Estimation of the Causes of Subprime Mortgage Crisis

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Abstract

In light of the recent mortgage crisis, identifying the origins is crucial to prevent such a crisis from reoccurring in the future. This paper primarily links foreclosure to subprime loan expansion. To that end, more than one and half million subprime loans originated between 2006 and 2007 across top metropolitan statistical area in the United States are analyzed. First, this research shows evidence that subprime loans played a significant role in the deterioration of the real-estate market. Second, it demonstrates that other variables such as income and lending standards have contributed to the high default rate. Third, it confirms the fact that subprime loans originated for the purpose of refinancing have more impacts on foreclosure. The results obtained are all significant and consistent.

Keywords: foreclosure, subprime, refinancing

Résumé

Ce rapport traite de la crise immobilière et essaie d'identifier ses causes et origines afin de pouvoir éviter des crises similaires dans le futur. En effet, cette étude s'intéresse principalement aux hypothèques à risque ainsi qu'au lien entre l'expansion du marché du crédit et la détérioration du marché immobilier. À cette fin, plus d'un million et demi de prêt émis entre 2006 et 2007 dans les grandes métropoles américaines ont été analysés. Les objectifs de cette étude sont de trois ordres. Premièrement, des preuves sont présentées afin de démontrer le lien existant entre les hypothèques à risque et le grand nombre de maisons saisies. Deuxièmement, cette étude cherche à quantifier l'impact des variables revenu et conditions de prêt sur la crise immobilière. Troisièmement, ce rapport démontre empiriquement le rôle prépondérant des hypothèques de refinancement quant au nombre de saisies. Enfin, les résultats obtenus sont significatifs et consistants avec la littérature antérieure sur le sujet.

Mots clés: maisons saisies, hypothèques à risque, refinancement

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Abbreviations

ABS Asset backed Security

ARM Adjustable rate mortgage

CDO Collateralized debt obligation

DTI Debt to income

FALP First American LoanPerformance

FFIEC Federal Financial Institutions Examination Council

FICO Fair Isaac Corporation

FRM Fixed rate mortgage

GSE Government sponsored enterprise

HMDA Home Mortgage Disclosure Act

HUD Housing and Urban Development

LTV Loan to value

MBS Mortgage Backed security

MSA Metropolitan statistical area

OFHEO Office of Federal Housing Enterprise Oversight

RMBS Residential mortgage backed security

Contents

List of Figures

List of Tables

1 Introduction

The sharp rise in U.S. mortgage default rates has led to the most severe financial crisis since the Great Depression. It has had impacts not only on the housing market, but also on the financial market, the goods and services market, the labour market and many others. Losses have reached extraordinary levels and are still rising. The recent global financial turmoil has been linked to many catalysts, such as the housing bubble, the increased level of risk, asymmetric information, and a change in monetary policy. In addition, preliminary evidence in the aftermath of the crisis indicates that the probability of default is higher for subprime loans. Subprime lending targets borrowers who lack or suffer from insufficient credit history, and who would otherwise be denied credit. It has increased remarkably over the last decade, evolving into a major segment of the mortgage market.

This paper provides information about subprime lending and the subsequent increase in default rate in an attempt to shed light on the causes of the crisis. More particularly, this analysis aims at empirically examining the impact of subprime origination on foreclosures. Data about foreclosures, subprime, income, loan amount, and others, are taken from several sources; in addition, micro-level data are analyzed to capture within-state variability, since the impact of the financial crisis differs from one region to another.

The paper is organized as follows: Section 2 describes the context of the crisis, defines key words and exposes the timeline of events; Section3 identifies the major impacts on the real-estate market and on the financial institutions; Section 4 reviews the related literature; Section 5 describes the empirical methodology as well as the data used for the analysis and presents the results obtained; and finally, section 6 concludes.

2 Background and timeline of events

2.1 Overview

The term "subprime" is not consistently defined in the literature so there is no unique definition of a subprime mortgage.

From the lender's perspective, a subprime mortgage loan is a residential loan directed to borrowers who are less likely to repay a loan because of lack or insufficient credit history. Thus, the lenders can charge higher upfront[1] and continuing costs[2] than conventional[3] or prime mortgage; they can ask for an interest rate premium based on the expected risks of default which, according to Chomsisengphet and Pennington-Cross (2006), is typically around 2 percentage points. Finally, such institutions are likely to practice predatory lending[4] and as a result can charge even higher interest rates on their loans.

Subprime loans have very loose underwriting standards. In fact, Kiff and Mills (2007), find that the loan-to-value ratios[5] are usually high: over 85 percent, the debt-to income requirements are not very stringent: above 55 percent, and subprime borrowers have a FICO[6] below 620. Moreover, subprime lenders are willing to accept limited or no documentation of borrowers' income and assets.

Subprime mortgages can vary a lot between one type and another. Interest-only payments allow borrowers to pay solely the interest for a period of time between 5 to 10 years, while pay option loans usually have adjustable interest rates and allow borrowers to choose their monthly payment. The latter can either pay the full amount, or pay only interest or a minimum payment lower than the payment required reducing the balance of the loan. Finally, there are hybrid mortgages that may start with fixed rates that are often below-market (i.e."teaser") rates and eventually convert to adjustable rates.

Interest rates on adjustable rates mortgages (ARMs) are pegged to a benchmark rate, such as the six month Libor rate or the one-year Treasury bill rate. Over time, ARMs have experienced a sharp increase whereas FRMs experienced a slowdown (Figure 1). Moreover, based on Chomsisengphet and Pennington-Cross (2006), ARM borrowers have on average, lower credit scores than fixed rate mortgage (FRMs) borrowers. For example, in 2003, FRMs were almost 50 points lower than ARMs (623 versus 675).

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[1] Upfront costs include application fees, appraisal fees, and other fees associated with originating a mortgage

[2] Continuing costs include mortgage insurance payments, principle and interest payments, late fees and fines for delinquent payments, and fees levied by a locality (such as property taxes and special assessments)

[3] Conventional loans are loans that are eligible for purchase by government sponsored entities: Fannie Mae and Freddie Mac.

[4] Predatory lending is an abusive practice where lenders charge excessive, often hidden fees; successively refinance loans; make loans without regard to a borrower's ability to repay; and engage in high-pressure sales tactics or outright fraud and deception

[5] Loan-to-value (LTV) ratio measures the amount of the loan expressed as a percentage of the value of the home

[6] FICO, developed by Fair Isaac Corporation, is a summary measure that captures the borrower's credit quality

Figure 1: Changes in type of loans over time
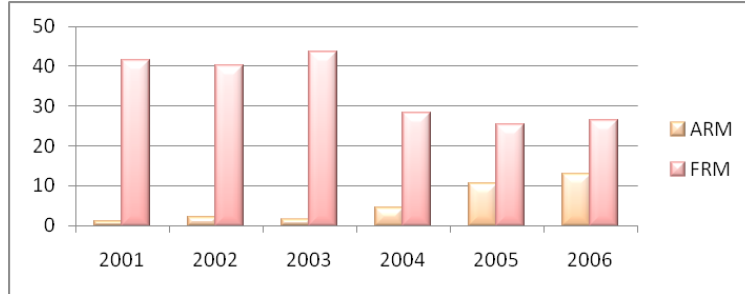
All figures are in percentage
Source: Demyanyk, Van Hemmert, (2008)

2.2 The rise of subprime lending

The subprime mortgage market gained national attention in the mid-1990s when it started being considered as a major component of home financing.

