The Role of the Securitization Process in the Expansion of Subprime Credit

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Abstract

We analyze the structure and attributes of subprime mortgage-backed securitization deals originated between 1997-2007. Our data set allows us to map loan-level data for over 6.5 million subprime loans to the securitization deals into which the loans were sold. We document the relationship between the structure of the securitization deal and the attributes of the underlying mortgage collateral, including housing market conditions at the time of deal origination. We find evidence that deals with higher levels of housing market diversification have a larger portion of the deal rated investment grade. Consistent with our primary hypothesis we find that deals comprised of loans concentrated in areas with high rates of home price appreciation also have a larger portion of the deal rated investment grade. We believe these results highlight how the structure of securitization deals could impact the supply of credit being afforded the mortgage origination market. Deal structure matters because the economics of the structuring process create incentives for deal arrangers to purchase loans that will provide the cheapest funding for the deal.

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The default rate on residential subprime mortgage loans sold into securitization deals has nearly tripled since 2004.[1] Rising default rates have resulted in substantial losses for investors holding investment-grade mortgage-backed securities (MBS) as well as holders of collateralized-debt obligations (CDOs) which employ MBS as collateral. The rise in defaults has taken its toll on credit markets in general. As of July 17, 2008, Bloomberg reported that banks and brokers have taken more than $435 billion in writedowns due to the poor performance of MBS, CDOs and other forms of leveraged loans. The observed phenomenon begs an obvious question: Why has the default rate of mortgage loans increased so dramatically?[2] A recent literature points to an increase in the supply of credit made to subprime borrowers in mortgage origination markets, allowing borrowers of marginal credit quality to obtain loans (Sufi and Mian 2008, Dell'Ariccia, Igan, and Laeven 2008). The cause of the increase in credit supply (or decrease in credit standards), it is argued, is increased securitization activity. If true, this suggests an important additional question: What role did the structure of mortgage-backed securitizations play in increased subprime defaults? Our study seeks to answer this question by examining the securitization process and structure of over 1,250 subprime mortgaged-backed securitization deals originated between 1997 and 2007, the attributes of the 6.7 million individual loans that comprise the securitization deals, and the macroeconomic conditions that existed in the areas where the loans were originated.

In ascribing the increase in the extension of subprime credit to heightened securitization activity, the literature has thus far relied on binary classifications of securitization; loans were either securitized or not. Our study highlights how the structure and ratings of subprime residential mortgage-backed securitization deals affect the economic incentives driving the loan purchase decisions of investment banks in the *secondary mortgage market.*[3] We focus on how the credit and housing market

[1] According to data from LoanPerformance, subprime loans included in securitization deals that were originated in 2002 had a 4.01% default rate by the end of 2003. By comparison, loans originated and sold into securitization deals in 2006 had a default rate of 13.7% by December 2007.

[2] One immediate answer is the decline in home prices. However, to the extent that subprime loans, particularly subprime loans with adjustable rates are the ones most affected by price declines, the relevant question is why such loans were originated.

[3] Figure 1a presents a schematic of the impact of securitization on the credit threshold in the mortgage origination market. Figure 1b documents the feedback effect that deal structure could have on the credit threshold. Loans that deliver favorable ratings in the securitization process will be originated in the primary market.

characteristics of the loans included in mortgage-backed securitization deals affect the terms on which a deal is arranged. Our primary finding is that deals concentrated in areas with high rates of house price appreciation have a larger percentage of the deal rated investment grade. Deals with a larger portion of the principal rated investment grade can fund the purchase of the underlying loan collateral at a lower cost because they can issue bonds with lower coupon payments (higher prices). The implication is straightforward. If higher rates of house price appreciation can lower the cost of funding a deal, the secondary market will demand loans in rapidly appreciating housing markets, and mortgage originators will rationally increase the supply. Our study is not an investigation of whether the credit ratings assigned to subprime securitization deals were "correct". Rather, we take the ratings process as given and seek to understand the economic implications of the securitization and rating process.

Our study is motivated primarily by a theory offered by Ashcraft and Schuermann (2008) which outlines how expected rates of house price appreciation can affect securitization deal structure, and eventually the supply of credit afforded the origination market. To the extent that mortgage pools concentrated in areas of high house price appreciation receive more favorable credit ratings (all else being equal), deal arrangers could rationally purchase mortgages of a lower marginal credit quality that are concentrated in areas of high price appreciation and still obtain the investment-grade ratings required to profitably market a securitization deal. We test the implications of this hypothesis in three ways. First, we test whether deals with loans concentrated in areas with high rates of house price appreciation are indeed able to get a larger portion of the securitization rated investment grade, and whether this translates into a lower cost of funds for the deal. Second, we test whether pools of loans concentrated in areas of high house price appreciation are of a lower average credit quality. Finally, a potential consequence of purchasing loans of marginal credit quality masked by high rates of house price appreciation is the potential for higher default rates when rates of house price appreciation slow down (or even turn negative). Accordingly, we analyze whether realized rates of house price appreciation have a significant association with deal-level default rates.

Aside from the considerable interest subprime loans are receiving from the media and investment community, we ask why the subprime experience should matter outside of an isolated episode. Prior literature attributes the profitable practice of pooling and tranching cash flows to the presence of asymmetric information (DeMarzo (2005)), or incomplete markets (Gaur, Seshadri, and Subrahmanyam (2003)). After all, in a world of perfect capital markets, why should the repackaging of cash flows be a profitable enterprise? Two recent studies, relying on the assumption that investors purchase bonds based on credit ratings, explain the proliferation of securitization activity to the potential for deal arrangers to deliver the cheapest possible set of assets that can obtain a high quality credit rating. Coval, Jurek, and Stafford (2007) conclude that "the growth of the credit tranche market can potentially be explained as an endogenous, institutional response to an arbitrage opportunity in the credit markets." In particular, Coval et al. demonstrate that because credit ratings do not account for the state in which defaults occur, naïve prices based solely on ratings will not account for systematic, priced risk factors. Brennan, Hein, and Poon (2008) also attribute the existence of pooling and tranching to potential "ratings arbitrage." Our sample of subprime securitizations may provide some limited, indirect evidence consistent with a theory of "ratings arbitrage."

To the extent that investors purchase MBS based solely on credit ratings, the key assumption in models of ratings arbitrage, investment banks are incented to deliver the cheapest portfolio of loans (which would be loans of lower credit quality) that can still obtain an investment-grade rating. Because we don't have wholesale prices of the underlying mortgage loan collateral, we cannot directly test this hypothesis.[4] However, our analysis of the association between rates of house price appreciation and pool credit quality could be viewed as an indirect test of deal arrangers' ability to arbitrage the ratings process by purchasing cheaper loans (loans of a marginal credit quality) that are able to deliver marketable credit ratings on account of high rates of house price appreciation.

Throughout our empirical analysis, we essentially make the assumption that arrangers of securitization deals (usually, investment banks) seek to maximize the portion

[4] One concern in an MBS setting would be that, although loans of a lesser credit quality are likely priced at a discount, the wholesale loan market could conceivably command a premium for loans concentrated in areas of high expected appreciation.

of each securitization deal that receives investment-grade ratings.[5] All else being equal, maximizing the weighted average of ratings in the deal lowers the cost of funding for the deal. To test our hypotheses, we calculate the total percentage of deal principal that received a AAA rating, and the percent receiving an investment-grade credit rating (BBB+ or higher (or the Moody's equivalent)). We then evaluate the total percentage of a deal rated AAA or investment grade against deal-level measures of house price appreciation. In so doing, we develop proxies to control for the potential default correlation in the underlying pool of collateral. In addition to default correlation, which impacts the shape of the default distribution, we control for other important loan attributes that predict expected loss in a pool of mortgage loans, such as FICO scores, loan-to-value ratios, loan type, loan purpose, and macroeconomic factors. Our sample also allows us to provide a description of the subprime securitization landscape. We document deal size and structure, deal frequency, and the changing characteristics of mortgage loans included in the deals through time and in the cross section.

We find the strongest support economically for our hypothesis related to rates of house price appreciation. On average, a 5% increase in the one-year lagged rate of house price appreciation is associated with a 1%-2% increase in the percentage of a deal rated investment grade (one standard deviation in the percent rated investment grade is 4%). The result is strongest in the year 2007. As expected, we also find that deals with lower levels of geographic concentration are structured on better terms, though the results are not large economically. Decreasing the geographic concentration of a deal by 5% (one standard deviation) increases the total proportion of the deal rated AAA by 0.4% (one standard deviation equals 6%). Our limited, indirect test of a ratings arbitrage hypothesis, which employs a simple two-way sorting technique, finds support for the hypothesis that high rates of house price appreciation allow banks to purchase loans of a lower marginal credit quality while maintaining favorable credit ratings. The results suggest that portfolios of subprime loans with similar credit ratings but disparate rates of house price appreciation vary widely in the percent of loans with an adjustable rate. Lastly, in an

[5] One potential objection to this assumption would be theories that rely on market incompleteness as motivation for securitization (Gaur, Seshardri, and Subrahmanyam (2003)). A market incompleteness theory argues that firms engineer securities from the securitization process that complete the market. If completing markets is the primary motive for securitization, it is not obvious that a deal arranger's primary objective is to obtain the best possible ratings for a deal.

effort to highlight the implications of our results, we identify strong associations between loan default rates and contemporaneous changes in housing prices.

Recent literature on the subprime crisis addresses a number of questions relevant to this paper. Sufi and Mian (2008) argue that a shift in the supply of credit made to subprime borrowers *caused* an increase in house prices and subsequent default rates. They attribute the increase in credit supply to the existence of securitization. Our results suggest that the relationship between house price appreciation and credit supply is at the very least simultaneous.[6] While an increase in the supply of credit may have increased house prices, it appears that rates of house price appreciation themselves can affect the supply of credit. Our results also build upon Sufi and Mian (2008) in that we identify how the securitization process may have caused an unexpected increase in credit supply. Our results provide evidence of the incentives for investment banks to purchase a higher proportion of loans in areas of high price appreciation, a process that could work as a mechanism rationing credit to the origination market. Mayer and Pence (2008) provide strong evidence in support of this premise; mortgage origination rates, a proxy for the supply of credit in the primary mortgage market, exhibit a positive, robust relationship with lagged rates of house price appreciation.

Dell'Ariccia, Igan, and Laeven (2008) demonstrate that lending standards declined in areas of high home price appreciation and attribute the decline in lending standards to increased competition among lenders. Keys, Mukherjee, Seru, and Vig (2008) show that securitized loans with a credit score slightly above the traditional subprime threshold (FICO 620) were 20% more likely to default then securitized loans slightly below the subprime threshold. The result is interpreted as evidence that the prospect of selling loans to secondary markets reduces lenders' incentives to carefully screen borrowers. Demyanyk and Van Hemert (2008) find that credit quality was inexplicably low during 2006-2007, even after controlling for house price appreciation. Gabriel and Rosenthal (2007) present and estimate a model explaining how active secondary markets can increase the supply of credit to primary borrowers. In sum, the previous literature has focused almost exclusively on the loan origination market and binary classifications for

[6] Sufi and Mian use a measure of pent up demand as an instrument for credit supply.

securitized loans. This paper, to the best of our knowledge, is unique in exploring the importance of the securitization process in the subprime crisis.

Our paper is organized as follows. Section 2 documents the institutional features of the securitization market. Section 3 provides a discussion of the theories of securitization and motivates our hypotheses. Section 4 describes the data. In section 5 we describe our empirical strategy and discuss results. Section 6 concludes.

