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The subprime crisis and its role in the financial crisis ☆

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ABSTRACT

This paper discusses some of the key characteristics of the U.S. subprime mortgage boom and bust and discusses the causes, particularly related to the relationship between subprime mortgage defaults and housing prices. We observe that housing prices and mortgage defaults had distinctly localized trends, but those trends ceased by 2005 when several states studied in this paper (Arizona, California and Nevada) began to move together. Furthermore, we observe the seriously delinquent subprime mortgages increased much more rapidly than was anticipated by historically-based econometric models. As such, this paper offers a partial explanation for how financial institutions misunderstood the declining house prices and increasing subprime default.

1. A review of recent events leading up to the subprime crisis

In the U.S., national average house prices rose between 93% and 137%, depending on the index employed, between 1996 and 2006.[1] Some markets, such as Los Angeles, Phoenix and Las Vegas, had even stronger house price growth. At the same time, mortgage interest rates were trending down, hitting 45-year lows in June 2003, and mortgage origination volume rose rapidly from $800 billion in 1996 to a peak of $3.9 trillion in 2003 (see Chart 1).[2]

Housing prices had been generally rising until 2006, although the S&P/Case-Shiller series and the OFHEO series demonstrated different turning points. Mortgage loan performance had begun to show signs of deterioration before the peak of the housing price run-up. Financial institutions began to curtail credit and mortgage spreads began to widen.

The housing market run-up in prices did not affect all markets equally. Certain markets in the industrial Midwest never saw any run-up in prices. Michigan and Ohio, part of the Midwest "rust" belt, lagged behind much of the country in terms of house price growth, primarily because of job loss and relocation to other parts of the country, such as the Southwest. In addition, while home prices rose rapidly in areas such as Phoenix, AZ, in the early part of this decade so did the number of jobs and population along with them. Over the five years ended in December 2006, Arizona gained over 400,000 nonfarm payroll jobs, and 88% of these were in the Phoenix metro area.[3] Las Vegas added an average 5000 people to its population each month over that same period.[4]

The current credit crunch is emblematic of the problems facing lenders and investors, with liquidity drying up and spreads widening dramatically on high quality prime mortgage-backed paper even though it continues to perform well. For example, serious mortgage delinquencies on prime fixed-rate mortgages were performing better than their 10-year average until the third quarter of 2007 when they began to rise, hitting 1.3% in the second quarter of 2008 while the

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[1] The two most often cited indices are the S&P/Case-Shiller Index and the Office of Federal Housing Enterprise Oversight (OFHEO) House Price Index.

[2] There is no authoritative source for mortgage originations data. See Pafenberg (2005) for a detailed analysis of data from the Home Mortgage Disclosure Act collected by the Federal Financial Institutions Examination Council, data collected and published by *Inside Mortgage Finance* and the Monthly Interest Rate Survey from the Federal Housing Finance Board. The data cited here are from HUD's Survey of Mortgage Lending Activity, *Inside Mortgage Finance*, and Freddie Mac.

[3] U.S. Bureau of Labor Statistics Monthly Employment Report.

[4] U.S. Bureau of the Census Population Estimates and Moody's Economy.com.

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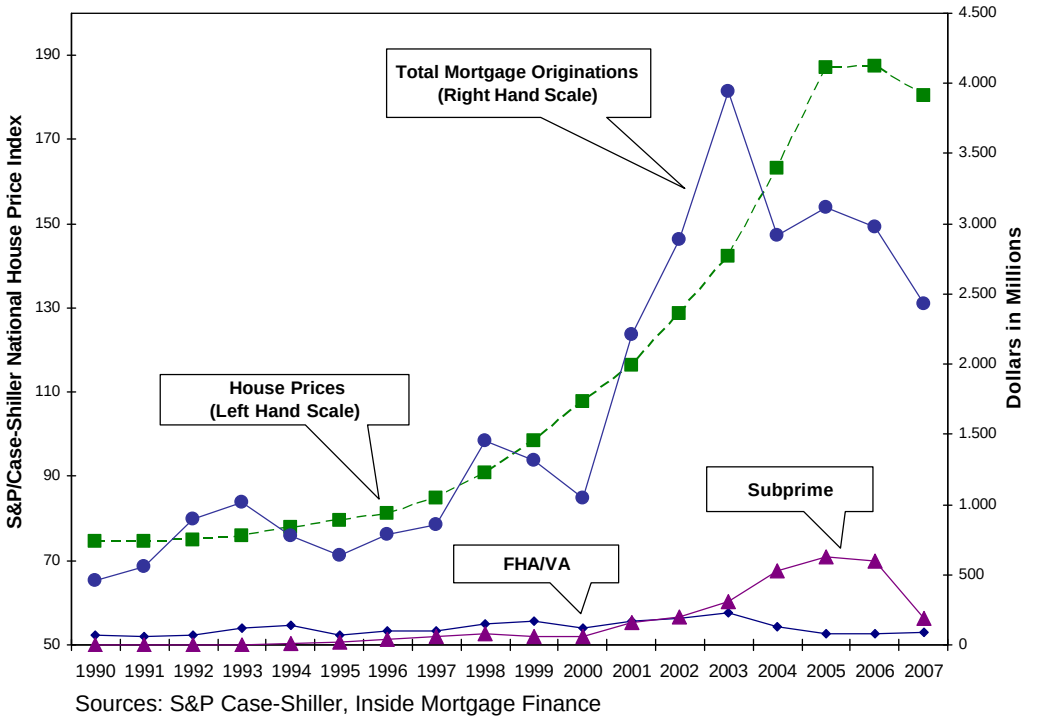


