Systemic Risk and Market Institutions

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Abstract

With private-label mortgage-backed securities (MBS), investors bore default risk; while this risk should have been priced, as systemic risk grew, the pricing of risk did not increase. This paper attempts to explain why this happened. We point to market institutions' incentive misalignments that cause asset prices to rise above fundamentals, producing systemic risk. The model attributes the asset price inflation to the provision of underpriced credit as lending institutions misprice risk to gain market share. The resulting asset price inflation itself then generates further expansion of underpriced credit.

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1. Introduction

Today's financial crisis is the result of market institutions' "rules of the game" that produce systemic risk. In efficient markets, asset prices follow a random walk. We point to market institutions' incentive misalignments that cause asset prices to rise above fundamentals, producing systemic risk. We first describe the pro-cyclical expansion of underpriced credit in the U.S. that drove asset prices up. We then briefly present the basics of a model which explains that this outcome is inevitable, given incentives to take risk to gain short-term profits. The model attributes the asset price inflation to the provision of underpriced credit as lending institutions misprice risk to gain market share. The resulting asset price inflation itself then generates further expansion of underpriced credit. We conclude with a discussion of why markets fail to contain inflated asset prices through the short-selling of assets or indices of assets and offer implications for market institutions going forward.

2. The Recent Deterioration of Lending Standards

The US housing mortgage and housing markets are at the center of the worldwide credit bubble and the subsequent financial crisis. The volatility adjusted run-up in US housing prices, particularly after 2003, exceeded price increases among all the major trading partners of the US. Similarly, the recent volatility-adjusted price decline is also more severe in the US relative to its major trading partners.[1] The price and price-rent ratios that were increasing in the US before 2003

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[1] For a discussion of why this occurred in 2003 and the role of fundamentals in the pricing of homes prior to 2003 but not after, see Andrey D. Pavlov, Zoltan Poznar & Susan M. Wachter, *Subprime Lending and Real Estate Markets*, *in* MORTGAGE AND REAL ESTATE FINANCE (2008). Appendix Figure 1 displays the volatility-adjusted price indices for 8 international markets; Jesse M. Abraham, Andrey Pavlov & Susan M. Wachter, *Explaining the United States' Uniquely Bad Housing Market*, 12 WHARTON REAL ESTATE REV. 24 (2008). The U.S. housing market is a clear outlier in terms of its price run-up and subsequent decline. For a history of the evolution of mortgage markets and their regulation, see Richard K. Green & Susan M. Wachter, *The Housing Finance Revolution*, 31 ECON. POL'Y SYMP.: HOUSING, HOUSING FIN., & MONETARY POL'Y, FED. RES. BANK OF KANSAS CITY (2007); Richard K. Green & Susan M. Wachter, *The American Mortgage in Historical and International Context*, 19 J. OF ECON. PERSP. 93 (2005); Patricia A. McCoy, Andrey D. Pavlov & Susan M. Wachter, Systemic Risk Through Securitization: The Result of

were attributable to interest rate declines and income increases, but not so after 2003. The US house price run-up post-2003 was accompanied by a credit bubble as subprime and other nontraditional mortgage lending took off in 2003. These loans differed from previously prevalent securitized agency debt in their lower lending standards, which, in turn, permitted constrained borrowers to overcome credit barriers and increased the demand for homes.

As the amount of nonprime lending increased, both absolutely and as a share of overall lending, the price of risk imbedded in these loans, rather than increasing, as might have been expected, decreased, both relatively and absolutely. For example, many of these loans were "teaser rate" adjustable rate mortgages (ARMs)[2] and as such were priced off of LIBOR.[3] Over time the margin over LIBOR decreased, despite the fact that as marginal borrowers became homeowners, the average borrower became riskier.

As the demand for homes increased, with the marginal borrower now able to overcome credit barriers, prices increased. Default rates, driven by loan-to-value ratios, thus remained low. With rising home prices it might have seemed reasonable that with the resetting of teaser rate loans and recasting of option ARMs [4], it would not be a problem to refinance, since home prices would rise and exceed debt levels.

Each non-recourse mortgage loan contains an imbedded put option that allows the borrower to "put" the property to the lender for the outstanding balance of the loan by defaulting on the loan. In other words, the borrower owns a put option that they can exercise against the

Deregulation and Regulatory Failure (2009) (unpublished working paper, on file with Yale Journal on Regulaiton).
[2] Teaser rate ARMs are adjustable-rate mortgages with a low introductory rate, "teaser rate," which is reset after two or three years to a higher interest rate.
[3] The London Interbank Offer Rate (LIBOR) is an exchange-settled interest rate for low-risk borrowers that is often used as a benchmark for risk-free lending.
[4] Option ARMs are adjustable-rate loans that allow the borrow to choose the monthly payment depending on their financial situation at the time. In particular, borrowers are allowed to make payments that do not even cover the interest rate on the mortgage, thus allowing the balance of the mortgage to increase over time.

lender to effectively sell the asset for the outstanding loan balance. The increased availability of lending at lower borrowing costs is reflected in the lower price of these loans and the underpricing of the put option embedded in these loans over time. This underpricing allowed an increase in demand and an increase in the price of the housing asset collateralized by the newly affordable lending. A housing price increase of unprecedented magnitude made refinancing possible, forestalling inevitable defaults and foreclosures and making nonprime lending appear safe.[5]

The market share of nonprime loans grew from under 15% in 2001 to almost half of originations by 2006 (the sum of the market share of Helocs, Alt-A, and subprime as shown in *Table 1*).[6] Within loan types, consolidated transaction price-based loan-to-value ratios (CLTV) also increased, as shown in *Table 2*. This implies borrowers were able to obtain financing with smaller and smaller downpayment at the same or declining borrowing costs. Also, *Table 2* shows, as systemic risk increased with higher CLTVs and with the growth in overall market share of riskier loans, the price of risk did not increase. Poorly underwritten teaser rate and pay-option or interest-only loans in particular took over 50% or more of the subprime origination market in many states. Such loans were extended disproportionately in states where mortgages were previously not affordable, as shown in Figures 1-4, thus temporarily expanding the market for homeownership and driving up prices.

