrower FICO Score at Origination | 0.040 | ** | 0.006 | * | 0.013 | * |
| Original Loan Term | 0.019 | ** | 1.126 | ** | 1.133 | ** |
| Loan Age | 0.020 | | 0.218 | | 0.225 | |
| Remaining Time to Maturity | 0.169 | *** | 0.166 | ** | 0.173 | ** |
| Interest Rate Volatility | 0.012 | | 0.009 | | 0.016 | |
| Interest Rate Slope | 0.015 | *** | 0.012 | ** | 0.019 | ** |
| Interest Rate Level | 0.155 | ** | 0.152 | ** | 0.159 | ** |
| Inflation Rate | 0.047 | | 0.044 | | 0.051 | |
| GDP | 0.026 | | 0.023 | | 0.030 | |
| Unemployment Rate | 0.027 | ** | 0.022 | ** | 0.031 | ** |

**Table 15. Loan Modification and Its Determinants: The Pandemic Impacts using the Full Sample**

The table presents a comparison of the regression results of loan modification on loan characteristics and macroeconomic factors between the pre-pandemic and pandemic periods. The sample used is the full sample of 76,933,527 FNMA single-family loan-year observations from 1999 to 2021. Pre-pandemic period is from 1999 to 2019. The pandemic period is from 2020 to 2021. Panel A presents the Probit regression results and Panel B reports the Logit regression results. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

**Panel A: Probit Model**

| | **1999-2019** | | **2020-2021** | |
|---|---|---|---|---|
| | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) |
| Number of Borrowers | 0.004 | ** | 0.007 | ** |
| Debt-To-Income | 0.857 | ** | 0.860 | ** |
| Borrower FICO Score at Origination | 0.005 | ** | 0.008 | ** |
| Original Loan Term | 1.125 | ** | 1.128 | ** |
| Loan Age | 0.217 | | 0.220 | |
| Remaining Time to Maturity | 0.118 | ** | 0.121 | ** |
| FTHB | 0.160 | ** | 0.163 | ** |
| Interest Rate Volatility | 0.009 | | 0.012 | |
| Interest Rate Slope | 0.012 | ** | 0.015 | ** |
| Interest Rate Level | 0.185 | ** | 0.188 | ** |
| Inflation Rate | 0.034 | | 0.037 | |
| GDP | 0.023 | | 0.026 | |
| Unemployment Rate | 0.024 | ** | 0.027 | ** |
| *Adjusted R square:* | *0.42* | | *0.47* | |

**Table 15. Loan Modification and Its Determinants:**
**The Pandemic Impacts using the Full Sample**
**(Continued)**

**Panel B: Logit Model**

| | 1999-2019 | | 2020-2021 | |
|---|---|---|---|---|
| | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) |
| Number of Borrowers | 0.008 | * | 0.011 | ** |
| Debt-To-Income | 0.915 | * | 0.918 | |
| Borrower FICO Score at Origination | 0.005 | ** | 0.008 | ** |
| Original Loan Term | 1.125 | ** | 1.128 | ** |
| Loan Age | 0.217 | | 0.220 | |
| Remaining Time to Maturity | 0.165 | ** | 0.168 | ** |
| FTHB | 0.193 | * | 0.196 | * |
| Interest Rate Volatility | 0.009 | | 0.012 | |
| Interest Rate Slope | 0.012 | ** | 0.015 | ** |
| Interest Rate Level | 0.152 | ** | 0.155 | ** |
| Inflation Rate | 0.044 | | 0.047 | |
| GDP | 0.023 | | 0.026 | |
| Unemployment Rate | 0.024 | ** | 0.027 | ** |

**Table 16. Loan Modification and Its Determinants:**
**The Pandemic Impacts using the First-Time Home Buyer Sample**

The table presents a comparison of the regression results of loan modification on loan characteristics and macroeconomic factors between the pre-pandemic and pandemic periods. The sample used is the full sample of 8,877,484 FNMA single-family loan-year observations from 1999 to 2021. Pre-pandemic period is from 1999 to 2019. The pandemic period is from 2020 to 2021. Panel A presents the Probit regression results and Panel B reports the Logit regression results. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively.