Chart 1. House prices and mortgage originations.

overall delinquency rates was 4.5% (Mortgage Bankers Association, 2008). Nonetheless, banks began to tighten credit in the fourth quarter of 2006, even on prime credit loans.

Chart 2 shows the net share of banks that reported tightening mortgage-lending standards over the prior three months in The Federal Reserve Board's Senior Loan Officer Survey along with serious mortgage delinquencies. The Fed only recently began separating the questions on prime and subprime mortgage lending in the first quarter of 2007, and the Mortgage Bankers Association began separating subprime and prime mortgage delinquency data in 1998. The Fed's Survey shows that when banks first began to tighten underwriting standards in the fourth quarter of 2006 the net share was small at 1.6%. By the third quarter 2008 survey, the net share of banks tightening prime mortgage underwriting standards was 74%, the highest share recorded in the 19-year history of the survey.

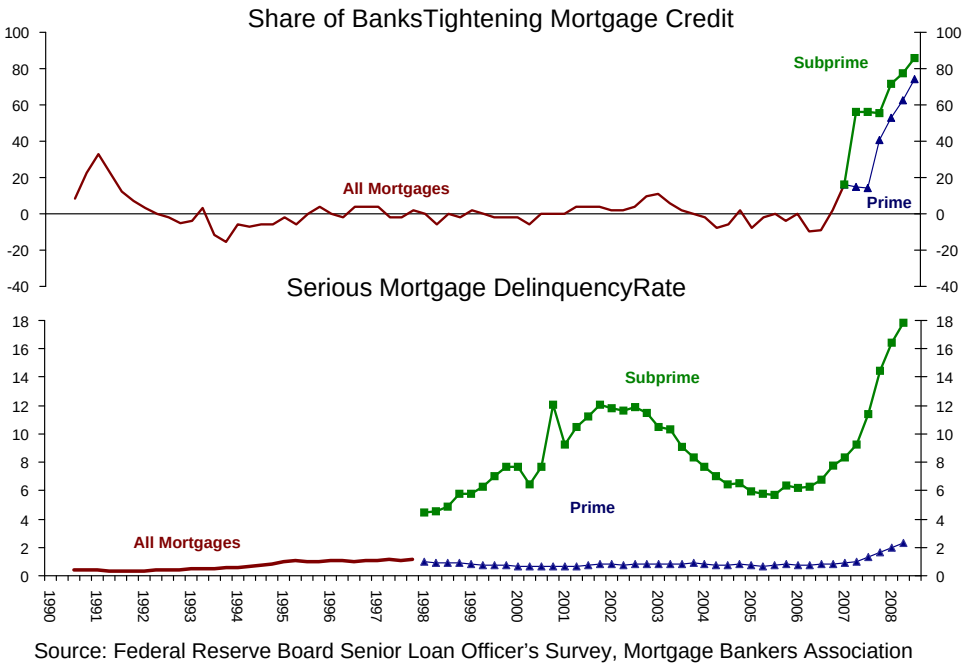
An important question is how this cycle differs from those of the past. For example, California has seen its share of booms and busts in home prices, and given past booms, we might reasonably expect a certain consistency in the relationship between home-value declines and delinquencies. On the other hand, this is a very modern mortgage market with many new and untested loan products.