Section 2: Institutional Features of the Securitization Market

Section 2a: Deal Structure

In order to understand how the securitization process can impact mortgage markets, we provide a brief outline of some of the key institutional features of the subprime securitization structure. Though no strict definition of a subprime mortgage exists, the term usually refers to a mortgage loan with poor credit quality, excessive leverage, or no income documentation. Borrowers who "state" a monthly income without documentation to verify the income can also be considered subprime.[7] High loan-to-value or debt-to-income ratios are also typical of subprime borrowers. Until the late 1990s, subprime loans represented a very small portion of total residential mortgage originations.

Pools of subprime loans are originated by retail banks or mortgage brokers and subsequently sold to private financial intermediaries, who are frequently Wall Street firms or their subsidiaries, and who are referred to as deal arrangers or deal underwriters.[8] The pool of loans is then placed into a bankruptcy remote trust, which is a separate legal entity and which owns the rights to each mortgage. Servicing of the mortgages is outsourced to a loan servicer. The pool of loans is separated into different "tranches" against which bonds are issued and sold to investors. Mortgage payments from the pool of loans are “passed through” to the bond holders and are the source of the bond's coupon payment. The type of bonds issued against securitized mortgages varies

[7] Borrowers who “state” a monthly income can also fall into a category of loans called “Alt-A”. Again, though no strict definition exists, “Alt-A” loans generally have higher credit scores than subprime borrowers but lack income documentation.

[8] In Appendix A3 we provide a list of firms who acted as deal underwriters in our sample of securitization deals.

substantially. Bond coupon payments can be fixed or variable. Some bonds are issued as interest only, so that the bondholder receives only the interest from an underlying mortgage pool, while others are issued as principal only. Bonds referred to as the "equity tranche" generally do not receive any principal.[9]

Individual loans are not assigned to specific tranches. Rather, tranches are organized in a seniority structure that assigns a priority payment scheme to payment streams emanating from the underlying loans. The prioritized payment of principal and interest varies by deal. Typically, the principal from loans that "pre-pay" (refinance or sell) before their stated maturities flows first to holders of senior tranches, while defaults first reduce the principal of the most junior tranches until their principal is exhausted. Holders of junior tranches are subject to default risk, or the risk that the principal balance of mortgages from which coupon payments flow will be eroded. Figure 2 displays a simple diagram of a sample securitization structure from our data. The deal, originated by Goldman Sachs in February 2006 had a total deal principal of $714.2 million. The figure reports the size of each tranche, its original credit rating and the rate of the first scheduled coupon payment. For a more detailed discussion of the institutional features of the subprime securitization market, we refer the interest reader to Ashcraft and Schuermann (2008).

Section 2b: Subordination, Excess Spread, and Other Forms of Credit Enhancement

Pre-specified cash flow rules are designed to ensure that bonds with investment-grade ratings receive the promised coupon payments with a very high probability, ex ante. In order to ensure that holders of investment-grade bonds receive the promised payments, deals receive "credit support" against the potential for mortgage defaults. The credit support works to protect senior tranches against the loss of coupon payments

[9] Equity tranches can receive payments at the beginning of their life. Deals with large margins between the underlying mortgage rate and coupon payments can pass the excess interest payments onto holders of the equity tranche. These payments only occur when every other tranche is receiving its full coupon payment. In practice, this only occurs in the infancy of a deal. When default rates increase, the excess margin is required to compensate more senior tranches. We discuss this concept of "excess spread" in much greater detail in section 2b.

stemming from default. The two most prevalent forms of credit support are subordination and excess spread.[10]

For any given tranche, subordination is the sum of the amount of principal that exists in any junior tranches. For example, if all tranches with an S&P credit rating of AAA represented 80% of the total principal in a deal, the AAA tranches are said to benefit from 20% subordination. Subordination for investment-grade tranches, which are those with an S&P credit rating of BBB+ (or Moody's equivalent) or higher, is defined in the same way. In our sample, the median proportion of deal principal rated AAA is 79.9%. The median proportion of principal rated investment grade is 94.5%. Portions of the securitization structure not rated investment grade are generally made up of one or two very small non-investment grade bonds that pay high coupons, and a tranche referred to as "over-collateralization." The over-collateralization tranche does not pay a coupon and exists solely to provide credit protection to more senior tranches. Loans that default first will destroy the principal balance of the over-collateralization piece before touching any tranche more senior. Only after the over-collateralization principal has been fully exhausted will defaults accrue to the next most junior tranche. Thus, senior tranches benefit from "thick" junior tranches, and in this way, subordination acts as a form of credit protection.

Excess spread is the second form of credit protection that exists to insure senior tranches against mortgage default. Excess spread is defined as the difference between the payments coming into the securitization structure from the underlying mortgage collateral and the rate being paid to coupon holders. Excess spread is calculated net of fees paid to mortgage servicers and other intermediaries, such as interest-rate swap counterparties. As Ashcraft and Schuermann (2008) explain, "…[excess spread] is the first line of defense for investors against credit losses, as no amount of principal of any tranche is reduced by any amount until credit losses reduce excess spread to a negative number." In this way, higher levels of excess spread provide more credit protection to holders of senior tranches.

[10] The term credit support is used interchangeably in the literature with the term "credit enhancement" or "credit protection." We will also use the terms interchangeably.

Deals benefit from other forms of credit enhancement such as "shifting interest," "performance triggers," and interest rate swaps. Shifting interest requires that all pre-paid principal be applied only to senior tranches for a pre-specified period (typically the first 36 months). The practice of shifting interest serves to increase the subordination of senior tranches because pre-payments reduce their principal balance, leaving their principal as a smaller percentage of the total deal principal. Performance triggers exist to ensure that pre-paid principal is not released to any class until the deal passes pre-specified performance tests.[11] Thus, if a deal is not performing well, the priority rules can be shifted to ensure senior tranches receive proper credit support. Finally, deals with floating coupon payments manage the risk that coupon payments to bondholders might rise faster than rates on the underlying mortgages by means of interest rate swaps.[12]

Section 3: Hypothesis Development

One of the key issues associated with the increase in subprime defaults is the observed increase in the extension of mortgage loans to borrowers of marginal credit quality (Dell'Ariccia, Igan, and Laeven, 2008). A critical question is why this occurred. The literature has suggested the existence of securitization as one explanation (Sufi and Mian (2008), Keys et al. (2008)).[13] The purpose of our paper is to clarify how the specific structure of securitization deals and the ratings process could influence the types of loans investment banks would purchase in the secondary mortgage market for the purpose of issuing securitized bonds. By identifying the loan attributes that maximize the gains for investment banks we can better understand why origination markets would have rationally originated loans of marginal credit quality, particularly in areas with high rates of house price appreciation.

[11] We do not have data on which deals in our sample benefit from the existence of performance triggers.
[12] A trust making floating coupon payments backed by a pool of fixed-rate mortgages could hedge the interest rate risk by entering into a swap agreement to pay fixed rates to a counterparty in exchange for variable interest payments.
[13] As predicted by Gorton and Pennacchi (1993) and Diamond (1984), originators of loans have little incentive to carefully screen or monitor borrowers if they do not bear the risk of the loans. This isn't entirely obvious, however. Reputational concerns could impact the quality of loans banks originate, even in an "originate-to-distribute" setting.

Section 3a: The Economics of the Securitization Structure

The bankruptcy remote trust established by investment banks for the purpose of a securitization transaction has cash outflows and inflows. The largest cash outflow is the cost of purchasing the portfolio of mortgage collateral from loan originators. The largest cash inflow is the gain on the sale of the bonds issued by the trust and sold to investors. Because of this, the credit rating of a securitization deal impacts the cash inflows of the trust, also referred to as the cost of funds. Bonds rated AAA and investment grade have lower coupon payments (higher prices) then poorly rated bonds.[14] Thus, the gains of a securitization deal should be increasing in the overall credit rating of the deal. This is the basis for our assumption that banks will seek to purchase loans that maximize the potential credit rating of a deal. Figure 2, which presents an example deal structure using an actual deal in our sample, documents a monotonic increase in coupon payments as tranche credit quality decreases. This pattern should be consistent across all the deals in our sample, as coupon payments should be positively related to tranche credit quality.

Section 3b: Credit Ratings, Default Correlation, and Housing Market Appreciation

In this section we explain how rates of house price appreciation and collateral diversification could impact the economics of a securitization deal. We begin with a discussion of the ratings process. In a cross section of subprime securitization deals, the proportion of a deal's principal assigned a AAA rating depends on two factors; the expected loss on the pool of mortgage collateral and the correlation of default in that collateral.[15]

Credit ratings reflect a rating agencies' assessment of the likelihood of bond default. As an example, assume that a AAA rating assigned by a rating agency to a bond corresponds to a 1% probability that the bond will default. Default on a AAA bond occurs when the entire principal that is junior to the AAA tranche is eroded on account of loan defaults. Thus, a bond with a AAA credit rating reflects an opinion of the agency

[14] The term "tranches" can essentially be used interchangeably with the word "bonds" in this setting.
[15] Technically, Fitch and Standard and Poor's estimate the probability of default. Moody's estimates expected loss, which is the probability of default multiplied by the expected loss conditional on default. In practice, this difference in ratings methodology does not appear to create any substantial differences in original credit ratings. In our sample of rated tranches, in cases where S&P and Moody's have both rated a tranche, there is very rarely a disagreement in the rating and the discrepancies are minor when they exist.

that there exists a 1% probability that all the collateral junior to a senior tranche will be eroded within the expected life of the AAA bond.

In order to determine the probability of default, a rating agency must estimate expected loss on the collateral pool. The expected loss in a pool of collateral is estimated as a function of loan attributes such as FICO scores, loan-to-value ratios, mortgage type, income documentation, loan purpose (refinance vs. purchase), and macroeconomic conditions, including house prices. The impact of specific loan attributes on loan default rates is documented by Sherlund (2008), Deng, Quigley, and Van Order (2000), and Pennington-Cross and Ho (2006). Loans with high FICO scores, low loan-to-value ratios, and low debt-to-income ratios default less frequently. It also has been shown that rates of house price appreciation have a strong negative association with default rates (Gerardi, Shapiro, and Willen (2007) and Sherlund (2008)).[16]

While the expected loss matters for the entire deal, the shape of the expected loss distribution impacts the amount of the deal principal that can be rated AAA. The shape of the loss distribution depends on the default correlation in the underlying collateral. Default correlation measures the extent to which defaults will occur at the same time. If loan defaults are correlated, the probability of experiencing a greater percentage loss is higher, even though the expected loss remains the same. That is, default correlation simply shifts the shape of the loss distribution. Default correlation also matters in the pricing of CDOs. Longstaff and Rajan (2008) demonstrate that the expected clustering of corporate defaults explains 27% of the CDX spread. Cowan and Cowan (2004) document the degree of default correlation in a pool of subprime loans for one lender and find that the magnitude of default correlation increases as an internally assigned risk grade declines.

The importance of default correlation in the context of ratings is best understood by example. Figure 3 serves as a helpful graphical reference for the following argument. First assume a scenario where the collateral has zero default correlation. If a deal has 80% of the principal rated AAA, the rating agency is estimating that the probability the

[16] Though house price appreciation may not directly cause default, as house prices stagnate or decline, some homeowners are left with little or no equity and have little incentive to continue making mortgage payments. In the case of adjustable-rate mortgages, stagnant house prices prevent homeowners facing a payment reset from refinancing if the price decline has left the homeowner owing more on the mortgage than the current market value of the home.