**Panel A: Probit Model**

| | **1999-2019** | | **2020-2021** | |
|---|---|---|---|---|
| | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) |
| Number of Borrowers | 0.010 | ** | 0.012 | ** |
| Debt-To-Income | 0.183 | ** | 0.865 | ** |
| Borrower FICO Score at Origination | 0.032 | ** | 0.013 | ** |
| Original Loan Term | 0.021 | *** | 1.133 | *** |
| Loan Age | 0.223 | | 0.225 | |
| Remaining Time to Maturity | 0.124 | *** | 0.126 | *** |
| Interest Rate Volatility | 0.014 | | 0.016 | |
| Interest Rate Slope | 0.226 | *** | 0.019 | *** |
| Interest Rate Level | 0.127 | ** | 0.192 | ** |
| Inflation Rate | 0.169 | | 0.041 | |
| GDP | 0.028 | | 0.030 | |
| Unemployment Rate | 0.029 | ** | 0.031 | ** |
| *Adjusted R square:* | *0.44* | | *0.42* | |

**Table 16. Loan Modification and Its Determinants:**
**The Pandemic Impacts using the First-Time Home Buyer Sample**

**Panel B: Logit Model**

| | 1999-2019 | | 2020-2021 | |
|---|---|---|---|---|
| | Coefficient Estimate | Significance Level (*/**/***) | Coefficient Estimate | Significance Level (*/**/***) |
| Number of Borrowers | 0.008 | * | 0.014 | ** |
| Debt-To-Income | 0.915 | * | 0.921 | * |
| Borrower FICO Score at Origination | 0.005 | ** | 0.011 | ** |
| Original Loan Term | 1.125 | ** | 1.131 | ** |
| Loan Age | 0.217 | | 0.223 | |
| Remaining Time to Maturity | 0.165 | ** | 0.171 | *** |
| Interest Rate Volatility | 0.008 | | 0.014 | |
| Interest Rate Slope | 0.011 | ** | 0.017 | *** |
| Interest Rate Level | 0.151 | ** | 0.157 | ** |
| Inflation Rate | 0.043 | | 0.049 | |
| GDP | 0.022 | | 0.028 | |
| Unemployment Rate | 0.023 | ** | 0.029 | ** |

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## Appendices

### Appendix A. List of Variable Names and Definitions.

Boom and Bust: The economical period of rapid growth, followed by a decline.

DTI: Debt-to-income ratio is a personal finance measure that compares an individual's monthly debt payment to their monthly gross income.

Default: The failure to fulfill an obligation to repay a loan.

Delinquency Rate: The percentage of mortgage loans that are delinquent within the portfolio of a financial institution.

First Time Home Buyer: Represents any home buyer that has purchased a residence for the first time.

First Time Home Buyer Modified: Represents any home buyer that has purchased a residence for the first time and has received a mortgage modification.

FNMA: The Federal National Mortgage Association is a government sponsored enterprise that provides mortgage financing.

FICO Score: Personal credit score calculated with software from Fair Issac Corporation.

Interest Rate: The proportion of a loan that is charged as interest to the borrower for having a loan.

Loan Count: The count of home mortgage loans that exist on the FNMA portfolio

Loss Mitigation: A loan servicers responsibility to reduce the loss to the investor of the loan.

Loan Modification (Modified): A change in the borrower's loan terms, generally to reduce the monthly payment.

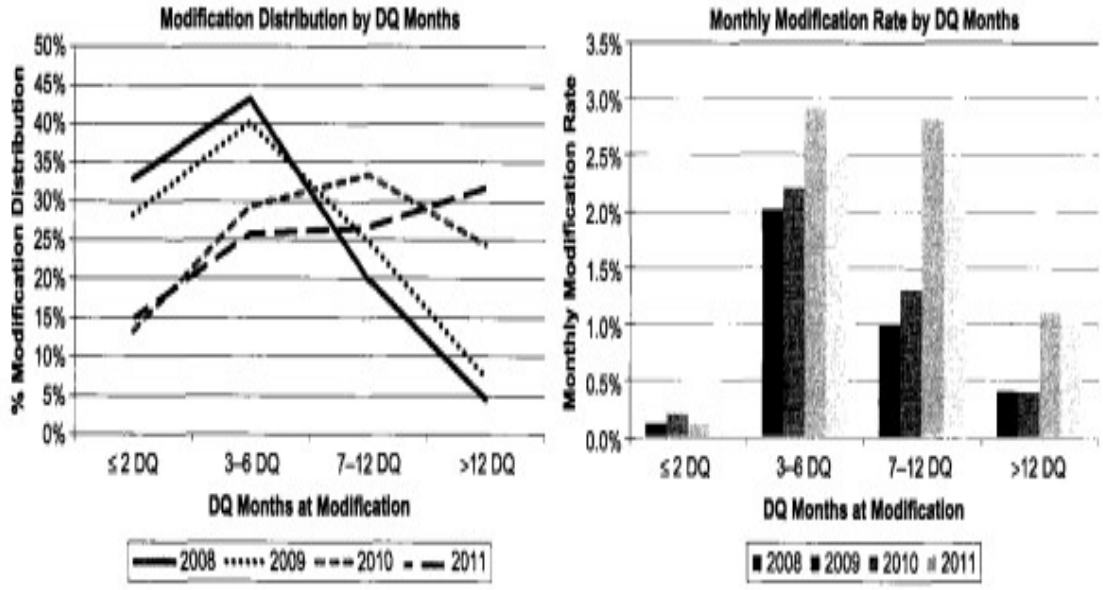
Loan to Value Ratio (LTV): The ratio of a loan to the value of the asset purchased.