When in the spring of 2007, credit conditions reversed, it was the markets where nonprime had expanded the most that were particularly vulnerable to the seizing up of nontraditional credit. Thus it was in the high priced, difficult to develop "sand states" where

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[5] *See* Andrey Pavlov & Susan M. Wachter, *The Inevitability of Marketwide Underpricing of Mortgage Default Risk*, 34 REAL EST. ECON. 479 (2006).
[6] "Heloc" stands for Home Equity Loan, "Alt-A" denotes alternative documentation loans, i.e., loans with limited documentation of income, asset value, or both, and "subprime" generally denotes mortgage loans extended to borrowers with prior credit problems or who are riskier in some other fashion.

housing was initially non-affordable that housing prices exploded with the wave of aggressive mortgage product and imploded as credit dried up (see *Figure 5*).

The problems of falling house prices and mortgage defaults and foreclosures, however, are no longer confined to the nonprime market. The extension of credit to marginal buyers increased the price of all homes and the subsequent withdrawal of credit reversed this change. Using reasonable 80% loan-to-value ratios, homes that were originally carefully underwritten are now also underwater. As home prices fall and unemployment rises, borrowers are defaulting on these loans as well, although defaults and foreclosures are greatest in markets where "aggressive lending" expanded loan demand.

3. *Loan Underpricing and Asset Prices*

In what follows we offer a model that links loan risk underpricing with real estate asset prices to explain why underpricing occurs. We identify the conditions under which asset price rises are not incidental or accidental but inevitable in the face of deteriorating lending standards. In other words, as the risk premium on residential mortgages drops to an artificially low level, this causes the asset price of houses to go up, leading to an asset value appreciation. This appreciation creates a false sense of security in the lenders and generates further deterioration of lending standards and asset price increases.

3.1. Lending Standards and Asset Prices

Following our previous work,[7] we note that the transaction price of an asset financed through a non-recourse loan is the composite of the fundamental value of the asset, *V*, the market value of the mortgage loan, *M*, and the face value of the adjustable-rate mortgage loan, *B*:

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[7] Andrey D. Pavlov & Susan M. Wachter, *Mortgage Put Options and Real Estate Markets*, 38 J. REAL EST. FIN. & ECON. 89 (2009).

$$P = V(\sigma) - M(\sigma, s(\sigma)) + B, \tag{1}$$

where σ denotes the expected future volatility of the asset and s denotes the option-adjusted spread of lending over risk-free interest rates.[8] This spread compensates the lender for the default risk of the mortgage. If this default risk is priced correctly, then the market value and the face value of the mortgage are the same, $M(\sigma, s(\sigma)) = B$, and the transaction price equals the fundamental value of the asset. If the risk of default is underpriced, then the transaction price of the real estate asset reflects not only the fundamental value of the asset, but also the mispricing of the mortgage, $B - M(\sigma, s(\sigma))$. If the market value of the mortgage is below the face value of the mortgage, then the transaction price exceeds the fundamental value of the asset because efficient equity markets take advantage of the mispricing and the asset is assumed to be of fixed supply.

A change in the spread, s, between lending rates of the bank cost of capital may in some cases be a rational response to declines in the volatility of the underlying asset. In this case,

$$\frac{\partial P}{\partial \sigma} = \frac{\partial V}{\partial \sigma} - \frac{\partial M}{\partial \sigma} - \frac{\partial M}{\partial s} \frac{\partial s}{\partial \sigma} \tag{2}$$

Assuming the volatility of the asset is fully diversifiable i.e., $\frac{\partial V}{\partial \sigma} = 0$, the right hand side of Equation (2) equals to zero because the spread adjusts to compensate the lender for the changes in the value of the put option embedded in the mortgage loan, $\frac{\partial M}{\partial \sigma} + \frac{\partial M}{\partial s} \frac{\partial s}{\partial \sigma} = 0$. If the increase

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[8] Option-adjusted spread denotes the spread of a lending rate over the risk-free rate adjusted for the leverage with which the asset is purchased ("loan-to-value ratio") and other characteristics of the asset that capture property-specific risks. The option-adjusted spread in our model accounts for the market risk in the loan outside the property and loan-specific characteristics.

in volatility affects the covariance of the asset return with the market, then $\dfrac{\partial V}{\partial \sigma} < 0$, but still

relatively small.[9]

The response of the asset price to the spread is:

$$\frac{\partial P}{\partial s} = \frac{\partial P / \partial \sigma}{\partial s / \partial \sigma} = \frac{\partial V / \partial \sigma}{\partial s / \partial \sigma} = 0 \tag{3}$$

Therefore, the correlation between transaction prices and lending spread is zero if the

increase in asset volatility is diversifiable, and close to zero if it affects the covariance between

the asset and the overall market.