20% of principal junior to the AAA tranche will be eroded due to defaults is 1%. Now assume a pool exists where collateral default is highly correlated. When collateral default is highly correlated, there exists a much larger probability that the 20% of collateral junior to the senior tranche will default. On the flip side, if defaults are correlated, there also exists a probability that none of the collateral will default. Thus, when the default correlation is high, the structure requires more protection for the senior tranche. In this way, for a given expected loss distribution, default correlation affects the size of the AAA tranche. We compute two empirical proxies of default correlation in our empirical tests. The first is a measure of geographic concentration of the mortgage collateral, and the second measures the covariance of housing returns in the mortgage collateral.

The preceding discussion addressing expected loss and default correlation outlines the basis of our main hypothesis regarding the impact of house price appreciation. In a cross section of deals, if a rating agency determines that certain pools of loans are likely to benefit from high rates of house price appreciation relative to other mortgage pools, all else equal (including default correlation), the expected loss will be lower on the pool with high rates of house price appreciation, and less subordination will be required of those deals. The cost of funding the deal will also be lower. To the extent that mortgage pools concentrated in areas with high rates of house price appreciation receive more favorable credit ratings (again, all else equal), deal arrangers could rationally purchase mortgages of a lower marginal credit quality that are concentrated in areas with high rates of high price appreciation and still obtain the investment-grade ratings required to profitably market a securitization deal.

Empirically, we test the implications of this theory in three ways. First, we test whether deals with loans concentrated in areas with high rates of expected house price appreciation are indeed able to get a larger portion of the securitization rated AAA and investment grade, controlling for default correlation. We then test whether house price appreciation impacts the cost of funds for a deal. Second, we test whether this impacts the types of loans that investment banks targeted for the purpose of securitization. We examine whether pools of loans concentrated in areas with high rates of house price appreciation are of a lower average credit quality. Finally, a potential consequence of purchasing loans of marginal credit quality masked by high house price appreciation is

the potential for higher default rates when rates of house price appreciation slow down. As such, we analyze the empirical association among credit quality, realized rates of house price appreciation, and deal-level default rates in our sample of subprime securitization deals.

Section 4: Data and Summary Statistics

Our empirical work relies primarily on the intersection of two data sets. The first provides detailed information on individual subprime mortgage loans. LoanPerformance, a subsidiary of First American Trust, reports information on borrower attributes and loan types for about 75% of all subprime mortgage loans originated over the past 10 years. The second set of data contains summary information on the structure and rating of residential mortgage-backed securitization deals and comes from ABSNet, a subsidiary of Standard and Poor's. The deal summary from ABSNet contains data on the total size of the securitization deal as well as the size and original credit rating of each tranche included in the deal. We measure house price appreciation for the ZIP code, Metropolitan Statistical Area (MSA), or state of each individual loan using house price data from Fiserv Case Shiller Weiss and the Office of Federal Housing Enterprise Oversight (OFHEO) in the case of state-level house prices. We obtain state-level unemployment data made available by the Census. The data appendix contains a more detailed description of each of the sources used to obtain our final dataset.

Our primary unit of analysis is at the deal level. We take the following steps to identify and aggregate residential subprime securitization data to the deal level. First we obtain the deal summary for residential mortgage-backed securitization deals originated between 1997 and 2007 from ABSNet. The deal summary from ABSNet includes information on the date of issuance and the total deal amount. It also includes the original credit rating, original principal amount of each tranche, and tranche CUSIPs (each tranche, or bond has a unique CUSIP). ABSNet does not classify the residential securitization deals as being subprime. We rely on the classification of subprime deals provided by LoanPerformance. No unique numerical identifier exists between the deal summary data from ABSNet and the LoanPerformance database, so we match by hand using deal names. The total number of subprime deals included in our sample is dictated

by the number of subprime deals in the LoanPerformance database that can be matched to the universe of ABSNet deals by hand, which totals 1,315 subprime deals. We drop 64 deals from the sample because they do not have sufficient ratings information to properly quantify the structure of the deal. We double check that our hand-matching process correctly matched the LoanPerformance and ABSNet data by examining a sub-sample of deal names and deal summaries from Bloomberg.

We use the deal summary from ABSNet and complementary data from Bloomberg which classifies each tranche's bond type to compute the amount of each deal rated AAA or investment grade. When possible, we use the S&P rating to determine the original credit rating of each tranche. In the few cases where S&P ratings do not exist, we use ratings provided by Moody's. The proportion of a deal rated investment grade is calculated as the sum of the N tranches with investment grade ratings divided by the total deal balance, as follows:

$$Fraction\ Invest.Grade = \frac{\sum_{i=1}^{n} principal_{AAA,AA,A,BBB+}}{\sum deal\ \ principal}.$$

To give an example, if a deal has a AAA, AA, A, and BBB+ tranche each with a $50 million balance, and the deal has a total principal balance at origination of $210 million, then 95.2% of the deal is rated investment grade. Alternatively, the subordination of the investment-grade tranches would be 4.8%. In this way, subordination measures the credit support provided to the entire investment-grade portion of the deal. Technically, subordination can be computed for each tranche. In our sample, the median deal has 16 tranches. For our purposes, the fraction of the deal rated investment grade is chosen as the relevant ratings measure because the supply of capital to securitization deals, especially from institutional investors, flows primarily to investment-grade tranches. We provide the details of an example deal from our sample in Figure 2. Figure 2 reports the amount of principal contained in each tranche, the original credit rating, the first coupon payment that was made to investors and the coupon spread over 1-month LIBOR.

The median securitization deal in our sample has 5,219 mortgage loans serving as collateral. We aggregate the individual loan-level data from LoanPerformance to the deal level by taking the loan-weighted average of each deal attribute. We outline this

process in the data appendix. We match rates of house price appreciation to the data in three steps. First we match ZIP-code house price indexes to individual loans according the ZIP code reported in the loan documentation from Loan Performance. If a house price index is not available for the ZIP code, we match MSA-level house prices.[17] Finally, if an MSA index is not available for the loan, we use a state-level house price index. After matching individual loans with their respective rates of house price appreciation we aggregate the house price appreciation rates to the deal level using individual loan sizes within each deal as weights. Finally, we merge unemployment rates to the deal level using the state unemployment data. The final data set includes 1,251 securitization deals, 6.7 million loans that serve as collateral in the deals, unemployment rates from 50 states, and house price appreciation data at the ZIP code, MSA, and state levels.

Section 4b: Summary statistics

Table 1 reports summary statistics on the attributes of securitization deals for the entire sample, which runs from 1997-2007. We report the mean, median, standard deviation, and extreme percentiles of key deal attributes. The average subprime deal has a loan-weighted median FICO score of 621, a median loan-to-value ratio of 84% and a debt-to-income ratio of 41%. The median proportion of the deal with investment-grade ratings is 94.5%, while the median deal has an excess spread of 361 basis points. The median unemployment rate at deal origination was 5.1%, median house price appreciation in the year preceding deal origination was 13.7%, and median overvaluation was 7%.[18]

Table 2 reports summary statistics for deals originated through time and reveals a substantial increase in the number of securitization deals originated over the last decade. More deals were originated in 2005 and 2006 alone than in the entire preceding nine years combined. The principal included in the deals was also substantially larger, having increased from a median size of $478 million in 2000 to $1.02 billion in 2006. Table 2 also highlights an important trend in the structure of securitization deals through time. The proportion of each deal that was rated investment grade declined almost

[17] ZIP-code level house price data is available for about a third of the loans in our sample. MSA-level data is available for a large portion of the remaining two-thirds of our sample.
[18] We discuss the overvaluation concept in the following section.

monotonically since 2001.[19] In 2001, the typical deal had 97.1% of the principal rated investment grade, while the typical deal had just 88.2% rated investment grade in 2007. The monotonic decline appears to be in response to a marked inter-temporal decline in the amount of excess spread for the typical deal.[20]

Table 2 also documents the time series pattern in the default rate of loans in each deal. The default rate is calculated as the total number of loans in the process of foreclosure or already foreclosed in the year after the deal was originated divided by the total number of loans in the securitization deal. As an example, the numerator in the default rate for deals originated in 2006 is calculated as the total number of defaulted loans by the end of 2007. The jump in the default rate from 5.6% in 2005 to 13.7% in 2006 is associated with a significant decline in the average rate of house price appreciation over the same period.

Table 3 reports the time series attributes of the loan characteristics of each deal as well as average rates of house price appreciation. FICO scores generally increased through the sample period, as did loan-to-value and debt-to-income ratios.[21] The percentage of loans originated with adjustable rates increased substantially through the period. In general, aside from FICO scores, Table 3 reveals deterioration in the quality of loans being securitized through time, a pattern also identified by Demyanyk and Van Hemert (2007). Rates of house price appreciation rose dramatically over the sample period, reaching their peak in 2005. The unemployment rate varied little, ranging from a low of 3.97% in 2000 to a high of 6.13% in 2003.

Section 5: Empirical Methodology and Results

Our empirical analysis is designed to test the benefits of diversification and the impact of differing rates of house price appreciation on the structure of securitization deals. The structure of a securitization deal should matter because it could impact the cost of funding the mortgage loans purchased for the securitization. We begin by developing proxies for collateral diversification. We then test how expected rates of house price

[19] The same pattern exists for the percent of a deal rated AAA.
[20] Recall that subordination and excess spread are both forms of credit support. Thus, they can be viewed as substitutes, albeit imperfect ones.
[21] Debt-to-income ratios are missing for some loans early in the sample. We estimate some of our empirical tests with and without debt-to-income ratios to preserve sample size.

appreciation impact the ratings and cost of funds for a deal. Our final set of tests analyzes the implications of our hypothesis. We analyze whether rates of house price appreciation are associated with the credit quality of loans banks are willing to purchase, and analyze the association between credit quality and loan performance.

Section 5a: Constructing Measures of Collateral Diversification

We begin by developing two empirical proxies for collateral diversification. We measure geographic diversification by constructing a Herfindahl index, a calculation which measures the geographic concentration of the mortgage collateral. Our second proxy for diversification, referred to as housing market diversification, measures the covariance in the housing market returns in a portfolio of mortgage loans. Our motivation for constructing two separate measures of diversification is straightforward. Geographic diversification does not guarantee diversification in housing market returns. To the extent that the housing market is a primary factor in the probability of loan default, a relevant measure of loan diversification is the correlation between the returns in housing markets of the loan collateral. As an illustration of this point consider that despite geographic distance, returns on a California house price index have a correlation coefficient of 0.87 with returns on an index measuring house price returns in Washington DC.[22]

We construct a Herfindahl index of the geographic concentration in each deal as follows. For each deal we calculate the percentage of the deal principal concentrated in each of the 51 states (Washington DC enters the calculation separately). The deal-level Herfindahl index is then calculated as the sum of the squared weights, expressed as $\sum_{i=1}^{n} w_i^2$. We report summary statistics on deal-level Herfindahl measures of geographic diversification in Tables 1 and 3. Not reported in Table 3 is the fact that in our sample, the average deal has 28% of total loan principal concentrated in California.[23]

[22] The correlation is calculated using the state-level repeat sales house price index from OFHEO. The data are quarterly and run from 1991-2007.