Redefault: Redefaults are when a borrower who receives a modification still ends up in delinquency or default

**Appendix B-1. Modification Timing Trends**

EXHIBIT 8

Modification Timing Trends

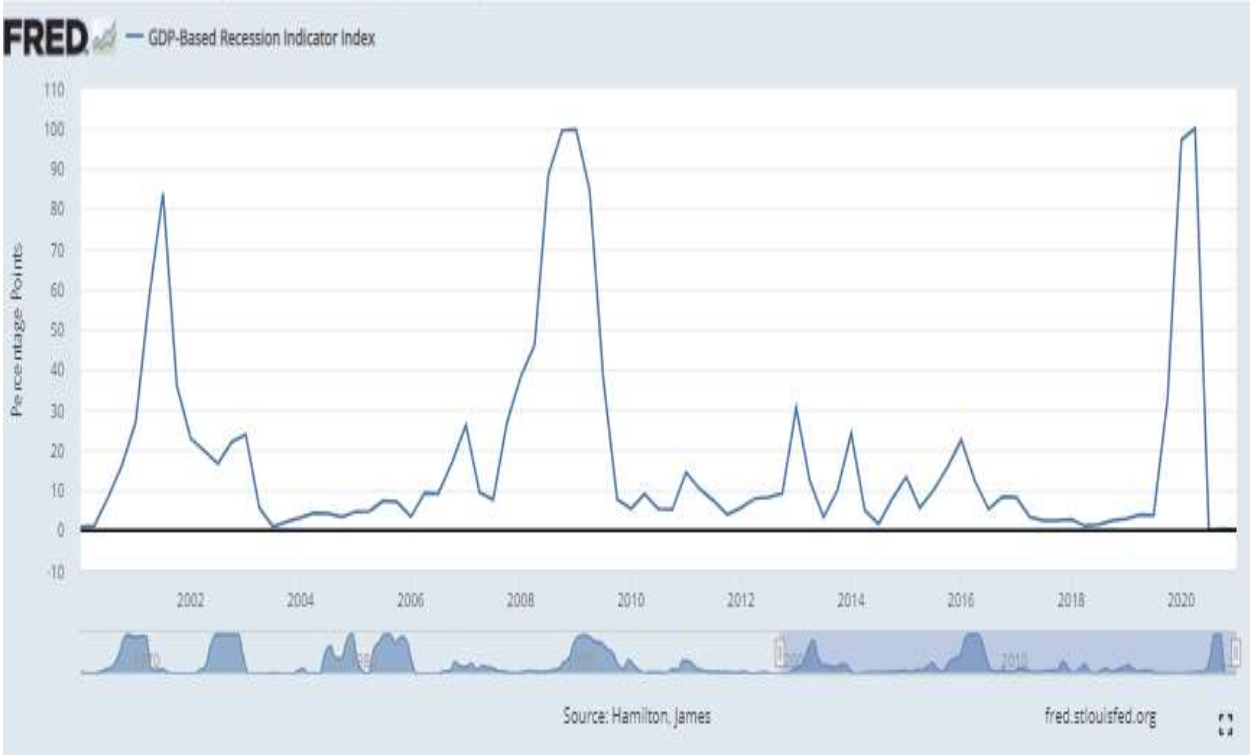



*Sources: CoreLogic, Amherst Securities as of May 2011.*

Displayed are the delinquency stages by month at which a homeowner completes a mortgage modification.

