Essay

Systemic Risk and Market Institutions

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With private-label mortgage-backed securities (MBS), investors bore default risk. This risk should have been priced. As systemic risk grew, why didn't the pricing of risk increase? 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.

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 United States that drove asset prices up. We then briefly present the basics of a model that 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.

I. The Recent Deterioration of Lending Standards

The U.S. residential mortgage and housing markets are at the center of the worldwide credit bubble and the subsequent financial crisis. The volatility adjusted run-up in U.S. housing prices, particularly after 2003, exceeded price

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increases among all the major trading partners of the United States. Similarly, the recent volatility-adjusted price decline is also more severe in the United States than in its major trading partners.[1] The price and price-rent ratios that were increasing in the United States before 2003 were attributable to interest rate declines and income increases, but not so after 2003. The U.S. 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 nonrecourse 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 he can exercise against the lender to effectively sell the

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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* (Univ. of Pa. Law School Inst. for Law & Econ., Working Paper No. 08-35, 2008), *available at* http://ssrn.com/abstract=1319757. Appendix Figure 1, *infra*, displays the volatility-adjusted price indices for eight 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. ECON. PERSP. 93 (2005); and Patricia A. McCoy, Andrey D. Pavlov & Susan M. Wachter, Systemic Risk Through Securitization: The Result of Deregulation and Regulatory Failure (2009) (unpublished manuscript, on file with *Yale Journal on Regulation*).

2 Teaser-rate ARMs are adjustable-rate mortgages with a low introductory "teaser rate," which is reset after two or three years to a higher interest rate.

3 The London Interbank Offered 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 borrower 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.

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 fifteen percent in 2001 to almost half of originations by 2006 (the sum of the market share of Helocs, Alt-A, and subprime as shown in Appendix Table 1).[6] Within loan types, consolidated transaction price-based loan-to-value ratios (CLTV) also increased, as shown in Appendix Table 2. This implies that borrowers were able to obtain financing with smaller and smaller down payments at the same or declining borrowing costs. Also, Appendix Table 2 shows that 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, pay-option, and interest-only loans in particular began to comprise fifty percent or more of the subprime origination market in many states. Such loans were extended disproportionately in states where mortgages were previously not affordable, thus temporarily expanding the market for homeownership and driving up prices.

When credit conditions reversed in the spring of 2007, 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 housing was initially unaffordable, that housing prices exploded with the wave of aggressive mortgage products and imploded as credit dried up.[7]

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.

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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, that is, loans with limited documentation of income, asset value, or both. "Subprime" generally denotes mortgage loans extended to borrowers with prior credit problems or who are riskier in some other fashion.

7 *See* Figure 1, *infra*.

II. 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 increases 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, the asset price of houses goes 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.

A. *Lending Standards and Asset Prices*

Following our previous work,[8] we note that the transaction price of an asset financed through a nonrecourse 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:

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

where σ denotes the expected future volatility of the asset and s denotes the option-adjusted spread of lending over risk-free interest rates.[9] 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, that is,

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

9 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.

$$\frac{\partial V}{\partial \sigma} = 0,$$

the right-hand side of Equation (2) equals zero because the spread adjusts to compensate the lender for the changes in the value of the put option embedded in the mortgage loan, that is,

$$\frac{\partial M}{\partial \sigma} + \frac{\partial M}{\partial s}\frac{\partial s}{\partial \sigma} = 0$$

If the increase in volatility affects the covariance of the asset return with the market, then

$$\frac{\partial V}{\partial \sigma} < 0,$$

but is still relatively small.[10]

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, rather than in response to changes in expected future asset volatility, then 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, then asset prices move above fundamental levels.

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 overpay 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.

10 The price impact of real-estate volatility changes through the covariance with the overall market is likely to be far smaller than the impact through changing the value of the option to default.

B. *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.[11] 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.[12] 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, making them safer. In loan pricing terms, this relationship means the option-adjusted spread on the old loans increases:[13]

$$\frac{\partial s^o}{\partial P} \geq 0 \tag{7}$$

This relationship also 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 (8):

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

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:

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

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 (as shown by Equation (5)), leading to a further decrease in spread and even higher

11 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 computed 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 a zero expected rate of return.

12 *See supra* note 10.

13 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.

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.