For some, the growth in subprime lending is viewed as an economic breakthrough. Former Federal Reserve Chairman Alan Greenspan generally referred to subprime lending as the "democratization of credit," that enables borrowers with impaired or limited credit history to receive access to home loans that would have been denied in the past. Subprime loans may give higher incentives to become homeowners instead of staying renters. Also, it may allow some homeowners, suffering from liquidity constrained, to extract cash from their properties.

Over the last decade, the share of subprime loans experienced a sharp increase. Using data reported by the magazine Inside B&C Lending (2006), total subprime loans grew from $65 billion in 1995 to $332 billion in 2003 (Table 1). Moreover, according to Federal Reserve Governor Randall S. Kroszner (2006), subprime loans were more prevailing, as newly originated mortgages conformed less to strict prime standards and to government-sponsored housing enterprises criteria. Nevertheless, it is the whole mortgage market that expanded, including conventional, subprime and other types of loans. Indeed, mortgage lending has more than quadrupled between 1995 and 2003.

Table 1: Evolution of subprimes

Year	Subprime Origina-tion	Yearly Change	Total Origination	Suprime / Total Origination	Subprime / GDP
1995	$65.0bn		$639.4bn	10%	1%
1996	$96.8bn	49%	$785.3bn	12%	1%
1997	$124.5bn	29%	$859.1bn	14%	1%
1998	$150.0bn	20%	$1,450.0bn	10%	2%
1999	$160.0bn	7%	$1,310.0bn	12%	2%
2000	$138.0bn	-14%	$1,048.0bn	13%	1%
2001	$173.3bn	26%	$2,058.0bn	8%	2%
2002	$213.0bn	23%	$2,680.0bn	8%	2%
2003	$332.0bn	56%	$3,760.0bn	9%	3%

Source : inside B&C Lending and World perspective

However, unlike the common notion that a mortgage loan is intended to people wanting to become homeowners, most subprime loans did not follow this same purpose. In fact based on Schloemer, Li, Ernst, and Keest (2006), the majority of subprime loans originated in the last decade have been for the purpose of refinance[7] rather than for home purchase. In 2004, 50.8% of total mortgage originated were for refinance whereas, only 39.5% were intended to purchase a home (Table 2). Indeed, American households have used intensively refinancing to pull money out of their homes. Figures from Greenspan and Kennedy (2004) indicate that over two trillion dollars were extracted in the past five years alone. In addition, according to Darlin (2006), even when interest rates were rising in 2006, the refinance pace did not slow down. Therefore, over $500 billion were extracted in home equity, which represents more than the total amount taken out in all of 2005.

Table 2: Distribution of subprime by purpose and year of origination

	1998	1999	2000	2001	2002	2003	2004
Purchase	30.45%	31.55%	38.47%	35.21%	32.84%	32.09%	39.5%
Refinance (cash out)	47.03%	51.85%	49.65%	52.06%	52.55%	53.7%	50.8%
Refinance (no cash out)	20.12%	15.06%	11.75%	12.71%	14.61%	14.2%	9.68%
Other	2.39%	1.54%	0.12%	0.03%	0.01%	0.01%	0.02%

Source: Schloemer, Li, Ernst, and Keest, (2006)

Furthermore, the financial market experienced an unrecorded increase in the rate of securitization[8]. In fact, according to Keys, Mukherjee, Seru and Vig (2008), the securitization rate has more than doubled going from 30 percent in 1995 to over 80 percent in 2006.

Securitization is a process where loans are purchased from originating firms such as banks, mortgage companies, and others institutions, and then assembled

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[7]Cash-out refinancing indicates that the borrower receives the difference in cash between a new loan that is larger than the old loan

[8]Securitization rate is the number of securities issued divided by loan originations in dollars

into pools and finally sold to third-party investors. These securitized credits represent claims on the principal and interest payments made by borrowers on the loans in a pool. Securitization helps converting illiquid assets into liquid securities and offers innovative financial benefits such as a greater diversification and spreading of risk, potentially broadening access to credit and lowering its cost.

Figure 2: Securitization rates
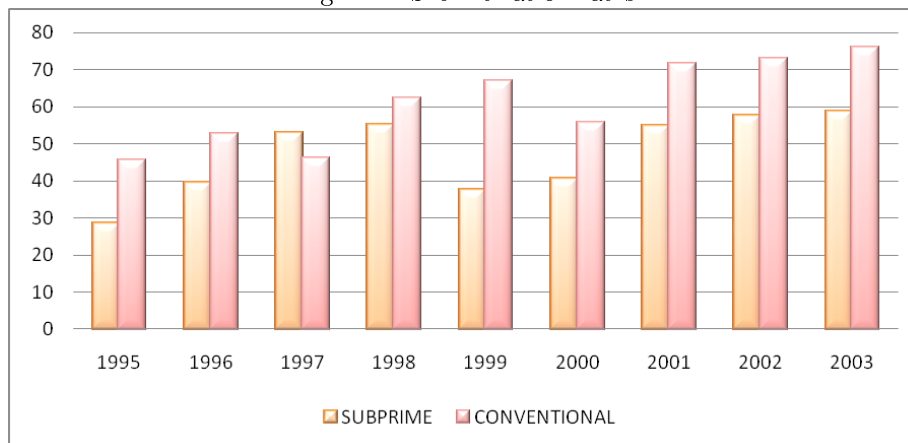
Figures are in percentage
Source: Inside MBS & ABS

In the last decade, brokerage firms, banks, and other private institutions took over residential mortgages securitization which used to be issued by government–sponsored enterprises (GSEs), such as Fannie Mae and Freddie Mac. These shifts from public to private entities lead to the fast development of private-label residential mortgage-backed securities (RMBSs). Based on Furlong, Takhtamanova, Laderman, and Krainer (2007), the share of total subprime financing through RMBSs grew from about 46 percent in 2001 to 75 percent in 2006.

Consequently, while the private and public sector might be working similarly, the main difference between them is that the latter is far more stringent on its eligibility criteria and primarily securitizes loans to higher quality borrowers who met legislative limits on loan size, credit score, and underwriting standards.

Figure 3: Fraction of mortgages sold to private mortgage institutions
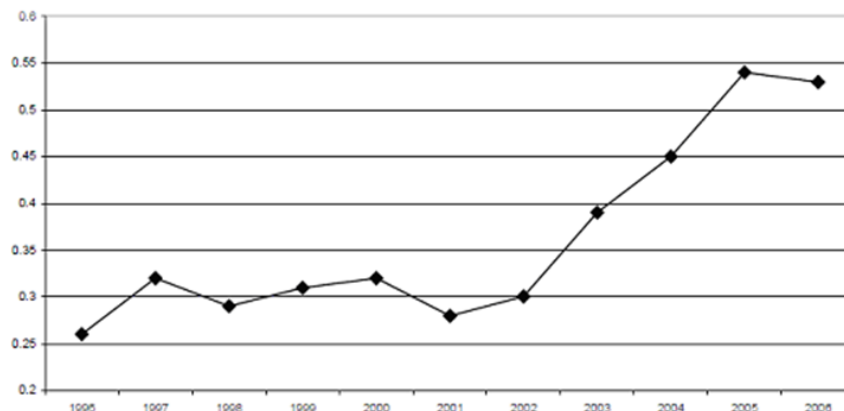
*Private mortgage institutions include all third parties except for Fannie Mae, Ginnie Mae, and Farmer Mac
Sources: Mian and Sufi, (2008), and HMDA data

Moreover, investors were not only holding RMBS but also other types of asset-backed securities (ABS). Therefore, they were not directly exposed to subprime loans but rather through a combination of debt. Indeed, mortgage institutions securitize several already securitized bundles of long-term debt instruments and then sell them to investors. For example, collateralized debt obligations (CDOs), are a package of multiple RMBSs and other types of debt. As a result, these investors did not know the risk exposure of their investment and thus had to rely on credit rating agencies such as Standard & Poor's and Moody's. Unfortunately however, a very large share of investments was originally highly rated (AAA or AA) but eventually turned out to be implicated in much higher risk.