2. The rise of new loan products

Despite what is popularly believed, few mortgage products introduced in recent years were truly new. Negatively amortizing loans have been around in various forms since the mid-1980s when the Depository Institutions Deregulation and Monetary Control Act of 1980 (DIDMCA) eliminated state laws limiting the maximum interest rate lenders could charge borrowers and the Alternative Mortgage Transaction Parity Act of 1982 authorized the use of and preempted state laws restricting loans with variable interest rates, balloon payments, and negative amortization (Missal, 2008). So called hybrid ARMs which feature a period of fixed interest rates followed by a longer period over which interest rates vary are a reinterpretation of traditional ARMs, which tended to feature constant-length adjustment times.

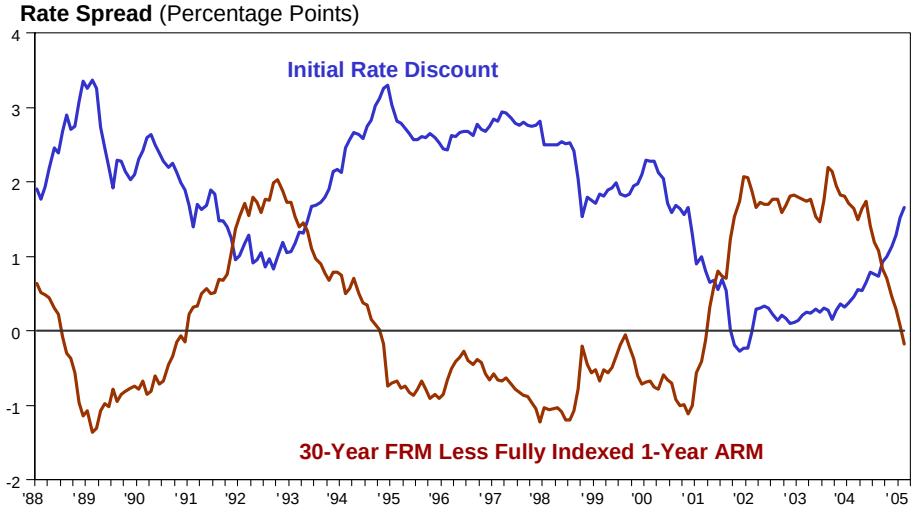
Teaser interest rates have been around since ARMs were invented as a way to create demand for these products when lenders face a relatively flat yield curve. Chart 3 shows the initial or teaser rate discount on prime one-year adjustable rate mortgages and the prime mortgage yield curve. In periods of a flat or inverted yield curve the discount could run as high as 3% points but the difference between the 1-year ARM rate and the 30-year fixed mortgage rate was one percentage point or less. In the subprime segment, Foote et al. (2008) show that the initial teaser rate on 2/28 ARMs averaged 7.3% in 2004 and increased to 8.6% in 2007, with an average spread of about 3% over the one year prime ARM rate. The average fully indexed subprime rate fell from 11.5% in 2004 to 9.1% in 2007. For reference, Prime conventional, conforming 1-year ARM coupon rates averaged 3.9% in 2004 and rose to 5.6% in 2007.[5] Due to the already high interest rates on subprime ARM loans and

[5] Primary Mortgage Market Survey®, Freddie Mac.



Source: Federal Reserve Board Senior Loan Officer's Survey, Mortgage Bankers Association

Chart 2. Tightening mortgage credit and mortgage delinquency rates.



Note: ARM data are for the 1-Year Treasury-indexed ARM; indexed rate is the sum of the 1-Year Constant-Maturity Treasury and the ARM margin, and the discount is the difference between the indexed rate and the actual first-year rate

Source: Primary Mortgage Market Survey®

Chart 3. ARM rate discount and mortgage yield curve.

initial discounts of almost 4% points in 2004 when the Federal Funds effective rate was averaging 1.35%, the payment shock at reset in 2006 on the loans when the Fed Funds rate rose to nearly 5% was enormous. Thus when the first wave of subprime defaults began in earnest, the problem was viewed to be a reset issue. But index Treasury and LIBOR rates fell in late 2006 and early 2007, transferring the problem from one of resets to one of badly performing loans.

Markets and academics have been mistaken on "new" mortgage loans in the past. The price-level adjusted mortgage, or PLAM, was introduced in the early 1980s as a mortgage that kept the real rate of interest constant by negatively amortizing the difference between real and nominal interest rates. This type of loan was viewed as the mortgage product of the future by Hendershott and Villani (1983) and Carr and Smith (1983), and other skilled housing