If, on the other hand, the spread declines because of underpricing, not in response to

changes in expected future asset volatility, the response of the price to the spread is very

different:

$$\frac{\partial s}{\partial \sigma} = 0, \ \frac{\partial V}{\partial s} = 0, \ \frac{\partial M}{\partial s} > 0, \tag{4}$$

therefore,

$$\frac{\partial P}{\partial s} = \frac{\partial V}{\partial s} - \frac{\partial M}{\partial s} = -\frac{\partial M}{\partial s} < 0. \tag{5}$$

In other words, if the decline in the spread of lending rates over the risk-free interest rate

is due to lender underpricing of credit risk, asset prices move above fundamental levels.

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[9] The price impact of real estate volatility changes through the covariance with the overall market are likely to be far smaller then the impact through changing the value of the option to default.

The increase in price due to underpriced lending is magnified in a market with a large concentration of credit-constrained borrowers. Underpriced financing induces borrowers not only to over-pay for the assets because they obtain cheap financing, but also to demand more assets because they are now less constrained. The interplay of these two effects magnifies the price increases, especially in supply-constrained markets.

3.2. Lender Response to Rising Asset Prices

Consider next a lender who needs to maintain a zero expected rate of return on the entire portfolio, including old and new loans.[10] Such incentives can arise from a reserve requirement based on the risk of the entire portfolio or any other regulatory risk management requirement based on the entire portfolio. It can also arise from short-term focus of the loan or security originators who can use the institution's apparently strong balance sheet to cover poor underwriting standards on new originations (see footnote 10). Let α denote the proportion of new loans relative to the entire portfolio. Assume that the weighted average option-adjusted spread on the entire portfolio needs to be above a certain regulatory or shareholder–imposed minimum level s^*. The lender then needs to set the spread on the new loans s^n so that the weighted average spread on the entire portfolio is s^*:

$$(1-\alpha)s^o + \alpha s^n \geq s^* \tag{6}$$

where s^o denotes the weighted average option-adjusted spread on the existing old loans. As underlying real estate asset prices rise, the equity cushion of the existing loans increases,

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[10] Since we assume a risk-neutral lender, zero expected rate of return on the portfolio is the goal of the lender. This rate of return is after costs are covered and capital in the business is compensated. In a competitive market and under the risk-neutral investor assumption, all firms target zero expected rate of return.

making them safer. In loan pricing terms, this means the option-adjusted spread on the old loans increases:[11]

$$\frac{\partial s^o}{\partial P} \geq 0 \qquad (7)$$

This allows the lender to charge a lower spread on the new loans and still maintain the overall weighted option-adjusted spread at the regulatory-required minimum $s*$. The spread on new loans then is determined by Equation (6):

$$s^n \geq \frac{s*-(1-\alpha)s^o}{\alpha} \qquad (8)$$

And since the option-adjusted spread on old loans, s^o, increases with asset prices, the spread on new loans, s^n, decreases with an increase in current asset prices:

$$\frac{\partial s^n}{\partial P} = -\frac{(1-\alpha)}{\alpha}\frac{\partial s^o}{\partial P} \leq 0 \qquad (9)$$

In other words, the spread on *new* loans declines as current asset prices increase. At the same time prices increase as the spread on new loans falls (see Equation (5)), leading to further decrease in spread and even higher asset prices. In a steady state, the spread of lending rates over the risk-free rate approaches zero, and asset prices are as if the investment is risk-free.

4. Potential Solutions

In what follows we explore why short-selling did not contain asset mispricing and potential market mechanisms that could break the cycle set by Equations (5) and (9).

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[11] The option-adjusted spread increases even if the interest rate on the loans remains the same because the loans are now safer and the original spread is too high relative to the risk of those loans.

4.1. Short-selling the underlying asset

One such possibility is to allow investors to short-sell the underlying real estate asset. Since the asset price takes the best outcomes as certain, the most a short-seller would lose is the risk-free rate of return. The upside for a short-seller, however, is large, as all outcomes but the absolute best result in positive, and sometimes substantial, payoffs to a short position. Real estate is difficult to sell short, however, so this potential solution is purely theoretical.

4.2. Short-selling the lender

Short-selling the lender can potentially mitigate and even break the cycle of Equations (5) and (9), but is unlikely to be effective because the entire bank book, including old and new loans, appears to have proper capital reserves. Of course this is just an illusion, as the increase in the option-adjusted spread on old loans is purely artificial and due to the availability of underpriced lending, not on real estate market fundamentals. Once underpriced lending is eliminated, the artificially increased option-adjusted spreads on the old loans are also eliminated, and the lender finds itself in reserve shortfall position. But going short on the bank loans requires the ability to maintain the short position until underpriced lending is eliminated from the market place, which may take a very long time. Therefore, the effectiveness of short-selling the lender shares works only for investors who can maintain the short position through a period of substantial bank share increases.

Furthermore, as Green, Mariano, Pavlov, and Wachter show, bank shares tend to decline to a far smaller extent than real estate prices because banks have diverse investments and lines of

business.[12] Therefore, short-selling bank shares creates a basis risk for the investor even if they correctly detect the over-pricing of real estate assets.