[23] See Mayer and Pence (2008) for a more thorough analysis of the geographic dispersion in subprime loan originations.

We construct deal-level measures of the diversification in housing market returns in the following way. Again, for each deal, we calculate the percent of deal principal concentrated in each of the 51 states. The total portfolio covariance in housing market returns is then calculated as $W'(\Sigma - \sigma_i^2)W$, where W is a 51x1 matrix of loan concentration weights, and Σ is a 51x51 variance-covariance matrix of housing market returns. We subtract the variance of each housing market from the weighted variance-covariance matrix because we are only interested in the covariance of the housing market returns, not the variance of an individual market. Thus the variance-covariance matrix has zeros in the diagonal. The calculation results in a 1x1 scalar which is a summary measure of the covariance in housing market returns for each deal, with the covariance matrix weighted by the loan concentration in each state. The intuition is as follows. A deal that is highly concentrated in two states whose housing markets are historically highly correlated (not geographically) will have a larger covariance, and thus a higher probability of experiencing housing market declines at the same time. Summary statistics of market diversification are also reported in Tables 1 and 3.

Section 5b: Market Fundamentals, House Price Appreciation, and Deal Structure

Having constructed proxies for collateral diversification we turn our focus to expected rates of house price appreciation. Our primary hypothesis proposes the existence of a positive relationship between expected rates of house price appreciation and the proportion of the deal rated investment grade. If a pool of loans is likely to benefit from high rates of house price appreciation over the life of the deal, less subordination will be required of the deal, and the cost of funding the deal will be lower. This relationship should have some impact on the types of loans investment banks seek to purchase for the purpose of securitization. Testing this hypothesis requires a proxy for the expectation of rates of house price appreciation over some future time horizon.[24]

Using actual rates of appreciation as a proxy for expected rates, a common approach in models of empirical asset pricing, is not a viable option. This is because our hypothesis suggests the existence of a relationship between deal structure in the secondary market and the eventual level of credit supplied to the primary market. To the

[24] The exact time horizon will vary by deal, but most of the principal for most deals lasts 3-5 years.

extent that credit supply in the primary market influences subsequent rates of house price appreciation, the central argument of Sufi and Mian (2008), realized rates of house price appreciation measured over a given time period after deal origination may be endogenously determined by the deal structure itself. In our attempt to overcome this endogeneity we use two proxies for expected rates of house price appreciation at the time of deal origination.

Our first proxy for expected house price appreciation relies on housing market fundamentals to construct a measure of whether a housing market is "expensive" or "cheap" relative to its long run equilibrium. Theoretically, home prices should demonstrate an equilibrium relationship with rents and the "user costs" of housing. As discussed in Gallin (2004) and Himmelberg, Mayer, and Sinai (2005), the fundamental relationship between house prices and rents is commonly expressed as:

$$R_t = P_t[(i_t + \tau_t^p)(1-\tau_t^y) + \delta_t + \lambda_t - E_t G_{t+1}],$$

where i_t is the real interest rate, τ_t^P and τ_t^Y represent property and marginal income tax rates, δ_t is the maintenance and depreciation rate, λ_t is a housing market risk premium, and EG_{t+1} represents expected capital gains. The expression $(i_t + \tau_t^p)(1-\tau_t^y) + \delta_t + \lambda_t - E_t G_{t+1}$ is referred to as the user cost of owning a home and represents the cost and benefit of taxes, depreciation and maintenance, expected capital gains, and the financial risk of owning a property. Multiplying the user cost of housing by the level of house prices generates an "imputed rent". The fundamental relationship between "imputed rents" and actual rents compares the true cost of owning a property for a year against the cost of renting an equivalent property. As stated succinctly by Himmelberg, Mayer, and Sinai (2005), "[I]f annual ownership costs rise without a commensurate increase in rents, house prices must fall to convince potential homeowners to buy instead of renting. The converse happens if annual ownership costs fall."

Our measure of expected price appreciation relies on the imputed rent to actual rent ratios first constructed by Himmelberg, Mayer, and Sinai (2005) and since updated

by Mayer.[25] The data are quarterly and are calculated for 46 major metropolitan areas. The imputed-to-actual rent ratios are normalized to their 25-year average. To provide intuition regarding our use of the imputed-to-actual rent ratio we provide the following example. In the 3rd quarter of 2005, Los Angeles had a normalized imputed-to actual rent ratio of 1.20, suggesting that house prices in Los Angeles were 20% more expensive than their 25-year average. If a housing market is 20% overvalued, a reasonable expectation is that prices will decline and rents will increase to correct the disequilibrium. The dynamics of the speed and magnitude of the price and rent corrections vary by market, but Gallin (2004) shows that prices do much of the correcting in a sample of national house prices and rents. For our purposes, we rely on the argument that housing markets which are fundamentally overvalued will correct back toward the long-run equilibrium, and that house prices will do some of the correcting.[26]

We require a deal-level measure of the imputed-to-actual rent ratio. We begin by assigning each individual loan the imputed-to-actual rent ratio that has been calculated for the MSA in which the loan resides. MSA-level ratios are available for 73% of the loan principal in our sample of subprime loans. To match the remaining 27% of loans to fundamental price and rent data we make the admittedly crude assumption that housing market fundamentals are similar geographically. Each loan that exists in an MSA for which fundamental data is not available is assigned fundamental data from the closest geographic MSA.[27] The most prominent MSA missing data is Las Vegas, due to a lack of rental history. We assign loans originated in Nevada the imputed-to-actual rent ratio that is calculated for Phoenix. We address the missing data problem further in the robustness section of the paper.[28]

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[25] Professor Chris Mayer has made the imputed to actual rent data available at http://www4.gsb.columbia.edu/realestate/research/housing. See Himmelberg, Sinai, and Mayer (2005) for a thorough discussion of ratio construction.

[26] As opposed to the possibility that increased rental rates alone will correct the disequilibrium.

[27] For example, imputed-to-actual rent data is not made available for Oklahoma. We therefore compute an average of the available ratios in the state of Texas and assign loans originated in Oklahoma the average ratio calculated for Texas.

[28] The potential bias is that the fundamental price-to-rent data are available for urban areas that are consistently more expensive relative to fundamentals than less populated areas. Assigning "urban" ratios to "rural" loans may create a positive bias in the imputed-to-actual rent ratio at the deal level. As an example, assigning Boston fundamentals to loans made in New Hampshire could create a positive bias. Fortunately, our sample is concentrated heavily in the 46 MSAs covered by Mayer.

The data are aggregated to the deal level using loan sizes as weights. Summary statistics of our deal-level measure of housing market values relative to fundamentals are presented in Tables 1 and 3. The median deal in our sample is concentrated in housing markets that are an average of 7% more expensive than their 25 year average. The time-series pattern in the imputed-to-actual rent ratio, presented in Table 3, reveals that housing markets in our sample of subprime loans were about 20% "overvalued" during 2006 and 2007, on average.

Our hypothesis proposes the existence of a relationship between expected rates of house price appreciation and the proportion of a deal rated AAA or investment grade. Because an imputed-to-actual rent ratio greater then one represents current market overvaluation (and an expectation of future price declines), we expect a negative statistical relationship between imputed-to-actual rents and the proportion of the deal that receives favorable ratings. In estimating the impact of housing market expectations we include a set of control variables that should also impact credit ratings. The proportion of the deal rated AAA should be negatively related to the default correlation in the portfolio of loans. Our proxies for default correlation include the deal-level Herfindahl index of geographic concentration, and the market diversification measure, which measures the covariance in housing markets underlying the deal. Deal-level FICO scores should be positively related to ratings. A borrower's leverage, captured by the loan-to-value ratio should have a negative relationship, as should the percentage of loans in a deal that have an adjustable rate. Owner occupied loans, purchase loans, and loans with full documentation should all be positively related to credit ratings. Finally, we control for the amount of excess spread in the deal and the unemployment rate at the time of origination and include a dummy variable if the deal has a form of external bond insurance.[29]

Tables 4 and 5 report the results of an OLS regression using deal data from 1997-2007. The dependent variable in Table 4 is the proportion of the deal rated investment grade and the dependent variable in Table 5 is the proportion of the deal rated AAA. Column 1 of each table estimates the relationship using the 1997-2007 pooled sample. To

[29] Because excess spread is a substitute for subordination, including it on the right-hand side could create an identification problem. However, recall that excess spread is essentially pre-determined when a pool of loans is being reviewed. Thus, the amount of excess spread supporting a deal is indeed a determinant of the level of subordination, but it is not determined simultaneously.

control for the possibility of a spurious statistical relationship in our short time series we include year fixed effects. We also estimate the relationship separately for each year of our sample for which we have sufficient data, beginning in 2003. The results are presented in columns 2-6. In the pooled regression we cluster standard errors by year, and in the cross-sectional regressions we cluster standard errors by deal underwriter.

The results presented in Tables 4 and 5 are surprising. In the pooled sample, housing market fundamentals have no significant relationship with deal structure. However, in the cross-sectional regressions estimated for years 2006 and 2007 in Table 4, higher levels of overvaluation exhibit a positive relationship with the proportion of the deal rated investment grade. The results suggest that a 5% (one standard deviation in years 2006 and 2007) increase in market overvaluation is associated with a 0.5-2% increase in the percent of the deal rated investment grade (4% represents one standard deviation). Similar results are presented in Table 5 when the proportion of the deal rated AAA is the dependent variable, although only statistically significant in the year 2007.

In Table 4, geographic concentration in the loan pool is negatively related to deal ratings for most years in the sample. Decreasing the geographic concentration of a deal by 5% (one standard deviation) increases the total proportion of the deal rated AAA by 0.4% (one standard deviation equals 6%). The lack of a consistent negative coefficient on our measure of housing market covariance in the model is somewhat puzzling. The two measures of collateral diversification have a correlation coefficient of -0.04, suggesting our measures of geographic and market diversification are not collinear. While a measure of the correlation in housing market returns (regardless of geography) is theoretically and intuitively appealing, the results suggest that geographic diversification is the more relevant measure in our sample, perhaps because it is easier to measure. Overall, our results provide some evidence consistent with the expectation that deals with higher levels of diversification are associated with a more favorable deal structure.

Section 5c: House Price Appreciation, Expectation Formation, and Deal Structure

The results presented in Tables 4 and 5 suggest that near the end of our sample, deals concentrated in overvalued markets had a larger portion of the deal rated investment grade and AAA. This is surprising because, ex ante, overvalued markets are

more likely to correct back to prices consistent with the fundamentals. The unexpected result could be attributed to mis-measurement in our proxy for market fundamentals, or a potential misspecification in our statistical tests. We address these possibilities in a concluding section of the paper. The result also suggests an interesting alternative proxy for the formation of housing market expectations. Market participants, potentially rating agencies included, may have been strongly influenced by prior rates of house price appreciation. Forming expectations via extrapolation is not without precedent. In citing and explaining the results of a series of surveys measuring consumers' expectations of future home price gains, Shiller (2007) observes, "times and places with high home price increases show high expectations of future home price increases and when the rate of price increases changes, so too do expectations of future price increases, in the same direction."