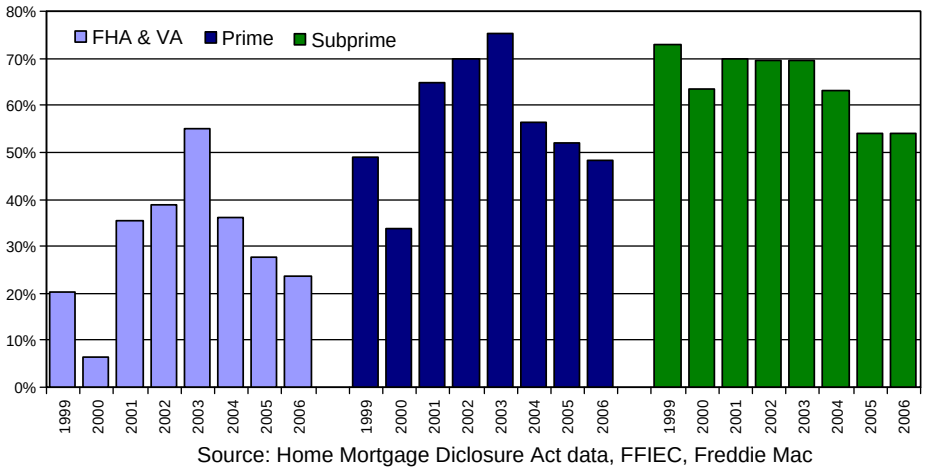


Chart 4. Refinance share of mortgage originations.

economists at the time (Hendershott and Weicher 2002). The success of this product was predicated on continuing high inflation, and when the Fed under Volcker's leadership brought down inflation, it also killed off demand for PLAMs. Other mortgage products, at least modified variations of older mortgage products, have been difficult to model correctly concerning how borrowers will react to changes in the terms, particularly when housing prices are declining.

For the most part, the more exotic mortgage products were kept in niche markets catering to sophisticated mortgage borrowers with unique financial circumstances. The rise in home values that eroded housing affordability at the same time creating greater demand for homeownership as a wealth accumulating vehicle led lenders and borrowers to seek features in mortgage financing that would allow them greater flexibility in choosing a home or to qualify for homeownership earlier than they otherwise would have using prime fixed-rate financing. In 2001, subprime originations represented 7% of the total single-family mortgage originations market and by 2006 subprime loans made up more than 20% of new originations. Alt-A loans represented a little over 2% of mortgage originations in 2001 and grew to 14% of originations by 2006.[6] In addition, over this time the subprime mortgage segment transitioned from being primarily a refinance market irrespective of changes in interest rates to a significant source of home-purchase financing (Chart 4).

The share of mortgages issued for non-owner-occupied homes rose to over 20% in 2005 from its average of 13% during 1999–2003.[7] The share may have been higher given incentives to misrepresent occupancy status to avoid higher mortgage costs and the difficulty of verification of intent. But the non-owner-occupied shares are highest along the Florida coast, coastal California, Phoenix, Tucson, Las Vegas and Hawaii. Not knowing about home price appreciation, these shares would make sense given the vacation–destination or snowbird attraction of these areas. However rapid home price appreciation may have fueled demand above already high levels.

Non-prime, higher risk mortgage products were segmented geographically and the neighborhood level in addition to broader regional patterns. Mian and Sufi (2008) show that mortgage credit-underwriting standards were relaxed from 2001 to 2005 in zip codes with large numbers of high-risk borrowers and negative relative income and employment growth. Relaxed standards were associated with increased mortgage lending, rising house prices, and a subsequent increase in defaults in their study. Agarwal et al. (2008) show that subprime lending activity was concentrated in areas of Phoenix that was older, newer or poorer, while loans to non-occupant investors were concentrated near vacation-oriented zip codes.

3. Subprime default and declining housing prices

One of the problems facing financial institutions that have either originated subprime loans or have purchased subprime asset-backed securities is that the decline in housing prices has contributed to the dramatic increase in subprime and Alt-A mortgage defaults. While there are other motivations for default such as job loss, housing price declines are very important because borrowers who otherwise might have sold the property or refinanced

[6] The subprime segment of the market is often defined as mortgage loans made to borrowers with blemished credit, which is sometimes interpreted to mean those with FICO® credit bureau scores below 620 or 660, loans originated by a lender who specializes in subprime loans, loans with a high coupon interest rate (the current *Home Mortgage Disclosure Act* reporting requirement is one such example of the interest rate definition), or by loan product, such as a 2/28 ARM or 3/27 ARM loan. The Alt-A segment is usually defined by loans that have prime or near prime credit (credit scores above 660), but for various reasons have no or limited documentation of income or assets as might occur with a self-employed borrower. It can also denote loans with nontraditional features such as interest-only or negative-amortization payments. Alt-A loans are usually included in prime mortgage statistics when data are not specifically separated. See also Lax et al. (2004). Statistics cited here are from Inside Mortgage Finance (2008).