Goodman, L. S. A., Roger; Landy, Brian; Yang, Lidan (2011). "Modification Success-What Have We Learned." The Journal of Fixed Income 21(2): 10.

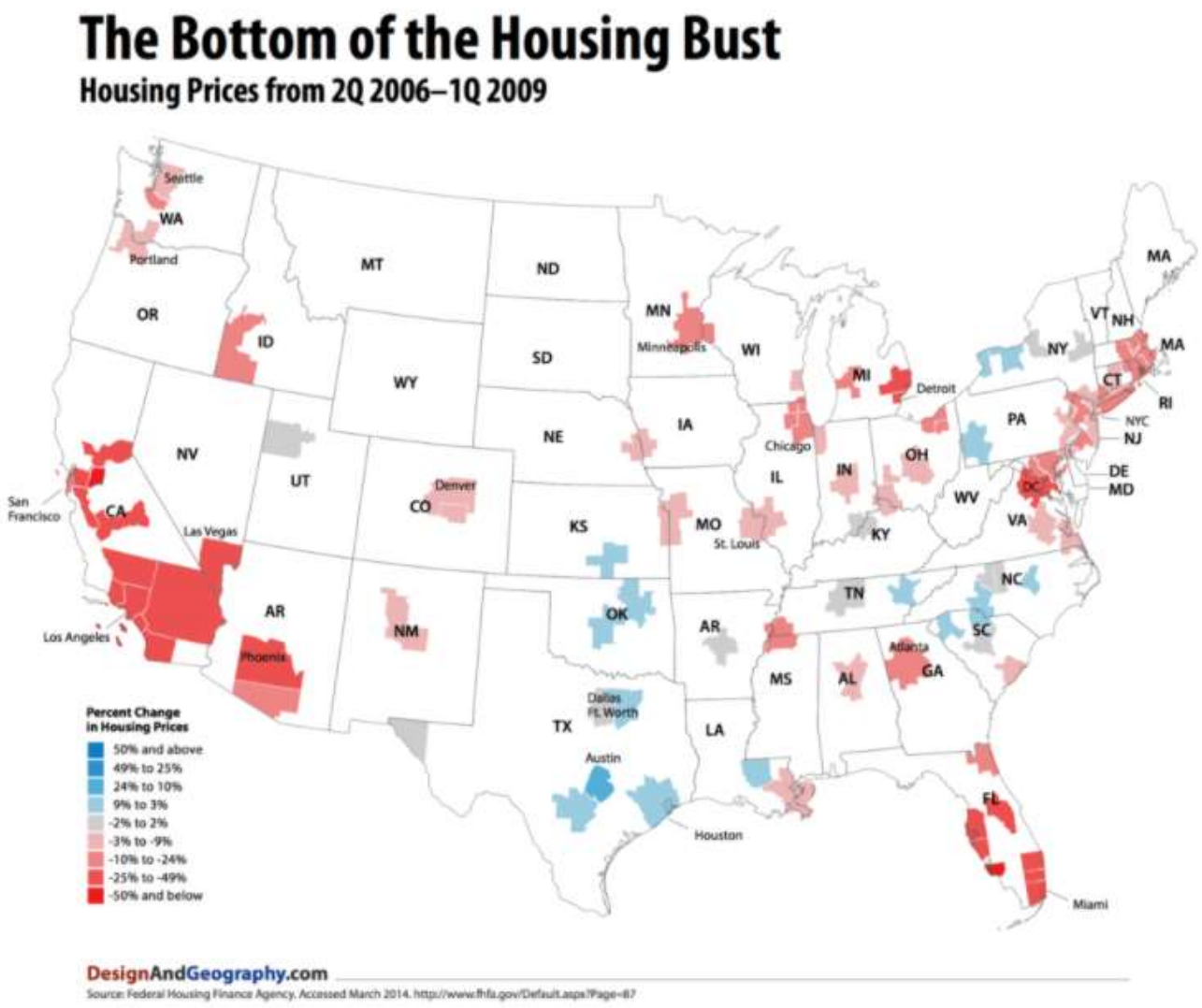
**Appendix B-2. GDP-Based Recession Indicator Index**




This index provides the recession percentage points that the U.S. Economy experienced during the indicated year.