On the other hand, the financial innovations were not the only main changes that occurred during the late 1990s. In fact, the real estate market and interest rates also experienced some drastic alterations. Based on Furlong, Takhtamanova, Laderman, and Krainer (2007), house prices increased tremendously, reaching in 2004 and 2005 unbelievable gains while, interest rates dropped sharply. Therefore, this period was characterized by low-cost access to the equity in homes. Furthermore, speculative borrowers were drawn toward the mortgage market because of the prevailing rise in housing prices and because house values were expected to keep appreciating. They were thus after capital gain opportunities.

Figure 4: Monthly house price index, purchase only
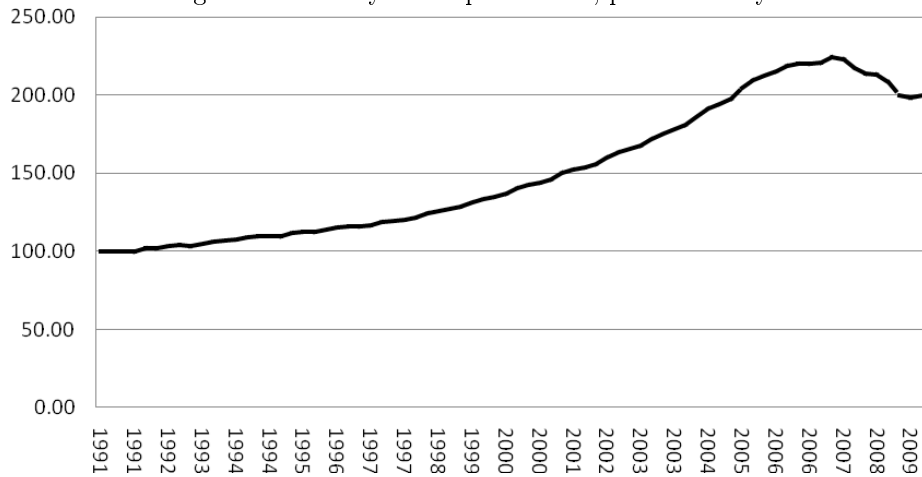
These favourable conditions combined with the development in asset-backed markets facilitated a substantial expansion of homeownership and thus encouraged people to take on more credits. Indeed, Figure 5 shows the sharp increase in homeownership from 1995 to 2005.

Figure 5: Homeownership rate
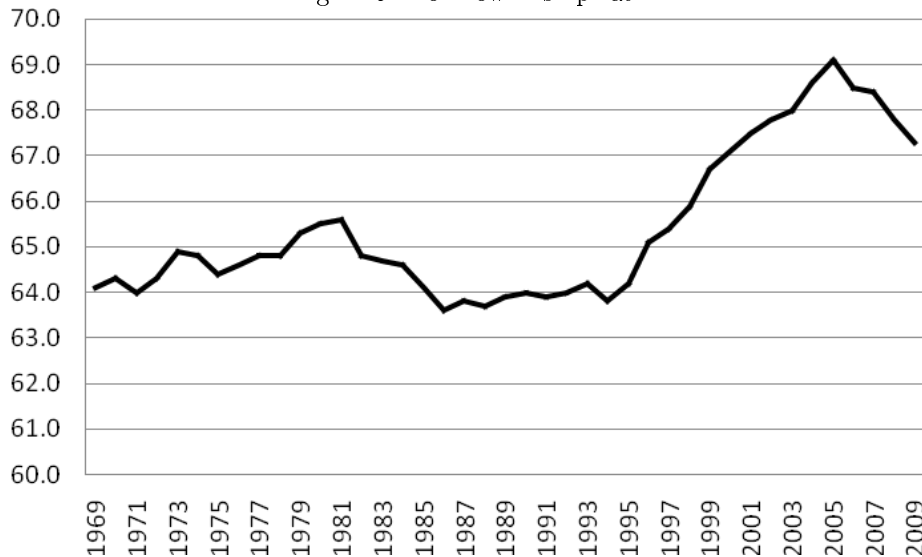
In addition to these changes in the market structure, some laws were implemented and have contributed to the growth of subprime lending.

- In 1980, the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) was adopted: it allowed charging high rates and fees to

7

borrowers which was not possible until then. It pre-empted state interest rate caps.

- In 1982, the Alternative Mortgage Transaction Parity Act (AMTPA) allowed the use of variable interest rates and balloon payments.

- In 1986, the Tax Reform Act prohibited the deduction of interest on consumer loans, yet allowed interest deductions on mortgages for a primary residence as well as one additional home. This made even high-cost mortgage debt cheaper than consumer debt for many homeowners.

2.3 Distribution of subprime lending

The subprime growth has transformed the mortgage financial system throughout the nation. However, the regional importance of subprime mortgages varies considerably.

Figure 6: Geographic dispersion of subprime originations in 2006
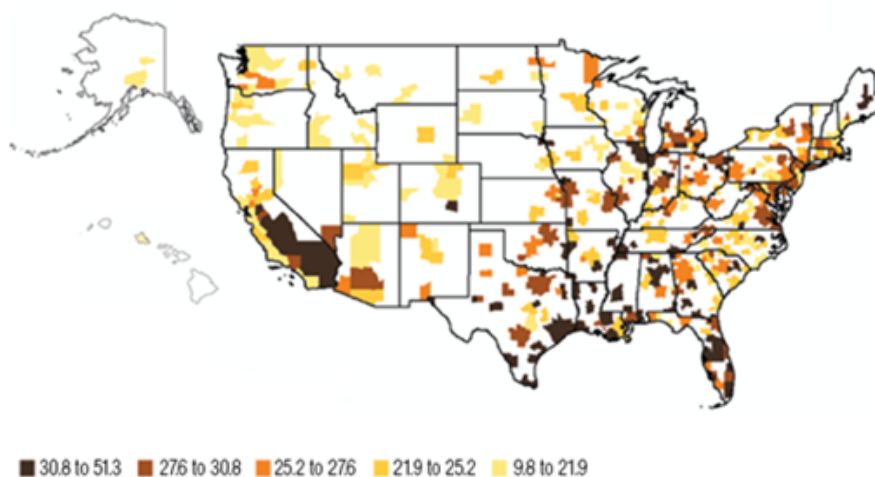
Source: HMDA Data- Released by FFIEC

According to Mayer and Pence (2008), Subprime originations appear to be heavily concentrated in fast-growing parts of the country with considerable new construction, such as Florida, California, Texas, Washington DC, and the Great lakes area. Concentrations are especially pronounced in Los Angeles, Chicago, Phoenix, Atlanta, New York, Houston, San Francisco, Washington D.C., Florida, and Dallas.