[7] Data from First American CoreLogic's LoanPerformance Prime Servicing database. The shares are about one-percent lower among non-prime loans in LoanPerformance Securities (ABS) database.

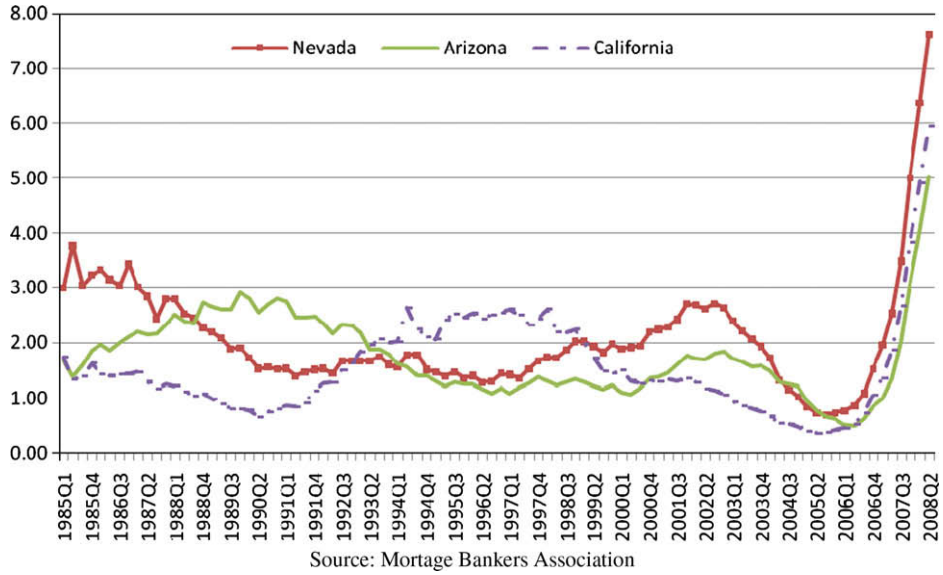


Chart 5. Serious delinquent mortgage rates (Prime and subprime) from 1985Q1–2008Q2.

when they hit a financial problem no longer have these options. In this section, we examine the States of California, Arizona and Nevada in terms of the characteristics of the subprime loans that were originated and their sensitivity to the decline in housing prices.[8]

California, Arizona and Nevada provide an excellent laboratory to examine the issue of housing price declines and increasing mortgage defaults. These states had the largest increase in housing prices during the 2000–2005 period. In addition, given the rapid deterioration in housing affordability, these states experienced a fundamental change away from the traditional full asset and income documentation, fixed-rate mortgage to low-documentation adjustable-rate mortgages.

In Chart 5, we examine the history of seriously delinquent mortgage loans going back to 1985. Since we were not able to obtain subprime mortgage delinquency data that is separate from prime mortgages prior to 1998, the exhibit delinquency information for all mortgages combined. While all three states experienced a dramatic increase in serious delinquency rates for mortgage loans during 2006 and 2007, they all have a history of serious delinquency problems with mortgages and the cycles sometimes move in the opposite directions. For example, seriously delinquent loans rates increased in Arizona during 1985 through 1991 while seriously delinquent loans in Nevada decreased over the same period, showing the importance of local economies and employment rather than a national systematic loan-delinquency problem. California, on the other hand, followed Nevada declines in serious delinquency rates over 1985 though 1991; however, California began experiencing increasing seriously delinquent rates that peaked in 1994 and did not begin declining until 1998. The negative correlation between Nevada and California from 1994 through 2002 once again highlights the importance of local and regional economies in mortgage defaults rather than a pervasive systematic effect. Beginning in 2002, serious delinquency rates for each state began moving together, and in particular all saw dramatic increases in delinquency rates beginning in 2006.

Housing price changes in Arizona, California and Nevada show interesting patterns as well.[9] As can be seen in Chart 6, California experienced rapid increases in housing prices in the 1985–1990 followed by falling housing prices (for most quarters) until 1996. Arizona and Nevada experienced consistent slow growth (with the exception of several quarters during the 1985–1990 period). While all three states showed accelerating price appreciation in 2003, California and Nevada growth rates were double that of Arizona's. Arizona peaked in terms of growth in 2005 Q2 while the growth rates in Nevada and California were beginning to slow down. Starting with 2005 Q2, housing price growth rates again moved together in terms of first deceleration in appreciation and then finally experiencing negative (and accelerating) housing prices growth rates. Like the mortgage serious delinquencies, we observe localized housing prices as maintaining some degree of difference until 2005 Q2 when the three housing markets moved in synchronicity. Once again, this represents a paradigm shift in our understanding of housing markets and its impact on mortgage delinquencies.