4.3. Short-selling of specific loans or loan pools

The last possibility is that investors are able to short-sell specific loans (or loan pools), in particular the new loans made by the lender. These loans offer little or no compensation for risk, thus the losses to a short-seller are limited to the risk-free rate of return.[13] Gains, on the other hand, are potentially significant as the new loans under-perform relative to the risk-free assets or even relative to older loans. This strategy is not without risk, as even the new loans can perform well for extended periods of time, but they are most exposed to elimination of underpriced loans in the market. In other words, the latest loans are most vulnerable to unwinding of the positions banks have taken over the years.

While attractive in theory, this mechanism cannot occur without a directed market regulation. Individual players have incentives to keep trades private and over the counter, and see no need to report prices or pool details to the broad markets. Therefore, to benefit from the ability to short-sell specific loans or pools, the market requires trade reporting requirements similar to stocks and many bonds, as well as an established and transparent mechanism for investors to express negative views and place negative market bets.

In summary, of the three possibilities listed above, short-selling of individual loans, or loan pools of similar vintage and characteristics, is the most effective ways for investors to break the cycle set off by lenders and real estate investors acting according to Equations (5) and (9).

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[12] Richard Green, Robert Mariano, Andrey Pavlov, & Susan Wachter, *Misaligned Incentives and Mortgage Lending in Asia* (Univ. of Pa. Law School Inst. for Law & Econ. Research, Working Paper No. 08-27, 2007), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1287687#.

[13] If a loan does not account for any risk, its rate of return is just the risk-free rate of return. If the loan repays with no loss, a short-seller of that loan would have to pay the original owner of the loan the risk-free rate on the loan.

5. Conclusion

Today's crisis in the U.S. emerged from a tectonic shift in the source and pricing for funding mortgage backed securities (MBS). While, historically, securitization has played a large role in the U.S. in the trading of MBS, investors have been exposed to interest rate risk only. Mortgage default risk was contained by underwriting, not priced, and not borne by investors. With the growth of a private-label subprime market, this changed. With private-label MBS, investors bore default risk; while this risk should have been priced, as systemic risk grew, the pricing of risk did not increase. This paper attempts to explain why this happened.

During the market evolution, fees drove the demand for securitization at every stage of the newly functionally differentiated production of mortgages. Banks received fees to originate and to distribute loans, the secondary market received fees to bundle mortgages, rating agencies received fees to rate the pools, and insurers received fees for issuing credit default swaps (CDS) used to hedge holdings of MBS. At each stage, entities were able to book fees without exposure to long term risks.

Due to incomplete markets, asset prices increase with the pro-cyclical production of loans. This lowers the perceived risk and the price of risk, inaccurately reflecting the risk of real estate loans on banks' balance sheets. In the absence of instruments to short sell fundamentally mispriced but marked-to-model rather than marked-to-market assets, it is not possible to counter the positive impact of additional (though temporary) mortgage supply on the demand for housing. As Herring and Wachter show,[14] real estate booms and banking busts tend to go together. The current financial upheaval is only the most recent in a series of financial crises in which property-based asset booms are accompanied by increases in systemic risk. Asset bubbles, in the absence

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[14] Richard Herring & Susan M. Wachter, *Real Estate Booms and Banking Busts: An International Perspective* (Group of Thirty, Working Paper No. 99-27, 1999), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=175348.

of arbitrage, occur pro-cyclically and the result is production of systemic risk as liquidity

providers increase their lending based on current above-market-fundamentals pricing of these

assets.

Historically the credit induced asset price bubble covers up the deterioration in credit

standards with the result of a more extended period in which the bubble forms, in the absence of

downward price pressure through short-selling. If they had been in place, both tradable indexes

(and derivatives and other market tradable instruments) to short sell mispriced assets and

prudential oversight of difficult-to-short products could have countered the production of

systemic risk.

Table 1: Mortgage Origination by Product

	FHA/VA ↓	Conv/Conf ↓	Jumbo ↓	Subprime ↑	Alt A ↑	HEL ↑
2001	*8%*	*57%*	*20%*	*7%*	*2%*	*5%*
2002	7%	63%	21%	1%	2%	6%
2003	6%	62%	16%	8%	2%	6%
2004	4%	41%	17%	18%	6%	12%
2005	3%	35%	18%	20%	12%	12%
2006	*3%*	*33%*	*16%*	*20%*	*13%*	*14%*
2007	4%	48%	14%	8%	11%	15%

Table 2A: Deterioration of Lending Standards, 2002 – 2006

	OrigYr	CLTV	CLTV>80	Seconds	FullDoc	IO%	DTI	FICO<700	Investor	WAC	ARMs SplitWAC
Prime	2002	66.4	4.1	1.9	56.0	46	31.0	20.7	0.7	5.5	-
	2003	68.2	10.1	10.9	48.6	53	31.8	21.8	1.6	4.6	-
	2004	73.5	20.7	23.1	51.2	71	33.5	22.0	2.1	4.5	-
	2005	74.1	21.7	26.8	47.3	81	33.6	18.9	1.9	5.4	-
	2006	75.3	26.2	35.3	33.6	91	37.2	19.5	2.3	6.2	-
Alt A	2002	74.5	20.8	2.7	29.3	26	35.4	46.4	9.9	6.3	0.8
	2003	78.0	33.3	23.4	28.1	56	35.3	44.7	12.9	5.6	1.0
	2004	82.6	46.9	39.1	32.6	75	36.2	44.3	15.3	5.5	1.0
	2005	83.5	49.6	46.9	28.3	83	37.0	40.5	16.5	6.0	0.6
	2006	85.0	55.4	55.4	19.0	87	38.3	44.2	13.5	6.8	0.6
Subprime	2002	81.2	46.8	3.7	66.9	1	40.0	93.4	4.7	8.5	3.0
	2003	83.5	55.6	9.9	63.5	5	40.2	91.6	4.9	7.5	2.9
	2004	85.3	61.1	19.1	59.9	20	40.6	90.6	5.3	7.1	2.6
	2005	86.6	64.4	28.1	55.9	32	41.2	89.7	5.4	7.3	1.9
	2006	86.7	64.0	31.0	54.6	20	42.1	91.5	5.7	8.2	2.0