Table 3: Distribution of subprime loans by major metropolitan area

MSA	Subprime Average	Subprime 2nd half 2006	Subprime 1st half 2006	Subprime 2nd half 2005
Los Angeles	14.32%	13.54%	15.36%	14.06%
New York	6.53%	7.25%	6.93%	5.40%
San Francisco	5.11%	3.96%	5.63%	5.76%
Washington D.C.	4.53%	4.60%	4.50%	4.50%
Chicago	3.64%	4.01%	3.37%	3.53%
Miami	3.45%	4.30%	3.45%	2.60%
Total	37.58%	37.65%	39.24%	35.84%

Source: Intex/DBRS

Moreover, geographical data shows that the locations where subprime rates are high are the same that include faster than average increase in house prices. Indeed, Mayer and Pence (2008), believe that mortgage activity is triggered by a mix of increased construction activities and housing price appreciation. According to them, an area embodying this kind of dynamic must have greater mortgage activities than areas with more depressed housing markets. Therefore, it may be profitable to move to rapidly growing areas: renters may have better incentives to transition to homeownership; investors may find real-estate opportunities and finally, homeowners may pull out capital gains through cash-out refinancing. However, even though many papers argue that construction and house prices are correlated with subprime lending, the link between these variables is not universally defined yet.

Furthermore, according to Minczeski and Taylor 2007, the subprime loans market has shifted from underserved areas to higher-income metropolitan areas. In fact, subprimes are initially designed to provide credit to lower-income borrowers and to contribute to their development and growth. However, it may be possible that moderate to high income borrowers have substituted conventional loans with subprime loans. The main incentive behind it is speculative behaviour and refinancing.

3 Impacts of subprime lending on the economy

3.1 Impact on foreclosures

The 2007 subprime mortgage crisis has lead to a large number of delinquencies[9] and foreclosures[10]. More precisely, only months after subprime origination in 2006 and 2007, foreclosures increased drastically. Data compiled by First American LoanPerformance (FALP) 2007, show that delinquency rate is not consistent across regions in United States and that the median subprime delinquency rate is 17.4 percent, with a range from about 7 to over 30 percent. Some of the cities that experienced the most severe delinquency rate are Stockton in California, Sacramento, San Diego, San Francisco, Detroit, Indianapolis, Boston, New York and Miami. For example, for the Stockton area in California jumped from about 3.5 percent at the end of 2005 to over 25 percent in 2007. Also, in the Las Vegas and Phoenix areas, subprime delinquency rates reached 17.7 percent and 12.7 percent, respectively, in 2007, compared with 4 percent and 3.6 percent at the end of 2005.

Figure 7: Mortgage foreclosure fillings as a percent of households for MSAs, 2007
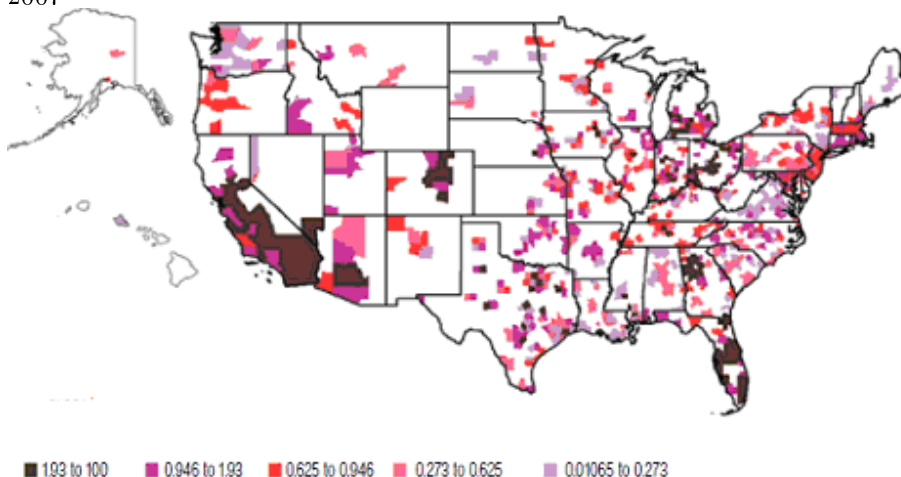
Source: RealtyTrac

Many factors are relevant in explaining the differences in subprime delinquency rates among MSAs such as variation in economic conditions, differences in the riskiness of borrower, and changes in the house prices. However, the main reason is the sudden and disparate decrease in housing prices across US regions.

Moreover, the slowdown of housing prices was accompanied by higher interest rates leaving borrowers with no equity to sell their homes and prepay their mortgages. Indeed, the Federal Reserve Board has increased interest rates from

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[9]Definition of delinquency vary , but the one used here defines it as the cumulative fraction of loans that were past due 60 or more days, in foreclosure, real-estate owned, or defaulted, at or before a given age

[10]Foreclosure is a legal procedure in which a mortgaged property is sold in a legal process to pay the outstanding debt

1% in 2003 to 5.25% in 2006 which led to a faster deterioration of the mortgage market.

Figure 8: House price appreciation and subprime delinquency rates among MSAs
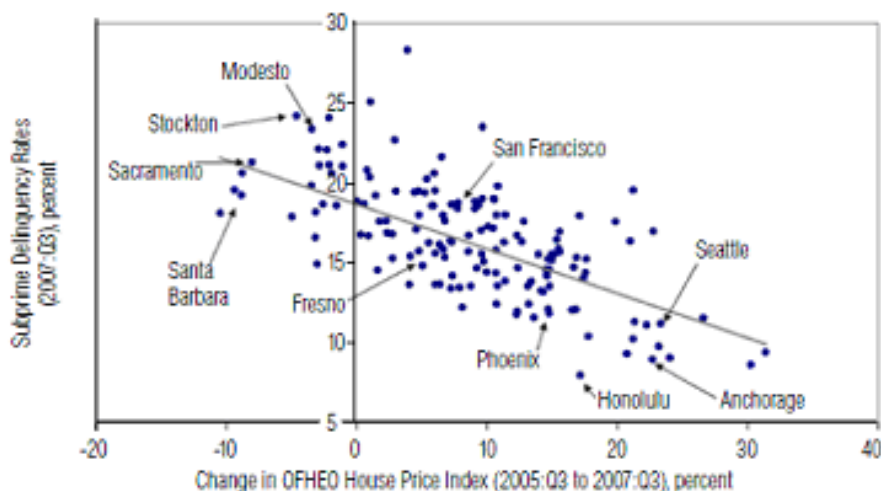
Sources: First American LoanPerformance and Office of Federal Housing Enterprise Oversight (OFHEO)

Finally, according to Demyanyk and Hemert (2008), loans originated in 2006 and 2007 have a much higher delinquency rate than loans originated in earlier years at the same age even after adjusting for year-by-year differences in loans (Figure 9).

Figure 9: Actual and adjusted delinquency rate
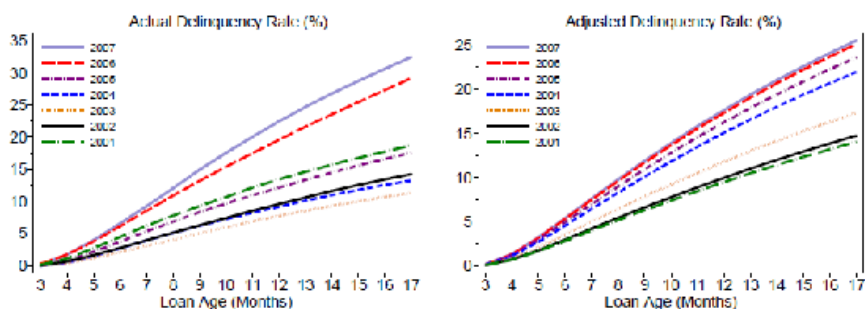
Source: Demyanyk and Hemert, (2008)

3.2 Impact on financial institutions

The subprime crisis has so far made losses on financial institutions that surpass 750 billion dollars as of 2008 based on estimates from Lehman Brothers and

Citigroup (2007). Also, more than 200 bank and mortgage institutions have either closed down operations, or declared bankruptcy.