In terms of the subprime mortgages that were originated in California, Arizona and Nevada, the type of loans began converging on a similar set of mortgage types and terms. Over the period 2003–2007, the California, Arizona

[8] Pence (2006), cutts and Merrill (2008), Ambrose and Sanders (2004) and others have examined the importance of state regulations in the study of mortgage markets.

[9] See Glaeser et al. (2005), Leamer (2007) and others for a discussion of the housing bubble and cycles.

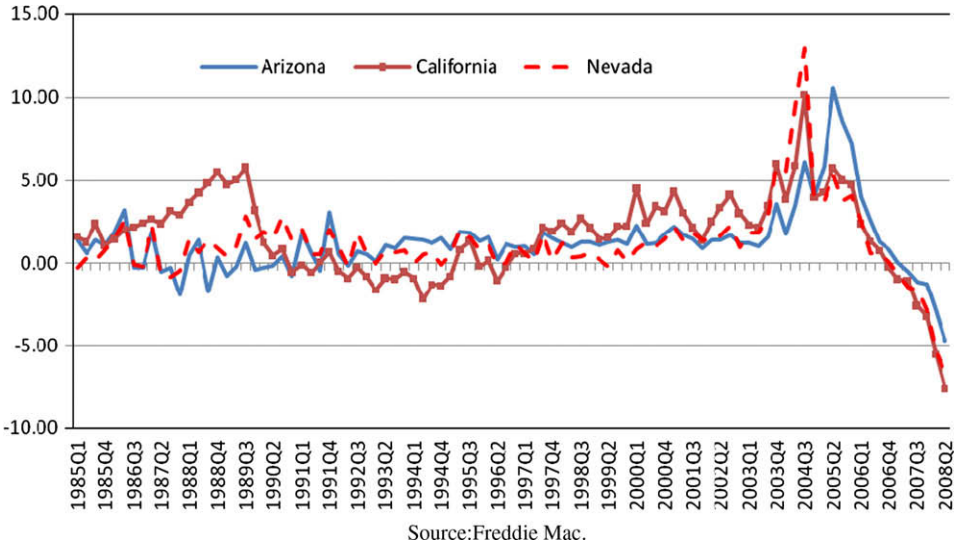


Chart 6. House price changes by state: Arizona, Nevada and California, 1985Q1–2008Q2.

and Nevada subprime (or nonprime) markets can be categorized as the following: (1) high percentage of adjustable rate mortgages; (2) high percentage of non-traditional mortgages (starting in 2004); and (3) high percentage of low- or no-documentation loans (see Tables 1–3). In addition, average loan-to-value ratios of around 80% were generally adequate in normal market conditions to provide a buffer against default, as long as housing prices did not decline more than 20%. First-lien LTV ratios increased in these markets slightly over the period but total LTVs, including subordinate liens, increased significantly. Perhaps the most interesting change in all three states is the rapid increase in non-traditional mortgages, which includes option-payment ARMs and other similar products often termed as "exotic" mortgages.

In Charts 7–9, we examine the California, Arizona and Nevada housing markets from the peak growth of housing prices (2005) to the second quarter of 2008. All three states have a remarkable similar experience. Housing price growth rates reached their peak in 2005–2006 and began to slow down. Negative house price growth began in 2006 for most states. As negative housing price growth accelerated, the seriously delinquent loan rate accelerated as well.

Table 1
Characteristics of nonprime mortgage originations by year, California.

	2003	2004	2005	2006	2007
Adjustable rate mortgages (%)	77	90	91	89	77
Non-traditional mortgages (%)	29	64	77	71	80
Non-owner share (%)	11	12	12	10	12
Share of low-no documentation (%)	57	63	74	80	80
Debt-to-income ratio (%)	40	40	41	41	40
Average loan-to-value (%)	81	80	79	79	79
Average FICO credit score	687	692	697	698	716

Source: First American CoreLogic. First liens only; by dollar amount. Nonprime loans include subprime and Alt-A loans in ABS securities.

Table 2
Characteristics of nonprime mortgage originations by year, Arizona.