Source: LoanPerformance data as of November 2006. UBS, April 16, 2007, Thomas Zimmerman, "How Did We Get Here and What Lies Ahead"

% Full Doc declined

Not much change in FICO or DTI

Spreads declined

[AU: Please identify and provide the sources for the above tables]

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Table 2B:

Mortgage Information Year of Origination	1999	2003	2006
Subprime Loans	512,476	1,426,503	2,376,949
Alt-A Loans	84,233	413,494	872,208
Total Number of Loans	**596,710**	**1,840,040**	**3,251,355**
ARM Loans	187,219	920,304	1,723,079
ARM Margin	6	6	5
ARM Teaser (% of ARM loans)	0.92	0.39	0.95
Interest-Only Loans	1,169	95,870	725,317

Source: Raphael Bostic et al, Mortgage Product Substitution and State Anti-Predatory Lending Laws: Better Loans and Better Borrowers?, (2009) (unpublished working paper, on file with the Yale Journal on Regulation).

Figure 1: 1999 - Percent of All Loans –Adjustable Rate

armp ▢ 0% to 25% ▢ >25% to 50% ▢ >50% to 75% ▮ >75% to 100%
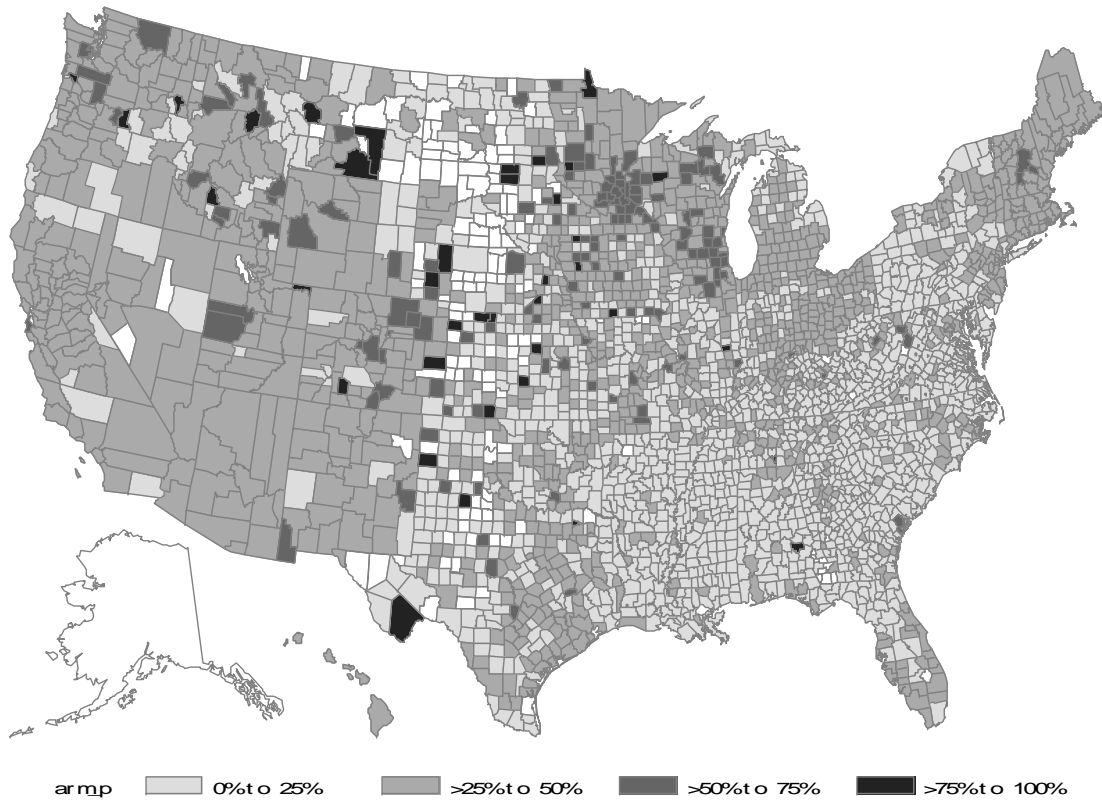
Figure 2: 2006 - Percent of All Loans – Adjustable Rate
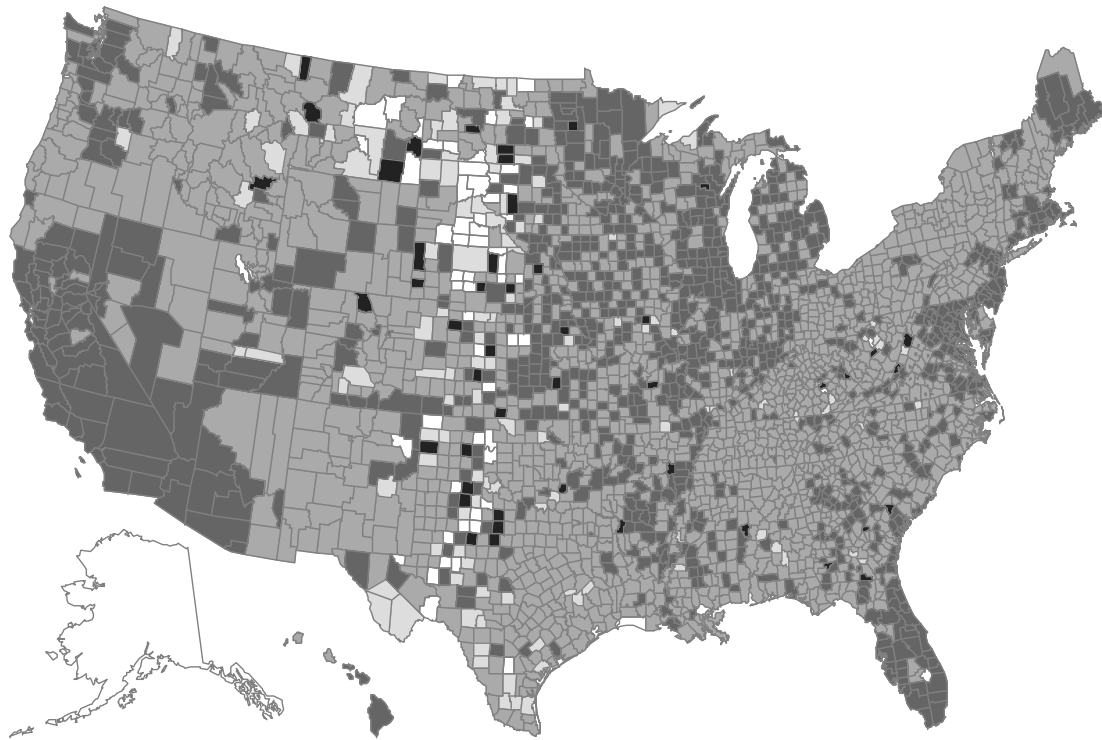
Figure 3: 1999 - Percent of All Loans – Low Documentation