Losses are mostly prominent among investors holding unrated and lower-rated MBS and CDO equity. These losses have occurred because mortgage borrowers have massively defaulted on their payments. Moreover, the delay between the different reactions in the securitization chain has played an important role. Indeed, the foreclosure process takes time to complete and thus principal payments to third party investors' are not immediately affected.

The table 4 shows that the banking industry as a whole has seen a dramatic slowdown in terms of profitability and performance. Also, this table shows a rise in non-current assets and other real estate owned (OREO).

Table 4: US banking industry

	2001	2002	2003	2004	2005	2006	2007
Return on assets	1.14%	1.3%	1.38%	1.28%	1.28%	1.28%	0.86%
Return on equity	13.02%	14.08%	15.05%	13.2%	12.43%	12.3%	8.17%
Leverage	7.79%	7.86%	7.88%	8.11%	8.25%	8.22%	7.98%
Noncurrent assets & OREO	0.87%	0.9%	0.75%	0.53%	0.5%	0.54%	0.94%
Net operating income growth	-0.48%	17.58%	16.39%	4.02%	11.39%	8.5%	-23.7%

Source: Federal deposit insurance corporation (FDIC)

4   Related literature

The literature based on the subprime crisis is quite recent and reviews different aspects of the problem. This report will limit itself to a few selected papers and their contributions to the understanding of the crisis. In addition, this report tries to find a logical link between the selected papers.

Mian and Sufi (2008) conduct a micro-level analysis across the United States in order to explain the mortgage credit expansion in subprime neighbourhoods. They define subprime zip codes as zip codes in the lowest quartile in which borrowers have a credit score under 660 as of 1996. On the other hand, they define prime zip codes as the highest quartile of borrowers with a credit score above 660. According to their hypotheses, the massive growth of mortgages in subprime zip codes in 2002-2005 can be explained by one (or more) of these hypotheses:

1. Improvement of credit worthiness of subprime borrowers

2. Expectation of future house price growth

3. Outward shift in mortgage supply increase.

The first two hypotheses are not necessary for the purpose of this report, although those two conditions are later rejected by the authors. Indeed, the facts established that the income and the mortgage credit growth are negatively correlated for the years 2002-2005. Also, the growth in credit occurred in very elastic housing supply that are highly unlikely to have large increases in house price growth expectations due to the fact that the quantity of housing stock adjusts quickly to any upward pressure on house prices.

As for the supply-based hypothesis, data from 2002-2005 show strong evidence of reduction in denial rates and relaxation in credit rationing constraints on mortgage applications in subprime zip codes. However, neither prime zip codes nor subprime zip codes before 2002 have experienced similar characteristics. As a result, the 2002-2005 expansion of mortgage credit mostly occurred in subprime zip codes.

In addition, another important finding of this paper is the 2002 to 2005 increase in the fraction of originated mortgages sold to non-GSE investors. In other words, 2002-2005 reflected a massive wave of mortgage securitization that mostly occurred in subprime zip codes. This central breakthrough lead to this conclusion: lenders in subprime zip codes increased their supply of mortgage credit in order to securitize or sell them to other private investors. As a result, subprime zip codes have experienced an expansion in mortgage credit.

Furthermore, some economists believe that an expansion of credit will lead to financial instability. For instance, Kiyotaki and Moore (1997) argue that the financial deterioration might occur through the release of credit constraints or Dell'Ariccia and Marquez (2006) argue it might occur through adverse selection. Furthermore, Dell'Ariccia, Igan and Laeven (2009) focuse their research on the expansion in mortgage credit and find that the rapid expansion in mortgage credit and the changes in the market structure are associated with a decline in lending standards and with excessive risk taking by lenders[11] leading to credit crisis.

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[11] They take denial rates as a proxy for lending standards and loan-to-income ratios for the risk taken

First, they find that in the subprime market, a strong negative relationship existed between the lending boom and lending standards. Subprime lenders appear to have denied fewer loan applications and to have approved larger loans in areas where the number of loan applications rose faster. In addition, they find that subprime lenders appeared to have denied fewer loan in areas with a larger number of competitors, and more specifically, in areas with a larger number of incumbent financial institutions. These areas subsequently experienced a sharper increase in delinquency rates.

A major difference between the prime and subprime market is that in the latter, information about the credit history of borrowers is not publicly available. Thus, under asymmetric information and speculative behaviour, subprime lenders found it more profitable to keep originating loans with no screening to the applicants resulting in deterioration in the quality of the pool of applicants. Indeed Fuller and Fuller (2009) believe that asymmetric information and moral hazards were fuelled by mortgage securitization. With securitization, mortgage lenders have more incentives to increase the amount of credit without too much worrying about the borrower and its risk of default. Thus, banks and mortgage originators have less information about the borrower, about its credit worthiness, the approximate value of the home and other macroeconomic measurements since they won't be the ultimate holder of the mortgage. However, third parties and investors have very little information about the underlying individuals and homes in the portfolio of mortgages they have purchased via an MBO.

This is consistent with theories of disintermediation where asymmetric information among lenders plays an important role in altering the supply of credit, and altering lending standards. Mian and Sufi (2008) come across similar results suggesting the possibility of moral hazard on behalf of originators selling bad loans to third-party lenders for the purpose of securitization. They find that the number of mortgages sold for securitization is positively correlated with subsequent increase in default rates.

Likewise, Schloemer, Li, Ernst, and Keest (2006) highlight the effects of subprime mortgages origination on the number of foreclosure filling. The results of this article are significant due to the large number of observations in the sample that included more than six millions securitized subprime loans from 1998 to 2004.

First, this study reveals that the subprime market inevitably leads to foreclosure. Indeed, it stipulates that even under recent favourable economic conditions such as house price appreciation, and good monetary policy, as many as one in eight subprime loans originated between 1998 and 2004 ended in foreclosure within five years. Also, half of all subprime loans will be delinquent at least once within five years.

Moreover, one of the most important contribution of this article is that not only does it prove that subprime leads to foreclosure but also asserts that subprime loans are riskier in themselves, regardless of the borrower's credit. Borrowers who are already financially stressed are receiving loans associated with a higher risk of default. Therefore, even after controlling for differences in credit scores, subprime mortgages are found to increase the likelihood of default. Some of the subprime characteristics that are adding risk include re-adjustable interest rates, prepayment penalties, balloon payments, "low-doc" and "no-doc" loans or the ability to refinance out of an unaffordable loan.

Furthermore, loose underwriting standards magnified the risk of loans that are already hazardous, and so does predatory lending. In addition, third-party originators such as mortgage brokers, who originated the majority of subprime mortgages, have a strong incentive to close as many loans as possible, but very little reason to consider the loans' future performance. Lenders shielded themselves from the full potential cost of foreclosures by selling their loans to investors through the secondary mortgage market. And finally, insufficient legal and regulatory consequences to lenders emitting home loans that are not appropriate or affordable for the borrowers' situation exacerbated this credit crisis.

5 The empirical analysis

This section is divided into three subsections. First, it explains the purpose and methodology of the analysis as well as defines the empirical model; second, it specifies the data sources; and finally, it presents results of the regression using feasible generalized least squares.

5.1 Methodology

The purpose of this report is to empirically determine whether the subprime loans played an important role causing the high number of foreclosures that occurred in the United States in 2006 and 2007. More specifically, the goal of this report is to test the hypothesis that subprime mortgage expansion is behind the subsequent high default rate and thus is responsible for the crisis. To that extend, related literature have revealed that only a few variables are significant and, consequently will be tested to see their impact on foreclosures. Also, as explained in Section 2, the effects of mortgage expansion has been very different from one region to another. Therefore, it is necessary to focus on micro-level data instead of national data. Indeed, Mian and Sufi (2008) assert that "any such analysis requires micro-level data, (...), the use of more aggregated data can lead to erroneous conclusions." In this report, the variables that are selected are listed at MSA[12] level (Metropolitan Statistical Area) – a core urbanized area with population density of at least 50,000.