	2003	2004	2005	2006	2007
Adjustable rate mortgages (%)	65	82	81	81	73
Non-traditional mortgages (%)	17	51	66	62	70
Non-owner share (%)	20	25	30	21	23
Share of low-no documentation (%)	51	50	62	70	71
Debt-to-income ratio (%)	37	37	38	40	39
Average loan-to-value (%)	85	82	80	80	82
Average FICO credit score	677	687	693	691	706

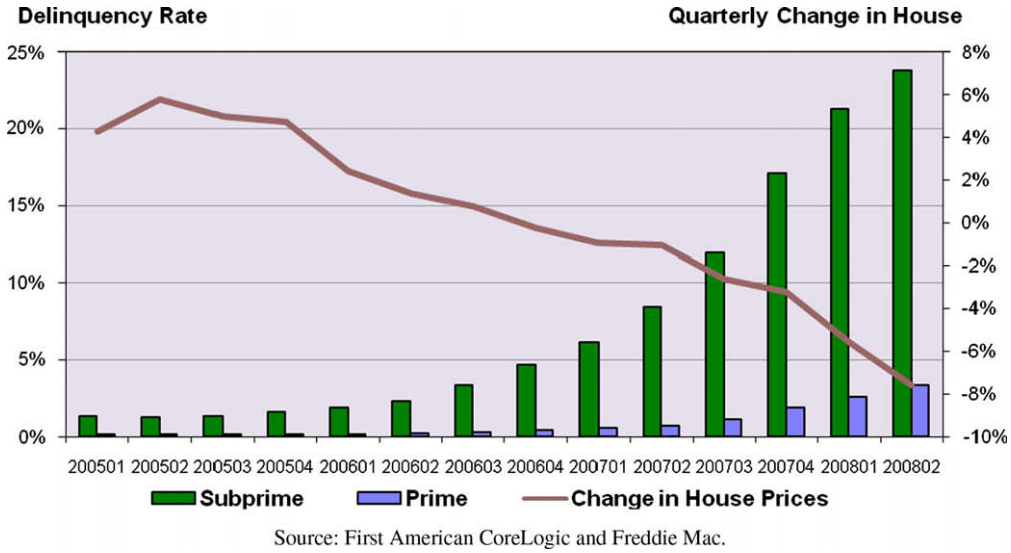
Source: First American CoreLogic. First liens only; by dollar amount. Nonprime loans include subprime and Alt-A loans in ABS securities.

Table 3
Characteristics of nonprime mortgage originations by year, Nevada.

	2003	2004	2005	2006	2007
Adjustable rate mortgages (%)	63	87	86	83	75
Non-traditional mortgages (%)	12	51	72	70	74
Non-owner Share (%)	22	27	26	24	27
Share of low-no documentation (%)	58	64	70	76	74
Debt-to-income ratio (%)	38	38	39	41	39
Average loan-to-value (%)	85	82	80	80	82
Average FICO credit score	678	688	692	693	708

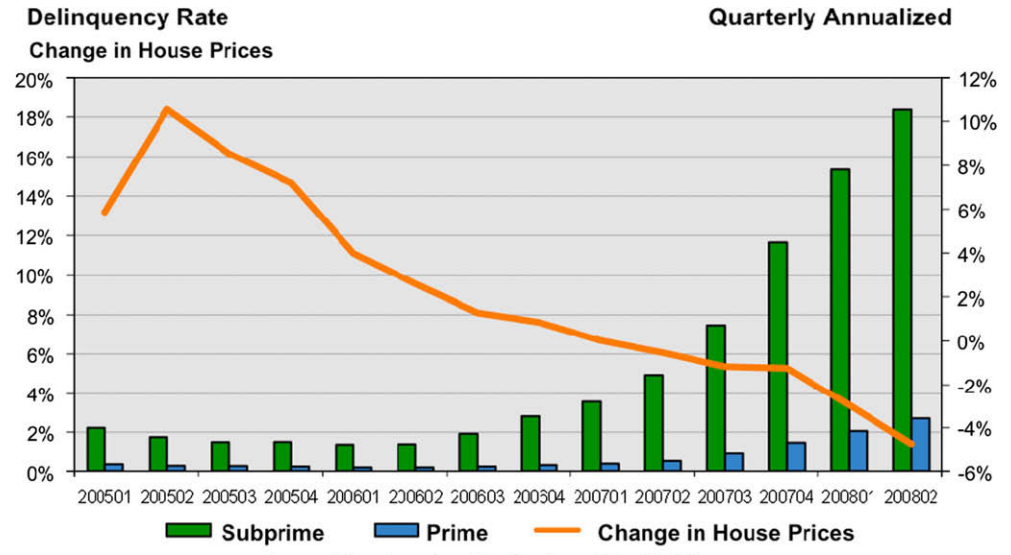
Source: First American CoreLogic. First liens only; by dollar amount. Nonprime loans include subprime and Alt-A loans in ABS securities.