lowdoc_p   0%to 25%   >25%to 50%   >50%to 75%   >75%to 100%
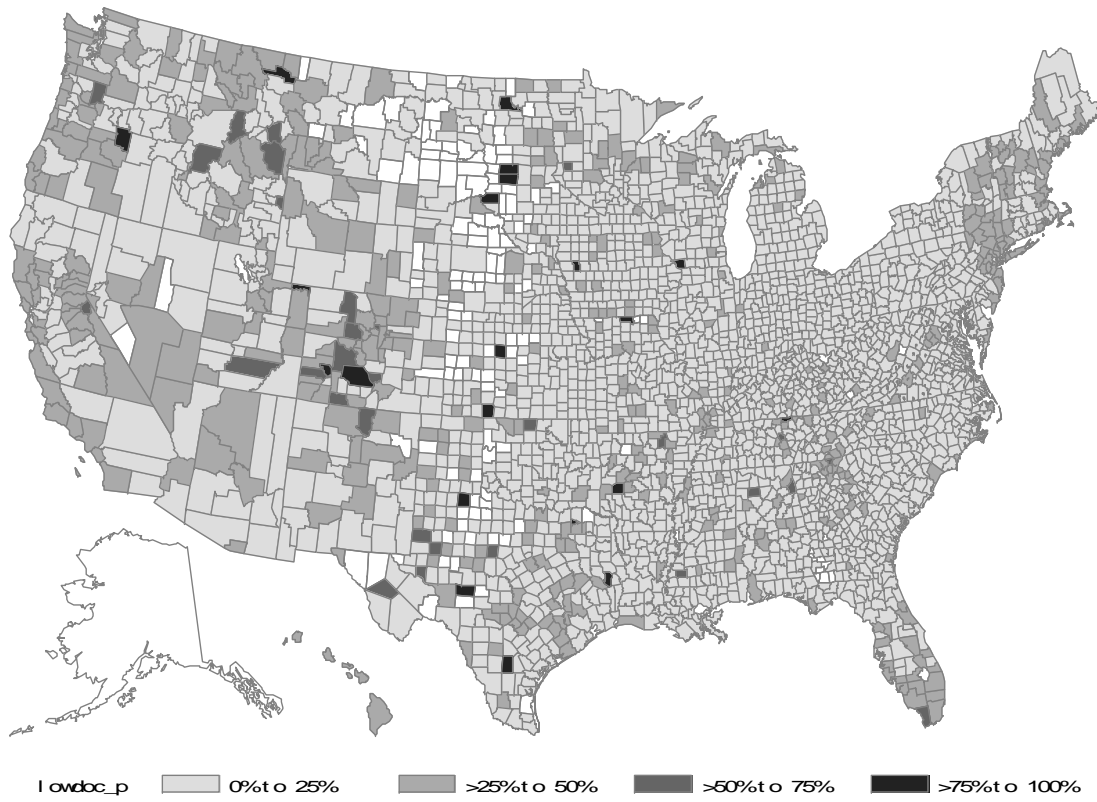
Figure 4: 2006 - Percent of All Loans – Low Documentation