Unfortunately, data on foreclosure are only available for the top 100 MSA, corresponding to the largest urbanised agglomeration among the 363 MSA. Therefore, this paper will have to limit itself to these observations even though more observations or smaller denomination would have been better. Also, due to a lack of publicly available data, the timeframe that is chosen corresponds to the years 2006-2007.

The analysis that is conducted tries to test whether there is a relation between foreclosures and the number of approved subprime. Additionally, other related variables are included to the analysis to verify their relationship with foreclosures. Therefore, the focus will be put upon the coefficients' sign rather than their face value to establish the impact on the dependent variable. This paper will test the validity of two primary hypotheses, (1) the subprime parameter is very significant and positively related to foreclosures, (2) loan amounts, income measure, and homeownership rates are key factors of the high default rate.

The subprime variable is obtained following a series of meticulous manipulation on a huge dataset. The first step was to gather the complete list of subprime lenders of the Department of Housing and Urban Development (HUD)[13]. Then, adding all loans originated by these lenders gives the total subprime loans. In fact, the HUD identifies subprime lenders according to the reported spread between mortgage loans and comparable-maturity Treasury for first-lien and junior liens with a three and five percentage points over the benchmark respectively. These loans are referred to as "higher-priced" loans while all other loans are treated as non-subprime.

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[12] Refer to The U.S. Census Bureau
[13] See appendix 1

Furthermore, the Federal Financial Institutions Examination Council (FFIEC) under the Home Mortgage Disclosure Act (HMDA) requires from all lending institutions located within a MSA and with assets in excess of 30 million dollars to file loan registers providing information on each mortgage loan application. Therefore, by identifying subprime companies and adding all the loans originated by these companies, we can have the closest value to the number of subprime loans in each MSA. Nevertheless, there is potential measurement error due to the omission of smaller lenders that do not report under HMDA and to inability to classify lenders who originate both prime and subprime loans.

The dataset obtained with this manipulation gives information about the purpose of the subprime loan. Subsequently, the analysis will try to evaluate the effect of refinancing and home purchasing on foreclosures. However, based on the literature, refinancing is expected to cause more foreclosures.

The loan amount gives an estimate about the real estate market in the area and thus indicates the house price change between 2006 and 2007. According to the literature, house prices are an important factor in the subprime mortgage expansion. In addition, the loan amount is used as a proxy for lending standards indicating that as granted amounts are increasing, the less stringent are the lending standards. Taking all this together, one might expect that as lending standards loosen, mortgages become riskier and thus may lead to more foreclosures.

The income measure used represents the ratio of the median family income in a particular census track compared to the median family income in the MSA where the census track belongs. This variable is considered an indicator of wealth in each census track area, assuming that inhabitant of this area have similar earnings and thus, similar creditworthiness. In other words, this variable tests the effect of income and creditworthiness on foreclosures.

The demographic variable added is the ratio of the average number of owners over the average number of dwellings. This variable refers to the homeownership rate which, as explained in Section 2, experienced a sharp increase after the subprime mortgage expansion. Also, this variable highlights the prevailing economic condition and the inhabitants' preference between being owners versus renters. Therefore, testing this variable allows evaluating the incentive induced by subprime origination.

In order to confirm these assumptions, several regressions will be undertaken and their respecting results will be analysed in the following section.

The regressions are conducted using feasible generalized least squares given the panel-heteroskedastic assumption. Indeed, since the parameters used vary in time and in space, the error term have a high probability to also vary with each observation. Thus, the heteroskedastic assumption is a very realistic one. Similarly, the presence of AR(1) autocorrelation is very likely to occur within panels. Consequently, the estimation with feasible generalized least squares can be more efficient and preferred across panels.

To summarize, this analysis uses a panel model across the 100th largest agglomeration in the United-States for the year 2006 and 2007. The different variables that may have an impact on foreclosure are put at test using feasible generalized least squares to correct for the existence of heteroskedasticity. It is expected that subprimes, loan amounts, and homeownership rates are positively correlated with foreclosures. Moreover, income measurement is expected to be negatively correlated. Finally, refinancing would be more significant that home

purchasing.

Therefore, the regressions of interest are:

$$FORCL = \beta_1 + \beta_2 SUB + \beta_3 AMT + \beta_4 INC \tag{1}$$

$$FORCL = \beta_1 + \beta_2 SUB + \beta_3 AMT + \beta_4 INC + \beta_5 ODW \tag{2}$$

$$FORCL = \beta_1 + \beta_2 REFIN + \beta_3 AMT + \beta_4 INC \tag{3}$$

$$FORCL = \beta_1 + \beta_2 HOMEP + \beta_3 AMT + \beta_4 INC \tag{4}$$

where

FORCL Number of foreclosure

SUB Number of subprime loan originated

AMT Loan Amount

INC Income

ODW Homeownership rate

REFIN Refinancing subprime

HOMEP Home purchasing subprime

5.2 Data and descriptive statistics

The variables that are used in the estimation of foreclosures are extracted from a variety of sources.

First of all, there are only three available sources on subprime mortgages: the Federal Financial Institutions Examination Council (FFIEC), Mortgage Bankers Association (MBA) and private sector data providers such as First American LoanPerformance (LP) or McDash Analytics. The latter two are reporting subprime loans according to the lender's business if it is predominantly in the subprime category. FFIEC compiles subprime loans in accordance with the Home Mortgage Disclosure Act (HMDA), based on a threshold interest rates charged to the borrowers when the loan was emitted, i.e. higher-priced loans. Unfortunately, MBA only gathers data on a state level basis and LP's data are accessible only to subscribed users. Therefore, the data collected and used in this report are from the FFIEC accessible through the Home Mortgage Disclosure Act (HMDA) for the year of 2006 and 2007. The HMDA Disclosure Reports summarize mortgage information from data that are prepared yearly by individual institutions as well as provide information about individual loan such as the amount borrowed, the number of denied applications, the institutions that gave out the loan, etc...

On the other hand, the FFIEC publishes various nationwide census data based on the U.S. Census Bureau's 2000 census data. Census information used in this report are the number of Owner Occupied Units and the number of 1- to 4-Family units. Finally, FFIEC Census Reports include income estimates

developed by the United States Department of Housing and Urban Development (HUD).

Foreclosure data comes from RealtyTrac and are compiled on a micro-level basis for the largest 100 US MSA. RealtyTrac has been chosen because of its large database covering more than 90 percent of U.S. households' data on foreclosures. Also, RealtyTrac is the only online marketplace for foreclosure properties that have its data publicly available. Unfortunately however, a limited number of observations is accessible to the public (100 compared to the 363 existing MSA).

RealtyTrac data comes from their yearly foreclosure reports where they publish the total number of foreclosure filings by metropolitan area. Foreclosure filings include foreclosure-related documents in all three phases of foreclosure: Default, Auction, and Real Estate Owned (REO) properties (that have been foreclosed on and repurchased by a bank).

The household numbers are based on the U.S. Census Bureau's 2005 estimates of total housing units.

5.3 Estimations

After reviewing the related literature and explaining the model that will be used in this report, this section lays out the results obtained from the above model, describing their significance and attempting to explain them. In all the following models, p-values are in parenthesis below the corresponding variable.