We explore the extrapolation hypothesis by investigating whether lagged rates of house price appreciation impacted the proportion of a deal that received favorable credit ratings. Explaining deal structure with lagged rates of house price appreciation is valid econometrically. Using lagged rates of appreciation clarifies causality and addresses the possible endogenous relationship between deal structure and future house prices. Deal structure in time *t* should not influence rates of house price appreciation in the preceding year. Relying on lagged rates of appreciation as a proxy for expected appreciation does have an obvious weakness. To the extent that rates of house price appreciation are persistent through time, a documented empirical attribute of the data, our estimation could be biased. The existence of an omitted variable that influences rates of house price appreciation and the structure of securitization deals over all the years of our sample is also possible.

Column 1 of Table 6 reports the results of estimating an OLS regression using the pooled 1997-2007 sample, where the proportion of a deal rated investment grade is regressed on lagged rates of price appreciation and other controls. The controls include our prior measures of collateral diversification and the list of borrower attributes that have been shown to affect the probability of loan default. The results suggest the existence of a positive, significant, and economically meaningful relationship between past rates of house price appreciation and credit ratings. A 5% increase in lagged house

price appreciation (one standard deviation) is associated with a 1% increase in the proportion of the deal rated investment grade (one standard deviation in the proportion rated investment grade is 4.1%). Column 1 of Table 7 reports results when using the proportion of the deal rated AAA as the dependent variable.

The potential for spurious results is pronounced in this regression because of the unconditional monotonic pattern displayed by rates of house price appreciation and deal structure through the bulk of our sample. We feel the results are not spurious for multiple reasons. First, unconditionally, the proportion of a deal rated investment grade is declining through time. Our results suggest that, conditional on rates of house price appreciation, the proportion of a deal rated investment grade actually increases, a result consistent with our proposed hypothesis. Second, the equation in column 1 of Tables 6-7 is estimated using time fixed effects with clustered standard errors by year.

If rates of house price appreciation affect deal structure, the relationship should exist in a cross section of deals each year. Table 6 reports results when estimating the proportion of a deal rated investment grade in each year for the years 2003-2007 (years for which we have the most data). In each cross sectional regression we cluster standard errors by the deal arranger to account for correlation in standard errors that is specific to a deal arranger. The results are robust for the majority of the years when estimated separately, and appear strongest for deals originated in 2003 and 2007. Table 7 reports year-by-year results when the proportion of a deal rated AAA is the dependent variable. The results for 2007 suggest that a 5% increase in the average lagged rate of house price appreciation increases the size of a deal rated AAA by about 3%. The results are robust in 4 of the 5 years and are strongest in 2003, 2005, and 2007.

The results presented in Tables 6 and 7 provide some evidence consistent with the hypothesis that prior rates of house price appreciation have a statistically and economically significant impact on the structure of subprime securitization deals. However, a relevant question is whether rates of house price appreciation are a first-order determinant of deal structure, or if FICO scores, loan-to-value ratios, or other factors have a larger economic impact on deal structure. Because the independent variables in our sample have varying units, the economic impact of house price appreciation relative to other deal structure determinants is not obvious. For example, the average FICO score

in the sample is 621, while the average loan-to-value ratio is 83.5%. To facilitate easy comparison of the relative magnitudes of each of the variable coefficients, we standardize the dependent and independent variables as follows: $\frac{Variable_i - Mean of Variable_i}{Std.Dev._i}$. The sample mean of each variable in the OLS regression is thus equal to zero with unit standard deviation. In table A1 of the appendix we report the results of our model estimated separately for each of the years 2003-2007 when the proportion of the deal rated AAA (scaled by standard deviation) is the dependent variable. Column 5 of Table A1 suggests that a one standard deviation increase in lagged price appreciation increases the percent of the deal rated AAA by 0.46 standard deviations. In the four years where the effect is positive and significant, lagged rates of house price appreciation increase the percent rated AAA by an average of 0.63 standard deviations. By comparison, for the four years FICO scores are significant, a one standard deviation increase in FICO scores increases the percent rated AAA by 0.35 standard deviations. Taken together, the results presented in table A1 of the appendix suggest that rates of house price appreciation are at least equally important as FICO scores and loan-to-value ratios in determining deal structure.

The results presented in Tables 6, 7, and Appendix A1 suggest that rates of house price appreciation have a meaningful economic impact on the structure of securitization deals. Yet, the results are striking for another reason. If expectations of rates of future house price appreciation are indeed strongly influenced by prior rates of price appreciation, then securitization deals originated at the peak of a housing cycle could be structured most aggressively precisely at the time they should be structured most conservatively. This is because deals originated at the peak of a housing cycle will, by definition of a cycle peak, be exposed to subsequent house price declines, thereby increasing the probability of default in the underlying loans. Because of this, investors are exposed to the ability of investment banks and rating agencies to forecast turns in the housing cycle, a caution first raised by Ashcraft and Schuermann (2008) and confirmed empirically in Tables 5 and 6.

The results also highlight a potential weakness in the use of lagged rates of house price appreciation as a proxy for expected rates of house price appreciation. The fact that lagged rates of house price appreciation impact deal structure does not guarantee that

rating agencies or investment banks held irrational expectations about future rates of house price appreciation. Poor ex post outcomes could simply represent a bad draw from a reasonable distribution of expectations formed ex ante.

Section 5d: Deal Structure and the Cost of Funds

The proportion of a securitization deal rated investment grade should impact the cost of funding the underlying portfolio of mortgage loans. A deal with better credit ratings should be able to issue a larger fraction of bonds at a lower coupon rate, on average. In this section, we test whether rates of house price appreciation and our measure of loan diversification impact the cost of funds for a deal. Our hypothesis, and earlier results presented in Tables 6 and 7 suggest that rates of house price appreciation should be negatively related to the cost of funds while higher levels collateral diversification should be positively related to the cost of funds.

Empirically, we measure the cost of funds for a deal as the spread of each bond's coupon payment over interest rate on the relevant risk-free asset. For floating rate tranches, the spread is calculated as the first coupon payment over one month LIBOR at the time of deal close. In our sample of subprime securitizations, 96.5% of the average principal in a deal is in the form of a floating-rate bond.[30] For the small percentage of tranches that pay fixed rates, the relevant risk-free reference rate is less clear. The ideal reference asset would be the yield to maturity on a risk-free asset selling at par with the exact maturity of the MBS. However, because of unknown pre-payment and default activity, the expected life of a fixed rate MBS is unclear. To overcome this problem we use an estimate of the life of each fixed-rate bond produced by Bloomberg, and use the rate on the T-bond with the closest maturity as the risk free rate of reference.[31]

We take the following steps to create a deal-level cost of funds. First, for each bond, we subtract the bond's first scheduled coupon rate from the relevant risk-free reference asset. We then aggregate the tranche spreads to the deal level using the size of each tranche's principal as weights. As an example, Figure 1 reports the spread of each

[30] The median deal has 16 tranches, 84.2% of which are floating-rate bonds, but 96.5% of deal principal is in floating form.
[31] In the few cases where Bloomberg does not produce an estimate, fixed rate bonds are matched with the rate on a five-year treasury.

tranche over the reference asset and the tranche-weighted cost of funds for the entire deal, which is about 25 bps.

Our goal is to test the impact of key deal attributes on the cost of funds for the deal. We estimate the relationship using both proxies of expected house price appreciation. Column 1 of Table 8 reports the results of estimating a pooled OLS regression using the 1997-2007 sample. The deal-level cost of funds is regressed on the implied-to-actual rent ratio, our deal-level measures of diversification, and other measures of deal credit quality. As in previous tests we also estimate the relationship separately for each year. Table 9 estimates the same model, with lagged rates of house price appreciation as the dependent variable.

Consistent with prior results, Table 9 suggests that deals with high rates of past house price appreciation appear to have a statistically significant lower cost of funds in years 2003, 2004, and 2007. A 5% increase in lagged house price appreciation decreases the cost of funds by 10-20 basis points (one standard deviation in deal-level coupon spread is equal to 24 basis points). However, the result is not consistent in every year. Deals with high rates of appreciation had a statistically higher cost of funds in 2006, though the magnitude is quite small (a 5% increase in house prices led to 3 basis point increase in cost of funds).

Deals with higher average FICO scores enjoy a lower coupon spread, while deals with a higher percentage of adjustable-rate mortgages have a 2-3 basis point higher cost of funds. The impact of adjustable-rate mortgages on the cost of funds is of interest because one aspect of our hypothesis suggests that arrangers could purchase loans of a marginal credit quality (ARMs) that are concentrated in fast growing housing markets and still obtain favorable ratings. The results in Table 9 suggest that although a deal with a higher concentration of adjustable-rate mortgages increases the cost of funds, the benefit of high rates of house price appreciation appears to more than offset those costs, on average.

Section 5e: Loan Attributes, House Price Appreciation, and Credit Ratings

In this section we explore whether rates of house price appreciation impact the types of loans deal arrangers purchase for the purpose of securitization. Theoretically, our

motivation is related to the type of argument found in Coval, Jurek, and Stafford (2007) and Brennan, Hein, and Poon (2008), which suggests that arbitrage profits are possible for a deal arranger in a securitization market if investors purchase collateralized securities based solely on credit ratings. Our analysis is by no means a direct test of the ratings arbitrage models, but we use the intuition to shape the basis of our argument. The results presented in Tables 6 and 7 suggest that deals with loans concentrated in areas with high rates of house price appreciation receive more favorable credit ratings, and thus cheaper financing for the deal. One immediate implication of this result is that deal arrangers could rationally purchase loans of marginal credit quality in areas with high rates of high price appreciation and still obtain the rating required to attract institutional investors, making the deal liquid and profitable. To the extent that loans of a marginal credit quality are cheaper, this could be a profitable strategy.[32] We caution that because we do not have the wholesale prices of loans, we cannot test this hypothesis directly.

We analyze the association between loan attributes, rates of house price appreciation, and credit ratings using a two-way sorting technique. We begin by sorting each of the 1,251 deals in our sample into quintile portfolios based on the proportion of the deal rated investment grade. Thus, the lowest-quintile portfolio contains deals with the lowest proportion of the deal rated investment grade. Next, within each of the five investment-grade quintiles, we sort deals into quintile portfolios based on lagged rates of house price appreciation. The result is 25 portfolios which contain deals that have been sorted on deal structure and rates of house price appreciation. We are interested in the credit quality of the loans within each portfolio. The portfolio sorts allow us to identify the spread in loan credit quality that is associated with disparate rates of house price appreciation while keeping the credit rating of the deal relatively constant.

We report average loan attribute data for each of the 25 deal portfolios in Table 10. We test the null hypothesis that the loan attribute data reported in the rows and columns of the tables are statistically different from the attribute sample mean using a two-way analysis of variance test. We report the p-values associated with the F-test statistic for the row and column factors, as well as a test of their interaction in Panels A-

[32] A potential flaw in this argument is the extent to which wholesale loan prices are impacted by rates of house price appreciation. Presumably, if demand for loans from areas of high price appreciation was strong enough over time, loan prices would adjust and correct any arbitrage opportunity.

D.[33] Panel A reports the average FICO score for each of the 25 deal portfolios. Panel B reports average loan-to-value ratios, Panel C reports average debt-to-income ratios, and Panel D reports the average percentage of loans that have adjustable rate mortgages within a deal for each of the 25 deal portfolios.

The patterns in adjustable-rate mortgage purchases are of particular interest. Within each investment-grade portfolio, the percentage of adjustable-rate mortgages included in a deal increases monotonically moving from the lowest quintile of house price appreciation to the highest. The portfolios with the best credit ratings also exhibit the highest spread in the proportion of the deals with adjustable-rate mortgages. Deals with the highest rates of house price appreciation in investment-grade quintile 5 have almost double the proportion of loans with adjustable-rates as deals in investment-grade quintile 5 that have the lowest rates of house price appreciation. The portfolio results suggest that deals loaded with adjustable-rate loans and concentrated in areas with high rates of house price appreciation were able to obtain more favorable deal structures.