lowdoc_p   0%to 25%   >25%to 50%   >50%to 75%   >75%to 100%
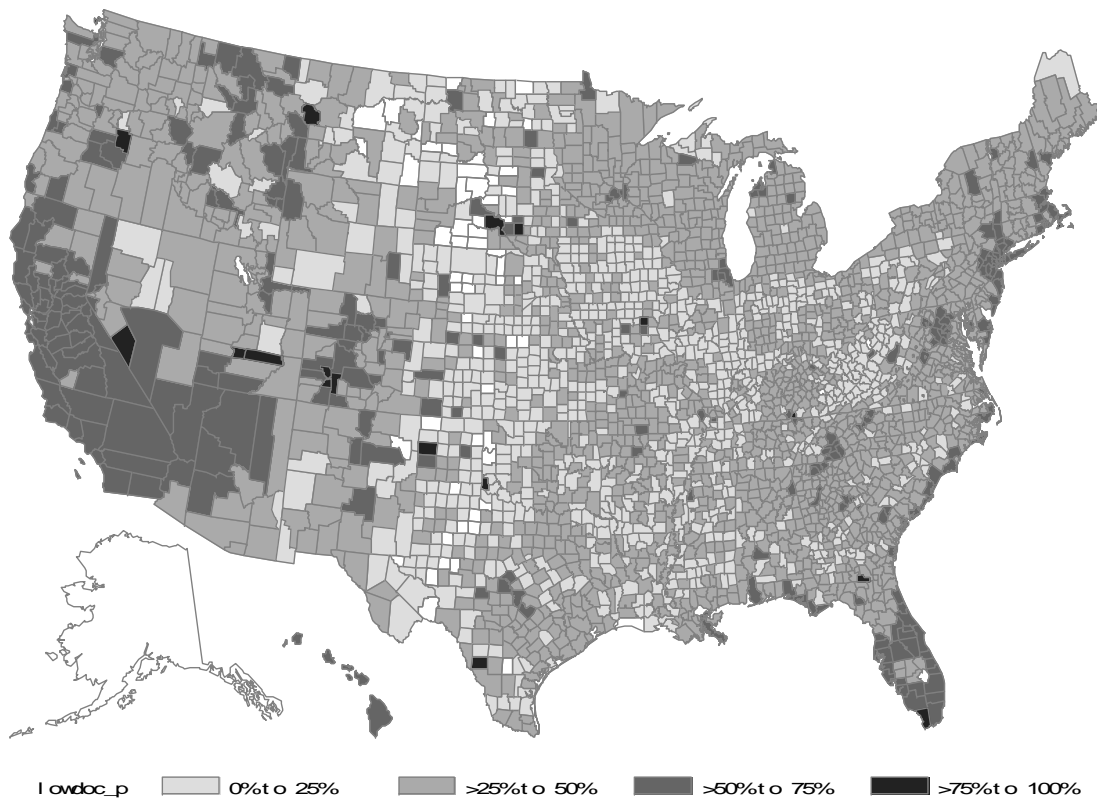
Figure 5: A housing bubble in 2003, especially in the "sand states"

Prices by City (Case-Shiller)
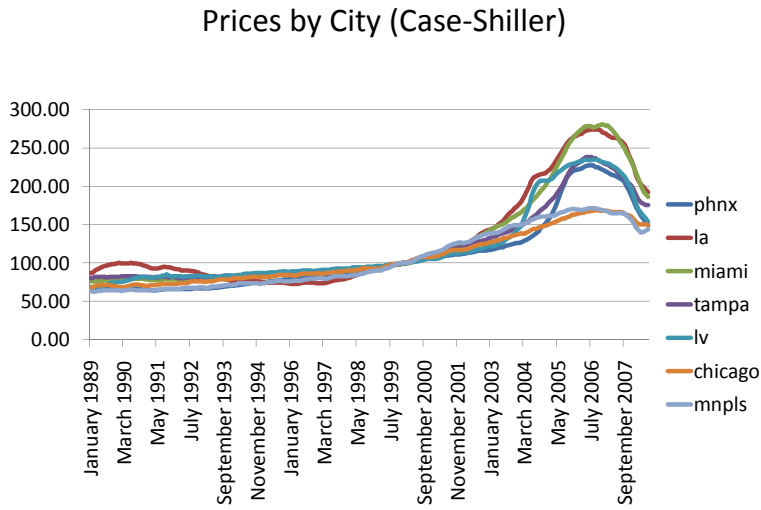
Source: S&P/Case-Shiller Home Price Indices, Standard & Poor's,