Economic Research FRED Economic Data, URL:
https://fred.stlouisfed.org/series/JHGDPBRINDX

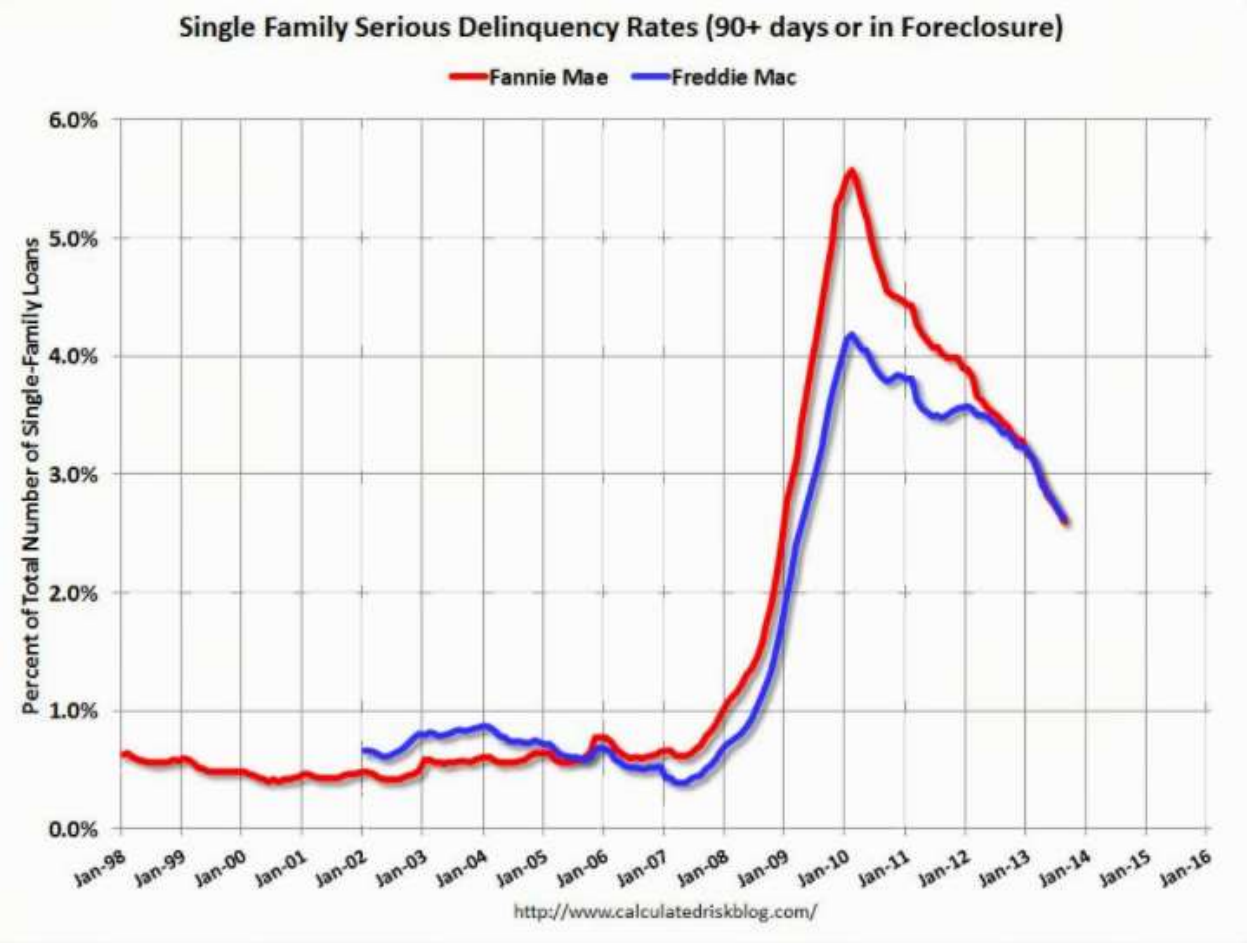
**Appendix B-3. The Bottom of the Housing Bust**




Hardest effect areas with housing prices stagnation during the economic housing bust.

Mulbrandon, M, (2014, April 21), Design & Geography, URL: https://designandgeography.com/2014/04/21/post-bubble-housing-price-stagnation-usa/

**Appendix B-4. Single Family Delinquency Rates FNMA & FHLMC**




The graph displays mortgage payments that are three or more monthly payments past due.

Calculated Risk, (2020, January 31), Calculated Risk Finance & Economics, URL: https://www.calculatedriskblog.com/2020/01/fannie-mae-mortgage-serious-delinquency.html