5.3.1 Regression 1

$$FORCL = \underset{(0.076)}{-32971} + \underset{(0.00)}{0.36SUB} + \underset{(0.121)}{23.72AMT} + \underset{(0.025)}{399.79INC}$$

This is a very basic regression where only the subprime, the loan amount and the income variables are included and tested to evaluate their effect on foreclosure. In the following subsections, the regression will be revised, adding new variables to observe their subsequent effect on foreclosures. The effect of these new variables on the overall regression will also be studied, to hopefully obtain more insightful deductions.

In this first regression, the subprime coefficient and the income coefficients obtained are significant at 0 and 2.5%. Thus, the conduced regression is considered to be efficient. In addition, the coefficient of the loan amount variable is significant at 12%.

Moreover, the variables' coefficients are positive, which imply that all three variables are correlated with foreclosure. These results are not surprising since they confirm the review of literature. More particularly, they are in accordance with those of Schloemer, Li, Ernst, and Keest (2006) who assert that subprime loan origination inevitably leads to foreclosure.

Furthermore, with regard to the loan amount variable, the positive relation between the latter and foreclosure indicates that for larger loan amounts the risk of foreclosure is much higher. Thus, it may be that during the analysis' timeframe, the high level of foreclosure fillings can be explained by subprime companies giving greater loan amounts to the public. In other words, this result confirms the link between subprime mortgage expansion, decline of lending standards and excessive risk taken by lenders.

Finally, the income measure is also positively correlated with foreclosures. This coefficient seems at first unexpected and contrary to the common belief that poor people are the main agents behind the crisis. However, as mentioned in many papers, riskier strategies and speculative behaviour, and specifically refinancing, were more prevalent in richer neighbourhoods. This could be a valid explanation for the fact that the higher the income measure, the greater the foreclosures.

5.3.2 Regression 2

$$FORCL = \underset{(0.037)}{-42818} - \underset{(0.831)}{0.089SUB} + \underset{(0.123)}{23.54AMT} + \underset{(0.012)}{493.68INC} + \underset{(0.267)}{94.13ODW}$$

In this regression, the variable "owners over dwellings" is added to the model. This variable refers to the homeownership ratio. The main point is to test for the effect of a demographic variable on foreclosure and on the overall model. Also, this new regression aims at examining whether the previous results are still maintained.

Unfortunately, this model is far less significant than the first one: the only really significant coefficient is for the income variable and has a p-value of 1.2%. Also, another striking difference in this model is the sign of the subprime coefficient, but since the latter is not significant at all (p-value of 83%) there is no point in explaining the negative correlation with foreclosure. Moreover, the loan amount and the income variables show similar correlation with foreclosure and are more significant; this observation could suggest that the conformity of the results confirms their respective role in the subsequent crisis.

One final result to interpret in this regression is the homeownership ratio, which is the number of owners over the overall number of dwellings. The positive sign may lead us to believe that the subprime market created an incentive to people to choose being owners rather than renters.

However, due to the overall significance of the regression, the results obtained in this model will not be taken into consideration. In addition, in the following regression, the variable owners over dwellings will not be used.

5.3.3 Regression 3

$$FORCL = \underset{(0.004)}{-37180} + \underset{(0.00)}{0.076REFIN} + \underset{(0.14)}{22.49AMT} + \underset{(0.013)}{440.08INC}$$

In this regression, subprime loans are substituted with subprime refinancing loans. The basic idea is to examine subprime loans by their purpose instead of looking at the total number originated. The first purpose of loan origination that will be examined is loan refinancing; in the following model, the focus will be on home purchasing. Also, as mentioned previously, the variable owners over dwellings will not be included in order to preserve the overall significance of the model.

The results obtained are significant and thus the model is considered reliable. Indeed, most of the variables have a p-value below 1%, except the loan amount variable which significant at 14% (p-value of 14%).

As for the coefficients' signs, the loan amount variable and the income variable are positively correlated with foreclosure. These results are similar to those of the first regression and thus validate the analysis and the outcomes.

Finally, the refinance variable refers to the number of subprime loans originated for the purpose of cash out. Refinancing is in itself a risky behaviour that is associated with a great deal of speculation and thus is more sensitive to minor economic changes. In fact, Schloemer, Li, Ernst, and Keest (2006) refer to refinancing as a major component in the subprime mortgage expansion and believe that it exacerbated the credit crisis. Therefore, there is no surprise in finding that refinancing and foreclosures are positively correlated.

5.3.4 Regression 4

$$FORCL = -30042 + 0.66HOMEP + 27.01AMT + 372.36INC$$
$$\underset{(0.1)}{} \quad \underset{(0.001)}{} \quad \underset{(0.077)}{} \quad \underset{(0.039)}{}$$

This last regression focuses on subprime loan originated for home purchasing and tries to relate it to foreclosure. The coefficients obtained are significant at 5% and 8%, and are positively correlated with foreclosures. Therefore, the relation between the explained variable and the explanatory variables is consistent with previous results.

Furthermore, comparing regressions 3 and 4 reveals the effect of different loan purposes on the number of foreclosure fillings. Indeed the home purchase coefficient is 0.66 compared to 0.76 – for the refinancing coefficient. So, as expected, refinancing leads to a greater number of foreclosures; more specifically, refinancing leads to 10% more foreclosures than home purchasing. Surprisingly however, the difference between the two coefficients is not as large as expected.

6   Conclusion

Recently, many studies have focused on the mortgage crisis and tried to comprehend its origins. Many papers have proposed some potential solutions to prevent the occurrence of similar crisis in the future. This paper's main goal is to link the subprime mortgage expansion to the high default rate observed in the United States. In addition, it tries to find the relation between foreclosure and some key variables. The analysis covers more than one and a half million subprime loans that have been originated in 2006 and 2007.

This paper provides evidence that the sharp increase in foreclosure fillings is associated with subprime loans, loan amounts and income. First, there is evidence that subprime loans are riskier than conventional loans and thus were considerably responsible for foreclosure. More particularly, this paper finds that foreclosure is more sensitive to refinancing subprime loans than to home purchase subprime loans. Second, there is evidence consistent with existing work that foreclosure is associated with easing credit standards. Indeed, for greater loan amounts, there are higher levels of foreclosures where loan amounts are used as a proxy for credit standards. Finally, there is evidence that income played a role in worsening the real-estate crisis. It seems that richer neighbourhoods were more involved in risky practices increasing the probability of foreclosure. Moreover, the effect of homeownership on foreclosure is either weak or absent because including this variable reduce the overall significance of the model. These results seem relevant because they are consistent with related literature.

One limitation of this project is that the analysis is limited to only 100 MSA. Also, this study is focused around the years 2006 and 2007. Thus, the results obtained do not cover the whole effect of the subprime mortgage crisis.