http://www2.standardandpoors.com/portal/site/sp/en/us/page.topic/indices_csmahp/0,0,0,0,0,0,0,0,0
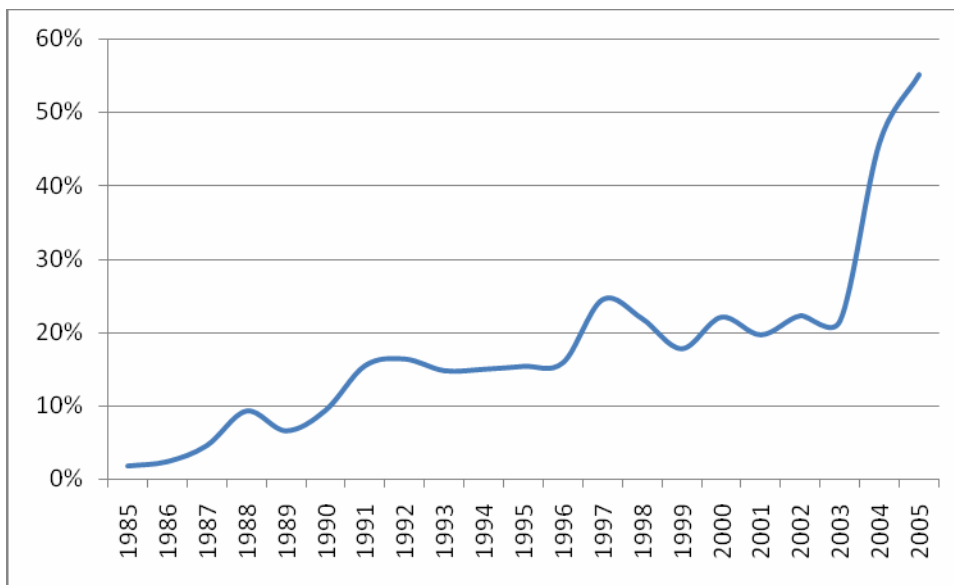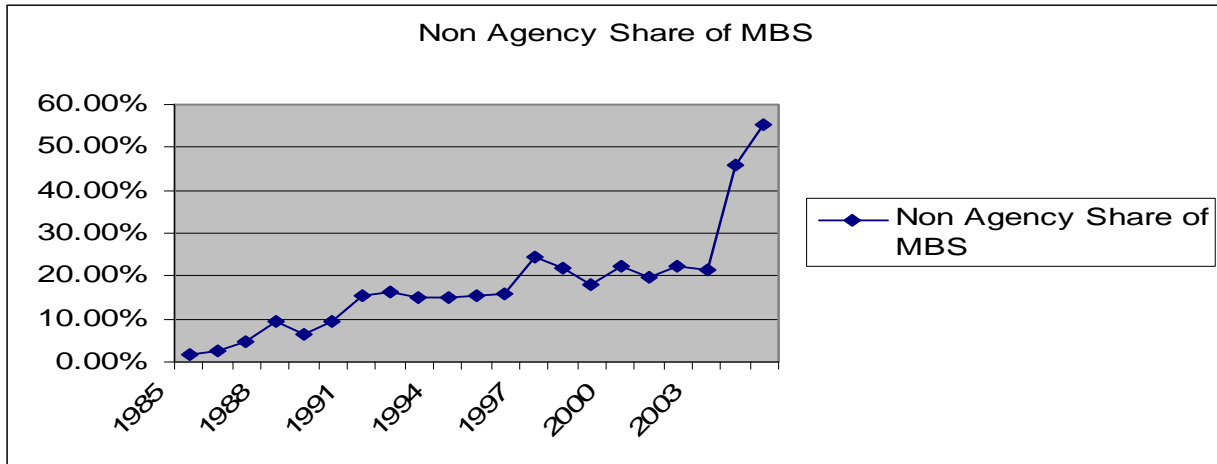
,0,1,1,0,0,0,0,0.html (last visited March 23, 2009).

Appendix Figure 1: Price Appreciation Controlled for Volatility
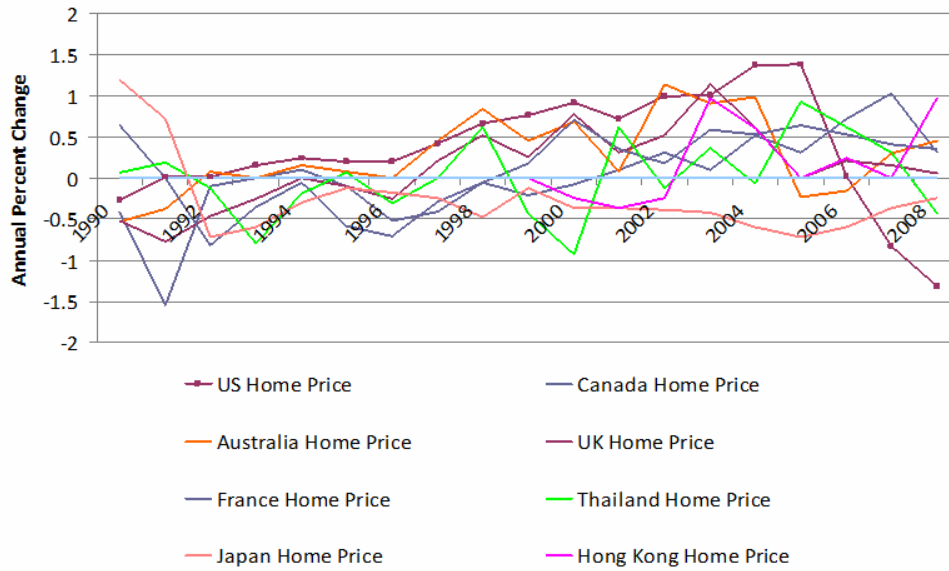
Source: Jesse M. Abraham, Andrey Pavlov & Susan M. Wachter, *Explaining the United States' Uniquely Bad Housing Market*, 12 WHARTON REAL ESTATE REV. 24 (2008)**.**

Appendix Figure 2: Non Agency Share of MBS market

Non Agency Share of MBS

Source: Inside Mortgage Finance, The 2006 Mortgage Market Statistical Annual- Volume 1.