III. Potential Solutions

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

A. *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.

B. *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 a 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 Richard Green and his coauthors show, bank shares tend to decline to a far smaller extent than real-estate prices because banks have diverse investments and lines of business.[14] Therefore, short-selling bank shares creates a basis risk for the investor even if he correctly detects the over-pricing of real-estate assets.

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

C. *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.[15] 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 those for 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).

IV. Conclusion

Today's crisis in the United States 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 United States in the trading of MBS, investors had been exposed to interest-rate risk only. Mortgage default risk was contained by underwriting, was not priced, and was not borne by investors. With the growth of a private-label subprime market, the characteristics of mortgage default risk 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 Essay attempts to explain why.

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

15 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.

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. These price increases lower 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 Richard Herring and Susan Wachter show,[16] 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 of arbitrage, occur pro-cyclically, and the result is the 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, and in the absence of downward price pressure through short-selling, results in an extended period of bubble formation. If either tradable indexes (and derivatives and other market-tradable instruments) that permitted investors to short-sell mispriced assets or prudential oversight of difficult-to-short products had been in place, one or both of the measures could have countered the production of systemic risk.

16 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.

Appendix

Table 1: Changes in Mortgage Origination by Product[17]

	FHA/VA (Reduction)	Conv/Conf (Reduction)	Jumbo (Reduction)	Subprime (Increase)	Alt-A (Increase)	HEL (Increase)
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[18]

	Orig Year	CLTV	CLTV >80	Seconds	Full Doc.	IO%	DTI	FICO <700	Investor	WAC	SpdtoWAC
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	74.3	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	83.0	55.4	55.4	19.0	87	38.3	44.2	13.5	6.8	0.6
Sub-prime	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	91.8	5.7	8.2	2.0

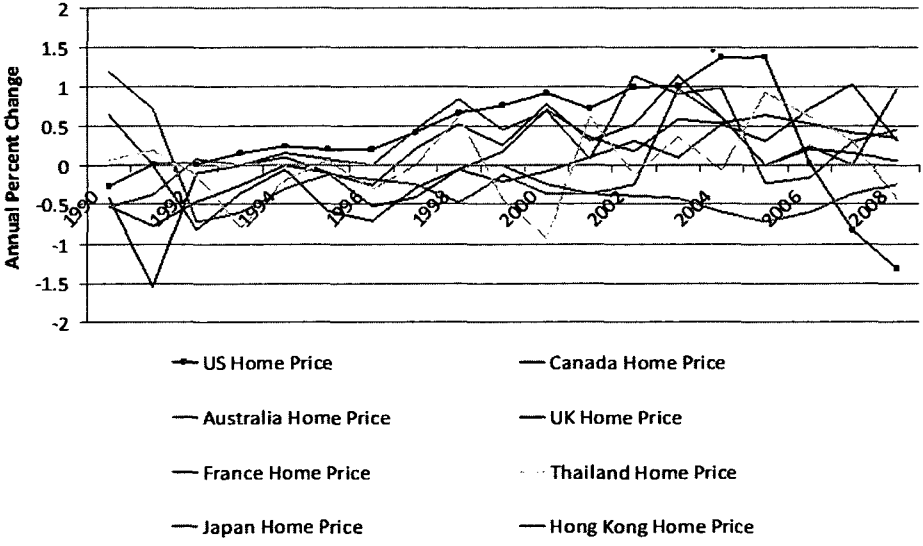
17 1 INSIDE MORTGAGE FINANCE, MORTGAGE MARKET STATISTICAL ANNUAL (2008).

18 Jesse M. Abraham, Andrey Pavlov & Susan M. Wachter, *Explaining the United States' Uniquely Bad Housing Market*, 12 WHARTON REAL ESTATE REV. 24, 35-36 (2008).

Table 2B: Mortgage Statistics[19]

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

Figure 1: Price Appreciation Controlled for Volatility[20]



19 Raphael Bostic et al, Mortgage Product Substitution and State Anti-Predatory Lending Laws: Better Loans and Better Borrowers?, (Mar. 23, 2009) (unpublished manuscript, on file with the *Yale Journal on Regulation*).

20 Jesse M. Abraham, Andrey Pavlov & Susan M. Wachter, Explaining the United States' Uniquely Bad Housing Market, 12 WHARTON REAL ESTATE REV. 24 (2008).