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- Federal Reserve Board

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- Freddie Mac

- Lehman Brothers and Citigroup (2007)

- Office of Federal Housing Enterprise Oversight (OFHEO)

Appendix

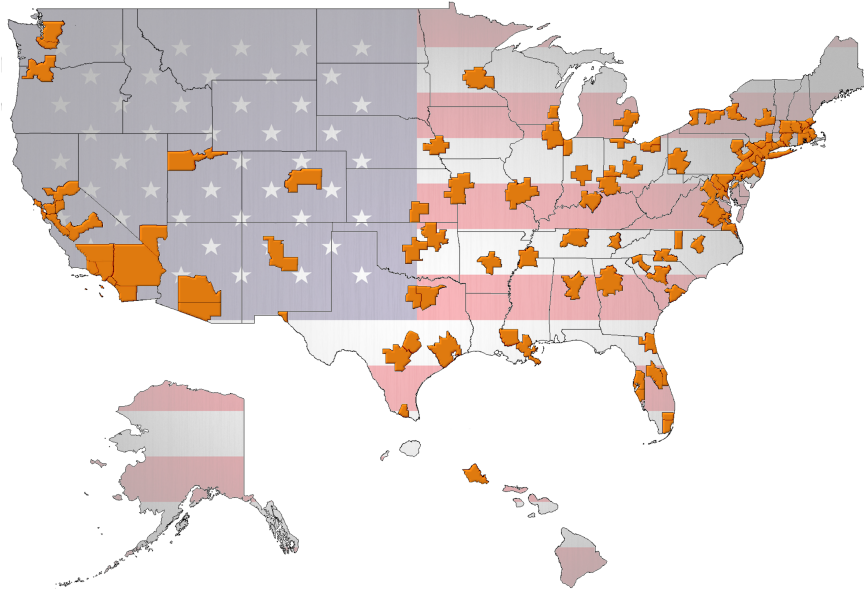Figure A.1: Distribution of the MSAs of interest

Table A.1: List of subprime lenders

AAMES FUNDING CORPORATION	HOMELAND MORTGAGE COMPANY
ACCREDITED HOME LENDERS, INC	HOMEOWNERS LOAN CORPORATION
ACOUSTIC HOME LOANS, LLC	HSBC MORTGAGE SERVICES, INC.
ACT LENDING CORPORATION	IMPAC FUNDING CORP
ADVANCED FINANCIAL SERVICES IN	INVESTAID CORPORATION
ADVANTIX LENDING, INC.	JLM DIRECT FUNDING LTD
ADVENT MORTGAGE, LLC	KELLNER MORTGAGE INVESTMENTS
AEGIS LENDING CORPORATION	LANCASTER MORTGAGE BANKERS
AIG FEDERAL SAVINGS BANK	LENDERS DIRECT CAPITAL CORP
ALLIANCE MORTGAGE BANKING CORP	LENDMARK FINANCIAL SERVICES
ALLIED MORTGAGE & FINANCIAL CO	LENDSOURCE INC
ALTERNATIVE FINANCING COP	LIBERTY AMERICAN MORTGAGE CORP
AMC MORTGAGE SERVICES, INC.	LIME FINANCIAL SERVICES, LTD.
AMERICAN BENEFIT MORTGAGE, INC	LOAN CENTER OF CALIFORNIA, INC
AMERICAN EQUITY MORTGAGE, INC.	LONG BEACH MORTGAGE CO.
AMERICAN GENERAL HOME EQU.(DE)	M&I BANK FSB
AMERICAN HOME EQUITY	MARIBELLA MORTGAGE, LLC.
AMERICAN HOME LOANS	MASTER FINANCIAL, INC.
AMERICAN PIONEER FINANCIAL SVC	MBNA AMERICA (DELAWARE), N.A.
AMERICAP FINANCIAL INC	MERITLENDING.COM
AMERIQUEST MORTGAGE COMPANY	MILA, INC.
AMERITRUST MORTGAGE COMPANY LLC	MLSG, INC.
ARGENT MORTGAGE COMPANY LLC	MONEY CORP (FN)
ASSOCIATES INT'L HOLDING CORP	MONEYONE, INC
BERGIN FINANCIAL, INC.	MOREQUITY, INC. (NV)
BRIDGE CAPITAL CORPORATION	MORTGAGE LENDERS NETWORK USA
BUDGET FINANCE COMPANY	NATION ONE MORTGAGE CO., INC.
BUDGET MORTGAGE BANKERS	NATIONSFIRST LENDING, INC
CALUSA INVESTMENTS, L.L.C.	NEW CENTURY MORTGAGE CORP
CASA BLANCA MORTGAGE, INC	NEW DAY FINANCIAL, LLC
CENTEX HOME EQUITY COMPANY LLC	NOVASTAR HOME MORTGAGE, INC.
CHAPEL MORTGAGE	NOVASTAR MORTGAGE, INC.
CHOICE CAPITAL FUNDING	NPB MORTGAGE, LLC
CITICORP TRUST BANK, FSB	OAK STREET MORTGAGE

CITIFINANCIAL COMPANY	OAK STREET MORTGAGE/GW
CITIFINANCIAL EQUITY SERVICES	OCEAN BANK FSB
CITIFINANCIAL SERVICES, INC.	OPTION ONE MORTGAGE CORP
CITIFINANCIAL, INC.	OPUS HOME EQUITY SERVICES, INC
COLUMBIA MORTGAGE & FUNDING CO	OWNIT MORTGAGE SOLUTIONS, INC
CONCORDE ACCEPTANCE CORPORATION	PEMM.TEK MORTGAGE SERVICES
CORESTAR FINANCIAL GROUP	PEOPLE'S CHOICE FINANCIAL CORP
CORINTHIAN MORTGAGE CORP	PINNACLE DIRECT FUNDING CORP
COURTESY MORTGAGE COMPANY	PLATINUM CAPITAL GROUP
DELTA FUNDING CORPORATION	POPULAR FINANCE, INC.
DOLLAR MORTGAGE CORPORATION	PREMIUM CAPITAL FUNDING
EASTERN SAVINGS BANK	RESMAE MORTGAGE CORPORATION
EHOMECREDIT CORP	RIGHT AWAY MORTGAGE, INC
EMPIRE MORTGAGE CORPORATION	SAXON MORTGAGE
ENCORE CREDIT CORP	SEBRING CAPITAL PARTNERS, L.P.
EQUIFIRST CORPORATION	SECURED FUNDING
EQUITY ONE, INC.	SELECT MORTGAGE GROUP, LTD.
EQUITY RESOURCES, INC.	SOUTHSTAR FUNDING
EVABANK	SPECTRUM FUNDING CORPORATION
EVERGREEN LENDING, INC.	SPRINT FUNDING CORPORATION
EXPRESS CAPITAL LENDING	STERLING MORTGAGE & INVESTMENT
FICORE FUNDING, INC.	STEWARD FINANCIAL, INC
FIELDSTONE MORTGAGE COMPANY	SUMMIT MORTGAGE
FIRST CHOICE FUNDING	SUNSET DIRECT LENDING
FIRST CONSOLIDATED MORTGAGE	TALBOT STATE BANK
FIRST CONTINENTAL MORTGAGE	THE CIT GROUP/CONSUMER FINANCE
FIRST GREENSBORO HOME EQUITY	THE LENDING CONNECTION, INC
FIRST NATIONAL BANK OF AMERICA	THE MORTGAGE OUTLET
FIRST NLC FINANCIAL SERVICES	THE MORTGAGE OUTLET, INC.
FIRST STATE MORTGAGE CORPORATION	TOWN & COUNTRY CREDIT CORP
FIRST STREET FINANCIAL, INC.	UNIMORTGAGE LLC
FLEXPOINT FUNDING CORPORATION	UNION FEDERAL SAVINGS BANK
FREMONT INVESTMENT & LOAN	UNITED MIDWEST SAVINGS BANK
GMFS, LLC	UNITED-BILT HOMES, INC.
HAMILTON MORTGAGE COMPANY	WALTER MORTGAGE COMPANY
HARBORSIDE FINANCIAL NETWORK	WELLS FARGO FIN'L, INC
HARBOURTON MORTGAGE INVESTMENT	WILMINGTON FINANCE, INC.
HOME LOAN MORTGAGE CORPORATION	WMC MORTGAGE CORP.