Obviously, loans originated in areas with high rates of house price appreciation are likely to use adjustable-rate mortgages because the realized appreciation has resulted in more expensive home prices. To the extent that average borrower wealth does not appreciate at the same rate as home prices (a tall order with home prices appreciating well over 10% annually over half our sample), the propensity to originate an adjustable-rate mortgage will be higher. However, the relevant result for our purposes is that despite having a much higher fraction of loans with adjustable rates, deals in high price appreciation quintiles received similar credit ratings as deals with a low percentage of adjustable-rate mortgages. All else being equal (granted, a status not perfectly obtained in portfolio sorts) to the extent that a portfolio of loans with a large percentage of adjustable-rate mortgages are cheaper than a portfolio of loans with a lower percentage of adjustable-rate loans, deal arrangers could benefit by purchasing the cheaper portfolio while still obtaining the investment-grade ratings on account of high rates of house price appreciation. Because we do not have data on wholesale loan prices, we cannot directly test the marginal impact of loan attributes on loan price. However, the portfolio sorts do

[33] The F-test statistic has (4, 1226) degrees of freedom when testing for equality in the row and column factors, and (16, 1226) degrees of freedom when testing for equality in the interaction of the two factors.

establish why a demand would exist for loans of a marginal credit quality in areas with high rates of house price appreciation, especially if investment banks feel confident that investors purchase bonds based solely on credit ratings.

Section 5f: Loan Attributes, House Price Appreciation and Default Rates

In this section, we explore the relationship between loan credit quality, default rates, and *realized* rates of house price appreciation using a two-way sorting technique. We now focus on realized rates of house price appreciation, defined as the annual percent change in the relevant house price index in the year following deal origination. We use rates of house price appreciation in the year following the deal because one potential consequence of purchasing loans of marginal credit quality masked by high house price appreciation is the potential for higher default rates if and when rates of house price appreciation slow down.

We begin by sorting deals into quintile portfolios based on credit attributes, using average FICO scores, loan-to-value and debt-to-income ratios, and ARM status as relevant credit attributes. We then sort deals into quintiles based on realized rates of house price appreciation within each of the credit quintiles. We report average default rates within a deal for each of the 25 deal portfolios. The deal-level default rate is calculated as the total number of loans within the deal in the process of foreclosure or already foreclosed by the end of the year *after* the deal was originated, divided by the total number of loans in the securitization deal. The sample thus includes 1,025 deals from the years 1997-2006. We test the null hypothesis that the deal-level default rate reported in each of the tables is statistically different from the sample mean default rate using a two-way analysis of variance test, and report the p-values from the associated F-test statistic.

Panel A of Table 11 reports average deal-level default rates for 25 deal portfolios sorted on FICO scores and contemporaneous rates of house price appreciation. Panel B employs the loan-to-value ratio as a credit metric, while panels C and D sort on debt-to-income and the percent of the deal with an ARM, respectively. Table 11 reveals a statistically significant pattern between default rates and declines in rates of house price appreciation. The lowest house price appreciation quintiles report default rates as high as

17.2%, a substantial difference from the sample average default rate of 6.7%. For each of the credit attributes, default rates in the lowest quintile of house price appreciation are nearly three times larger than default rates in the highest quintile of appreciation. The highest default rates are concentrated in portfolios that contain the largest percentage of loans with an adjustable rate in the lowest price appreciation quintiles.

Table 11 also suggests that, at least in this housing cycle, rates of house price appreciation have had a larger (magnitude) association with default rates then traditional measures of loan credit quality. To see this, we compare the change in default rates moving down credit attribute quintiles within a given appreciation portfolio against the gradient in default rates moving across appreciation portfolios within a given credit quintile. For example, consider the default rates reported in the loan-to-value quintile 3 of Panel B. Default rates drop from an average of 12.4% to an average of 3.9% when moving from left to right through the appreciation portfolios. Compare that with the change in default rates for quintile 3 of the house price appreciation quintiles reported in Panel B. The average deal default rate increases from 4.6% in the lowest loan-to-value quintile to 7.5% in the highest loan-to-value quintile.

Again, while house price declines do not directly cause default, as house prices stagnate or decline, some homeowners are left with little or no equity and thus have little incentive to continue making mortgage payments. In the case of adjustable-rate mortgages, stagnant house prices could preclude homeowners facing payment resets from refinancing if the price decline has left a borrower owing more on the mortgage than the current market value of the home. Because adjustable-rate mortgages are usually extended to borrowers of lower credit quality, the results of Table 11 highlight the potential consequences associated with purchasing adjustable-rate mortgages, which are masked by high rates of house price appreciation.

Section 5g: Robustness Checks

In this section we briefly discuss steps we have taken to consider the robustness of our results. The first concern is related to our measure of house price appreciation. Our primary measurement uses house price indexes at the ZIP-code, MSA, and state level. One concern with this approach is that the ZIP-code indexes are more volatile than the

MSA and state indexes. During periods of significant appreciation, this has the potential to create an upward bias in our measure of house price appreciation. To address this concern we compute deal-level measures of price appreciation using the state house price indexes only. The results in Tables 6, 7, and 9 are robust to this approach, suggesting that our estimates are not driven by a relatively few fast-growing ZIP codes packed with subprime loans.

Our second robustness check deals with our measure of housing market fundamentals. The imputed-to-actual rent ratio is only available for 73% of the loan principal in our sample. Loans that were missing fundamental data were assigned data from the nearest geographic MSA. Assigning loans from rural areas fundamental data from urban populations could create an upward bias in our deal-level measure of market valuation. To address this concern we calculate the imputed-to-actual rent ratio at the deal level using only loans in the deal that have available data. The results of this calculation suggest that assigning fundamental data from the nearest geographic location to loans with missing data does not create an upward bias. When calculated without loans with missing data, the average deal-level implied-to-actual rent ratio is 1.108 compared to an average of 1.09 when missing data loans are included. We re-estimate Tables 4 and 5 with the recalculated ratio and find the results change very little.

Section 6: Conclusion

Recent literature suggests that the current increase in subprime defaults is the result of an increase in the supply of mortgage credit manifest as a decline in underwriting standards. The source of the decline in underwriting standards, it is argued, is the existence of securitization markets. However, to date, the literature has treated securitization as a binary outcome; loans were either securitized or not. The purpose of our paper is to highlight how the structure of securitization deals could impact the supply of credit being afforded the origination market. In an effort to understand the importance of the securitization process, we focus on how the credit and housing market characteristics of the loans included in securitization deals affects the terms on which a deal is arranged. Put differently, we believe that deal structure matters because the economics of the structure incent deal arrangers to purchase loans that will provide the

cheapest funding for the deal. Demand from the secondary market for certain types of loans will impact origination patterns in the primary mortgage market. While we do not have data on origination patterns in the primary market, we are able to identify loan characteristics that influence deal structure, essentially identifying empirically the conditions under which the securitization process could impact the primary origination market.

Our results suggest that deals are able to get a larger portion of the structure rated investment grade if the underlying mortgage collateral is less geographically concentrated. While the results related to diversification are statistically significant, they are not economically large in magnitude. Our primary hypothesis proposes that deals with loans that are concentrated in areas expected to have high rates of house price appreciation receive more favorable credit ratings. We test this hypothesis using a fundamental measure of a housing markets value relative to its long-run average. Markets that are "expensive" relative to their long-run average are reasonably expected to experience price declines in the future. Our results suggest that, surprisingly, deals that were concentrated in the most overvalued housing markets received a larger portion of the deal rated investment grade, at least during 2006 and 2007. The result suggests that market participants may have extrapolated expectations of future house price appreciation from prior rates of appreciation. Accordingly, we test whether lagged rates of house price appreciation impact the proportion of a deal receiving favorable credit ratings. Deals with loans that are concentrated in areas that have exhibited high rates of house price appreciation in the year prior to deal origination receive more favorable credit ratings, all else equal. This result is concentrated in 2005, 2006, and 2007, depending on the specification. We also demonstrate that deals with loans concentrated in areas with high rates of house price appreciation are able to purchase loans of a lesser credit quality and still obtain favorable credit ratings. Finally, we demonstrate an association between realized rates of house price appreciation, loan credit quality, and deal-level default rates. The analysis suggests that rates of house price appreciation, at least in this housing cycle, appear to have had a stronger association with default rates then standard measures of loan credit quality.

Our study highlights how the structure and ratings of subprime residential mortgage-backed securitization deals could affect the economic incentives driving the loan purchase decisions of investment banks in the secondary mortgage market. If higher rates of house price appreciation can lower the cost of funding a deal, the secondary market will demand loans in rapidly appreciating housing markets, and mortgage originators will rationally increase the supply.

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Figure 1a. The Impact of Securitization on Credit Standards

This figure diagrams how the existence of a securitization market could lower credit standards in the mortgage origination market.

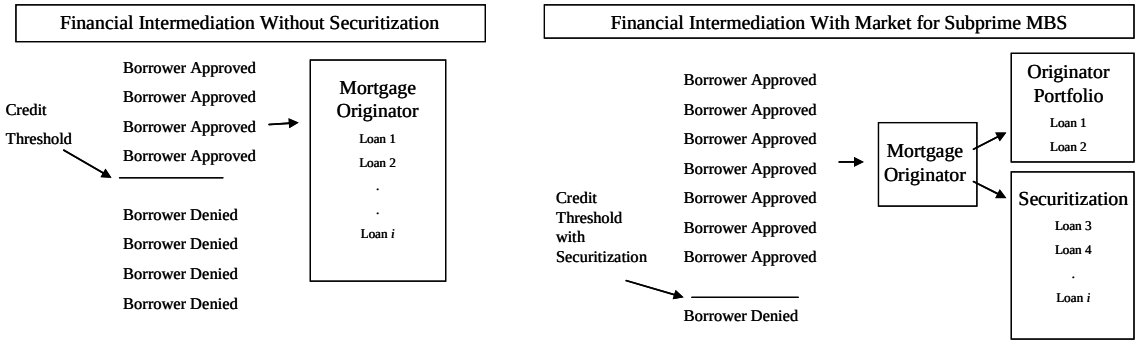

Figure 1b. Feedback from the Securitization Process in the Secondary Market to Credit Standards in the Primary Market.

This figure diagrams how the economics of the securitization structure could impact credit standards in the origination market. Loans with attributes that provide more favorable credit ratings in the securitization process will be originated in the primary market.