Perhaps the most stunning observation about these markets is that the fundamental relationship between house price growth and subprime mortgage delinquencies changed over time, notably in 2005 and 2006. Up until 2005 and 2006, we actually observe accelerating housing prices and declining subprime mortgage delinquencies (see Charts 5 and 6). There was a switching point that occurred in the 2005 and 2006 years where the relationship between a slowing/declining housing market and an increase in subprime delinquencies dramatically changed.



Source: First American CoreLogic and Freddie Mac.

Chart 7. Housing price declines and subprime delinquency rates by year, California.



Source: First American CoreLogic and Freddie Mac.

Chart 8. Housing price declines and subprime delinquency rates by year, Arizona.

This fundamental change in the relationship between house prices and subprime delinquencies is quite troubling from a risk management perspective if the models are based on historical information.

Thus, the fundamental relationship between seriously delinquent subprime mortgage rates and housing price changes experienced a dramatic change in the 2005–2006 period. When we combine this result with the previous finding that mortgage default had been localized/regionalized prior to the latter half of 2002 and particularly by 2006, it is clear that there is a fundamental paradigm change in default and housing price models that has profound implications for risk management models and the hedges put into place on subprime mortgage asset-backed securities (ABS) and for financial institution models of mortgage (and bank) risk.[10]

4. Summary and conclusions

In this paper, we examine the relationship between housing prices and seriously delinquent mortgage rates in three states: Arizona, California and Nevada. We find that the housing and mortgage markets demonstrated cy-

[10] For example, Demyanyk and van Hemert (2007) and Foote et al. (2008) found in loan-level analysis that having datailed characteristics of the loans in portfolios and understanding past trends in delinquency and house-price behavior does not explain current events.

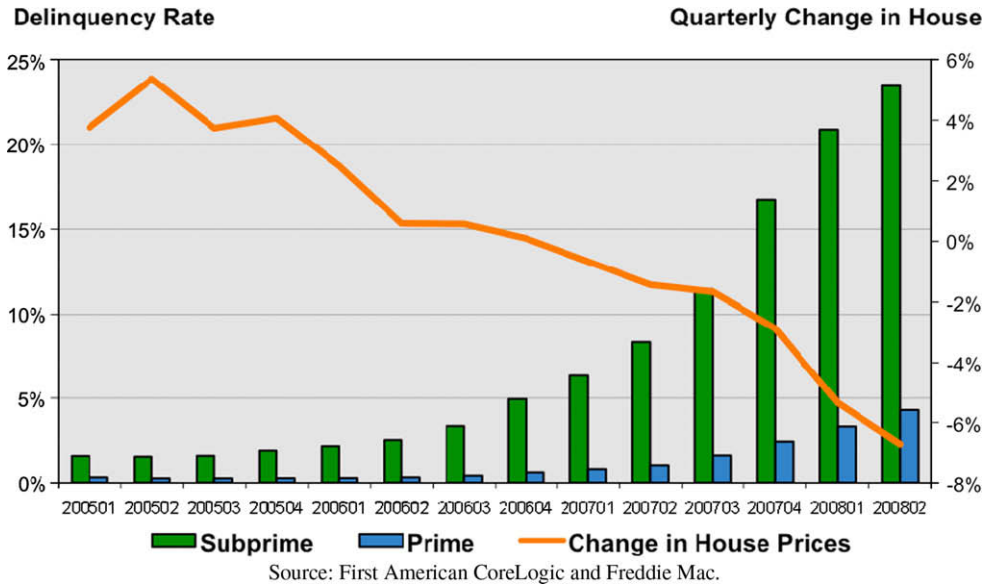


Chart 9. Housing price declines and subprime delinquency rates by year, Nevada.

cles that were often inversely related to each other until 2005. After 2005, housing prices and seriously delinquent mortgage rates were closely related.

We also found that before 2005, housing price changes in these states were related to changes in seriously delinquent mortgage rates, but there relationship was weak at best (and non-existent for California). However, in the 2005–2008Q2 period, we found that the relationship had fundamentally changed and that house price changes and seriously delinquent subprime mortgage rates were strongly related. That is, as housing prices continued to fall, serious delinquent subprime mortgage rates continued to increase.

The results in this paper are important for risk managers at financial institutions, investors and government agencies in that it demonstrates that sophisticated risk management models based on historical data can be misleading if the relationship between housing prices and subprime defaults were not properly modeled. The sudden paradigm shift in 2005 and 2006 demonstrates that markets can change dramatically and the most sophisticated models can be taken by surprise.

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