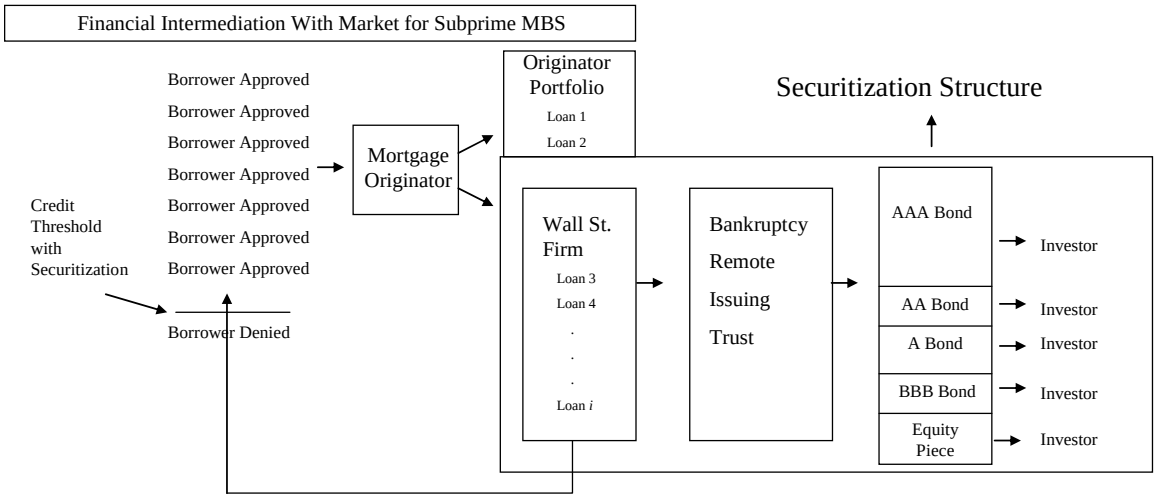

Figure 2. The Structure of a Subprime Securitization Deal.

This table presents the structural details of a subprime securitization deal in our sample. The deal, named GSAMP Trust 2006-NC1 was arranged by Goldman Sachs and was originated in February 2006. The total deal principal is $714.2 million, with $8.93 million serving as overcollateralization. One-month LIBOR in February 2006 was 4.58. The tranche-weighted spread over LIBOR is .258%.

Class Name	Original Balance (000's)	Percent of Total Principal	Original Rating (S&P)	Coupon Type	First Coupon Rate	Spread Over 1-Mth LIBOR	Spread over Reference Treasury
A-1	$310,299	43.4%	AAA	Floating	4.675%	0.095%	
A-2	$224,955	31.5%	AAA	Floating	4.785%	0.205%	
A-3	$42,565	6.0%	AAA	Floating	4.895%	0.315%	
M-1	$23,213	3.3%	AA+	Floating	4.965%	0.385%	
M-2	$21,784	3.0%	AA+	Floating	4.985%	0.405%	
M-3	$12,857	1.8%	AA	Floating	5.005%	0.425%	
M-4	$11,070	1.5%	AA	Floating	5.105%	0.525%	
M-5	$10,714	1.5%	AA-	Floating	5.125%	0.545%	
M-6	$9,642	1.3%	A+	Fixed	6.000%		1.430%
B-1	$9,285	1.3%	A	Floating	5.205%	0.625%	
B-2	$10,000	1.4%	A-	Floating	5.745%	1.165%	
B-3	$6,428	0.9%	BBB+	Fixed	6.000%		1.530%
B-4	$5,357	0.8%	BBB	Fixed	6.000%		1.530%
B-5	$7,142	1.0%	BBB-	Fixed	6.000%		1.530%
CE	$8,928	1.3%	N.R.				

Figure 3. Default Correlation and Expected Loss Distribution.

This figure uses a hypothetical distribution of expected loss to demonstrate how default correlation changes the shape of the loss distribution, but not the expected loss. Expected loss in the two distributions is equal.

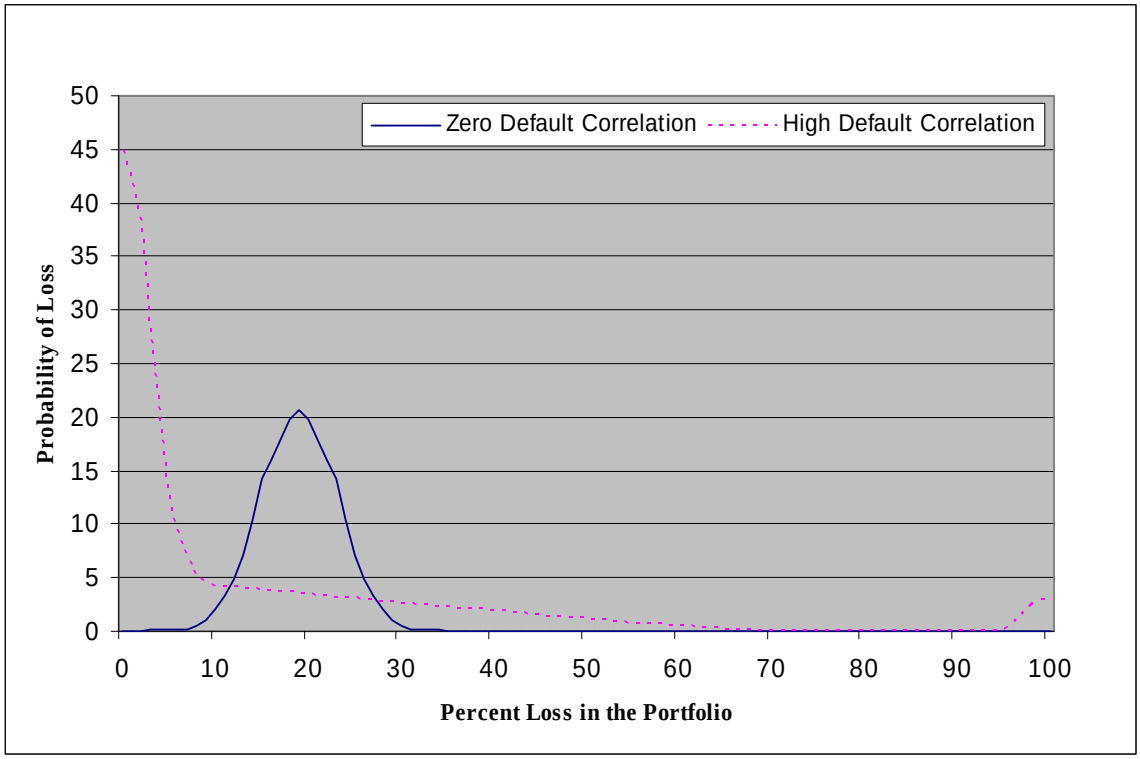

Table 1. Deal Summary Statistics.

This table reports summary statistics related to the structure of subprime securitization deals. The sample runs from 1997-2007. Size of the AAA tranche is defined as the total principal balance of tranches with a "AAA" rating at the time of deal origination divided by the total principal of the deal. Size of the investment-grade tranche is the sum of all tranches with an original credit rating of "BBB+" or higher (or the Moody's equivalent when relevant), divided by the total principal balance of the deal. Excess spread is calculated as the difference between the deal origination loan-weighted mortgage rate and the first coupon promised to investors. Deal FICO is a loan-weighted average of the deal FICO scores at origination. Deal CLTV is the loan-weighted average of a borrower's loan-to-value ratio at deal origination. Deal DTI is the loan-weighted average of a borrower's debt-to-income ratio at deal origination. The deal unemployment rate is calculated as the loan-weighted state unemployment rate at the time of deal origination. House Price Appreciation t-1 is calculated as the one-year growth rate in residential house prices in the zip-code, MSA, or state of the loan origination and is aggregated to the deal level using loan sizes as weights. Housing market diversification is a measure of the correlation of the housing markets in which the loans were originated. Geographic diversification is a Herfindahl index measuring the geographic concentration of loans in the deal. The text of the paper contains a detailed description of how the two measures of diversification are computed. The implied-to-actual rent ratio is a measure of how "expensive" a housing market is relative to its 25-year average. The ratio is calculated and made publicly available by Chris Mayer at http://www4.gsb.columbia.edu/realestate/research/housing. The text outlines how we aggregate MSA-level measures of housing market fundamentals to the deal level. Deal coupon spread is the spread between coupon rates being paid to bond investors over 1-mth libor (where 1-month libor is measured as the monthly average in the month of deal close). Deal coupon spread is calculated for tranches that pay floating coupon payments to bond investors. The coupon spread is aggregated to the deal level using tranche sizes as weights.

	N	Mean	Med	Std. Dev.	5%	95%
Size of AAA Tranche	1251	0.810	0.799	0.064	0.723	0.933
Size of Investment Grade Tranche	1251	0.937	0.945	0.041	0.865	0.994
Excess Spread	1238	4.02	3.61	1.37	2.41	6.35
Deal Coupon Spread	1251	0.447	0.408	0.269	0.180	0.846
Deal FICO	1240	623.7	621.3	21.7	593.9	657.2
Deal CLTV	1251	83.91	83.95	6.06	76.68	92.58
Deal DTI	1025	40.71	41.01	2.68	37.82	43.33
Deal ARM	1251	0.777	0.817	0.178	0.431	0.951
Deal Unemployment Rate	1251	5.17	5.05	0.65	4.31	6.24
House Price Appreciation t-1	1251	13.33	13.76	5.30	3.56	20.56
Market Diversification	1251	0.307	0.313	0.043	0.236	0.370
Geographic Concentration	1251	0.134	0.117	0.074	0.051	0.281
Implied-to-Actual Rent Ratio	1251	1.090	1.072	0.109	0.947	1.262

Table 2. Deal Summary Statistics through Time.

This table documents key subprime securitization deal summary statistics through time. The sample runs from 1997-2007. Size of the AAA tranche is defined as the total principal balance of tranches with a "AAA" rating at the time of deal origination divided by the total principal of the deal. Size of the investment-grade tranche is the sum of all tranches with an original credit rating of "BBB+" or higher (or the Moody's equivalent when relevant), divided by the total principal balance of the deal. Excess spread is calculated as the difference between the origination loan-weighted mortgage rate and the first coupon promised to investors. The origination deal mortgage rate is the mortgage rate being paid by the borrower at loan origination, loan-weighted to the deal level. Rate of first coupon is the first coupon payment being paid to bondholders, and is weighted by the size of each tranche. Default rate calculates the total number of loans in foreclosure or default by the end of the year after the loan was originated. Housing market diversification is a measure of the correlation of the housing markets in which the loans were originated. Geographic concentration is a Herfindahl index measuring the geographic concentration of loans in the deal. The text of the paper contains a detailed description of how the two measures of diversification are computed. The implied-to-actual rent ratio is a measure of how "expensive" a housing market is relative to its 25 year average. The ratio is calculated and made publicly available by Chris Mayer at http://www4.gsb.columbia.edu/realestate/research/housing. The text outlines how we aggregate MSA-level measures of housing market fundamentals to the deal level. Deal coupon spread is the spread between coupon rates being paid to bond investors over 1-mth libor (where 1-month libor is measured as the monthly average in the month of deal close). Deal coupon spread is calculated for tranches that pay floating coupon payments to bond investors. The coupon spread is aggregated to the deal level using tranche sizes as weights.

Year	Avg. Deal Size ($ Mill.)	N	Proportion of Deal Rated AAA	Proportion of Deal Rated Investment Grade	Excess Spread (%)	Deal Mortgage Rate at Origination (%)	Rate of First Coupon (%)	Deal Coupon Spread	Default Rate* (%)
1997	$189	4	0.957	0.968	2.693	9.387	6.900	.	0.230
1998	$378	6	0.987	0.995	3.585	9.716	6.123	0.105	6.340
1999	$540	12	0.905	0.951	3.788	9.835	6.117	0.171	4.410
2000	$478	14	0.898	0.966	4.187	11.062	6.875	0.240	8.940
2001	$828	31	0.893	0.971	6.026	9.997	3.925	0.257	7.340
2002	$773	67	0.880	0.965	6.154	8.629	2.478	0.445	5.220
2003	$870	134	0.861	0.968	5.748	7.689	1.966	0.547	4.110
2004	$1,103	230	0.828	0.956	5.086	7.127	2.041	0.506	4.010
2005	$1,107	301	0.796	0.939	3.451	7.212	3.763	0.389	5.630
2006	$1,018	317	0.776	0.919	2.887	8.029	5.142	0.252	13.740
2007	$854	135	0.755	0.882	2.927	8.232	5.305	0.326	.

*Total number of defaults by the end of the year after the year in which the deal was originated.

Table 3. Deal-Level, Loan Attribute Summary Statistics through Time.

Table 3 reports deal-level attributes of the loans included in subprime securitization deals. The sample runs from 1997-2007. Deal FICO is a loan-weighted average of the borrower FICO scores at origination. Deal CLTV is the loan-weighted average of a borrower's combined loan-to-value ratio at deal origination. Deal DTI is the loan-weighted average of a borrower's debt-to-income ratio at deal origination. Owner occ. is reported at the loan level as a dummy variable equal to one if the borrower lives in the home for which the loan was originated. Owner occ. is aggregated to the deal level by taking the loan-weighted average of the dummy variables. Full doc is a dummy variable equal to one if the borrower presented full documentation in support of reported income at the time of origination. It is aggregated to the deal level by taking the loan-weighted average. ARM is a dummy variable equal to one if the loan is an adjustable-rate mortgage, and is aggregated to the deal level by taking the loan-weighted average. House Price Appreciation t-1 is calculated as the one-year growth rate in residential house prices of the zip-code, msa, or state of the loan origination and is aggregated to the deal level by summing the loan-weighted average one-year appreciation rate. The deal unemployment rate is calculated as the loan-weighted state unemployment rate at the time of deal origination.

Year	N	FICO	L.T.V. (%)	D.T.I.* (%)	Owner Occ.	Full Doc.	ARM	H.P.A. $_{t-1}$ (%)	H.P.A.$_{t-1}$ Std Dev. (%)	H.P.A. $_{t+1}$ (%)	Unemploy-ment Rate (%)	Market Divers.	Geographic Concentration	Implied-to-Actual Rent Ratio
1997	4		76.3		0.784	0.365		2.89	0.97	3.47	5.16	0.225	0.081	0.882
1998	6	612.9	74.7		0.933	0.625	0.242	5.12	1.35	6.86	4.73	0.257	0.079	0.788
1999	12	598.2	77.1	35.8	0.936	0.483	0.463	7.06	1.53	8.53	4.48	0.252	0.078	0.838
2000	14	590.0	77.7	35.2	0.923	0.691	0.545	8.94	1.91	8.88	3.97	0.246	0.099	0.971
2001	31	597.2	78.5	39.2	0.934	0.745	0.669	9.40	1.18	8.39	4.62	0.256	0.102	0.975
2002	67	613.6	79.5	38.7	0.941	0.680	0.704	9.07	1.93	10.70	5.94	0.279	0.134	0.993
2003	134	623.5	79.9	39.3	0.941	0.679	0.674	11.20	2.09	14.27	6.13	0.287	0.142	0.983
2004	230	622.9	83.5	40.2	0.935	0.612	0.765	15.79	3.51	17.27	5.77	0.299	0.158	1.030
2005	301	628.8	85.1	40.7	0.932	0.580	0.840	18.11	2.50	11.85	5.14	0.313	0.142	1.078
2006	317	626.2	86.4	42.0	0.933	0.557	0.844	13.68	3.97	1.16	4.65	0.326	0.126	1.208
2007	135	624.3	85.0	41.9	0.927	0.581	0.756	4.33	3.15	.	4.42	0.326	0.107	1.212

* Debt-to-income data is only available for about 80% of the deals. The missing data is distributed evenly across time.

Table 4. Housing Market Fundamentals and Credit Ratings.

The table presents the results of OLS regressions using deal data from 1997-2007. The dependent variable is the proportion of the deal's principal rated investment grade. The key independent variable, labeled "Implied-to-Actual Rent Ratio" is a measure of how "expensive" a housing market is relative to its 25-year average. The ratio is calculated and made publicly available by Chris Mayer at http://www4.gsb.columbia.edu/realestate/research/housing. The text outlines how we aggregate MSA-level measures of housing market fundamentals to the deal level. Housing market diversification is a measure of the correlation of the housing markets in which the loans were originated. Geographic concentration is a Herfindahl index measuring the geographic concentration of loans in the deal. The text of the paper contains a detailed description of how the two measures of diversification are computed. The remaining independent variables are loan-level borrower attributes that have been aggregated to the deal level. The deal-level unemployment rate is included to control for macroeconomic conditions in local markets at the time of deal origination. We also include time fixed effects in the pooled regression to control for other macroeconomic factors that may change through time. Tables 1-3 contain summary statistics and an indication of the units of each of the variables used in the regression.

	Dependent Variable: Proportion of the Deal Rated Investment Grade					
	(1)	(2)	(3)	(4)	(5)	(6)
	1997-2007	2003	2004	2005	2006	2007
Implied-to-Actual Rent Ratio	0.011	0.111	0.028	0.003	0.110**	0.407***
	(0.24)	(1.13)	(0.51)	(0.06)	(2.45)	(3.77)
Market Diversification	-0.022	-0.080	-0.190***	0.143**	0.110**	-0.209
	(0.32)	(0.94)	(4.07)	(2.47)	(2.24)	(1.35)
Geographic Concentration	-0.038	-0.065	-0.064*	0.034	-0.083*	-0.395***
	(0.95)	(1.55)	(1.79)	(0.68)	(1.77)	(3.06)
FICO	0.000***	-0.000	0.001	0.000**	0.000***	0.000
	(3.54)	(0.97)	(1.33)	(2.65)	(4.88)	(1.65)
Loan-to-value	-0.001**	-0.001**	-0.002*	-0.000	-0.000	-0.004***
	(2.31)	(2.16)	(2.04)	(0.46)	(0.70)	(4.47)
ARM	-0.009	0.011	0.007	-0.023*	-0.005	-0.048**
	(1.31)	(0.77)	(0.38)	(1.77)	(0.22)	(2.26)
Owner Occ.	-0.005	-0.061	-0.025	-0.029	-0.040	0.296**
	(0.15)	(0.72)	(0.23)	(0.60)	(0.40)	(2.31)
Full Doc.	0.008	0.029	0.017	0.025*	0.014	-0.058*
	(0.70)	(1.33)	(1.30)	(1.87)	(0.70)	(1.79)
Purchase	-0.005	0.019**	-0.022	-0.042*	-0.019	0.135**
	(0.40)	(2.48)	(0.57)	(1.76)	(0.66)	(2.67)
Unemployment	0.006	-0.009	-0.002	0.010	0.038***	-0.012
	(1.18)	(0.97)	(0.17)	(0.76)	(2.97)	(0.34)
Excess Spread	0.000	-0.008**	0.004	0.010**	0.002	-0.008
	(0.19)	(2.68)	(1.05)	(2.37)	(0.32)	(0.90)
External Insurance Dummy	0.008	0.011***	-0.005	0.013	0.020	0.012
	(1.49)	(3.37)	(0.63)	(1.66)	(1.37)	(0.56)
Constant	0.801***	1.185***	0.803***	0.609***	0.372*	0.392
	(9.76)	(6.80)	(5.13)	(3.11)	(1.90)	(1.06)
Std. Err. Clustered by Year	Yes	--	--	--	--	--
Std. Err. Clustered by Issuer	No	Yes	Yes	Yes	Yes	Yes
Observations	1231	133	230	299	317	135
Adjusted R-squared	0.449	0.142	0.083	0.123	0.105	0.318

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. Housing Market Fundamentals and Credit Ratings.

This table presents the results of OLS regressions using deal data from 1997-2007. The dependent variable is the proportion of the deal's principal rated AAA. The key independent variable, labeled "Implied-to-Actual Rent Ratio" is a measure of how "expensive" a housing market is relative to its 25-year average. The ratio is calculated and made publicly available by Chris Mayer at http://www4.gsb.columbia.edu/realestate/research/housing. The text outlines how we aggregate MSA-level measures of housing market fundamentals to the deal level. Housing market diversification is a measure of the correlation of the housing markets in which the loans were originated. Geographic concentration is a Herfindahl index measuring the geographic concentration of loans in the deal. The text of the paper contains a detailed description of how the two measures of diversification are computed. The remaining independent variables are loan-level borrower attributes that have been aggregated to the deal level. The deal-level unemployment rate is included to control for macroeconomic conditions in local markets at the time of deal origination. We also include time fixed effects in the pooled regression to control for other macroeconomic factors that may change through time. Tables 1-3 contain summary statistics and an indication of the units of each of the variables used in the regression.

	Dependent Variable: Proportion of the Deal Rated AAA					
	(1) 1997-2007	(2) 2003	(3) 2004	(4) 2005	(5) 2006	(6) 2007
Implied-to-Actual Rent Ratio	-0.022	0.092	-0.029	-0.053	0.054	0.253*
	(0.52)	(0.75)	(0.39)	(1.18)	(1.23)	(2.08)
Market Diversification	-0.033	-0.039	-0.131	0.145*	-0.016	-0.089
	(0.60)	(0.38)	(1.30)	(1.90)	(0.27)	(0.61)
Geographic Concentration	-0.059	-0.011	-0.033	-0.015	-0.050	-0.278*
	(1.76)	(0.15)	(0.47)	(0.28)	(1.38)	(2.03)
FICO	0.001***	-0.000	0.001**	0.001***	0.001***	0.001**
	(3.62)	(0.42)	(2.32)	(3.17)	(11.06)	(2.43)
Loan-to-value	-0.001***	-0.002**	-0.003**	-0.001	-0.001	-0.003**
	(3.43)	(2.42)	(2.51)	(0.82)	(1.70)	(2.60)
ARM	-0.026	0.006	-0.045	-0.070***	-0.021	-0.055*
	(1.63)	(0.23)	(1.26)	(3.76)	(0.99)	(1.90)
Owner Occ.	0.010	0.134	-0.003	-0.026	-0.105	0.140
	(0.22)	(0.64)	(0.02)	(0.63)	(1.11)	(0.72)
Full Doc.	0.021*	0.067	0.039	0.034*	0.025	0.004
	(2.12)	(1.49)	(1.14)	(1.82)	(1.19)	(0.11)
Purchase	-0.010	0.004	-0.018	-0.049*	-0.028	0.126*
	(0.82)	(0.21)	(0.36)	(1.77)	(0.96)	(1.97)
Unemployment	0.003	-0.001	-0.021	0.026*	-0.002	-0.058
	(0.79)	(0.07)	(1.41)	(1.75)	(0.18)	(1.11)
Excess Spread	-0.004	-0.010	0.003	-0.002	-0.007	-0.010
	(1.75)	(1.54)	(0.30)	(0.31)	(1.23)	(0.80)
External Insurance Dummy	0.051***	0.070***	0.033*	0.068**	-0.022	0.101**
	(4.34)	(4.95)	(1.74)	(2.60)	(0.79)	(2.62)
Constant	0.573***	0.865***	0.633**	0.299	0.083	0.442
	(5.06)	(3.26)	(2.38)	(1.16)	(0.48)	(0.80)
Std. Err. Clustered by Year	Yes	--	--	--	--	--
Std. Err. Clustered by Issuer	No	Yes	Yes	Yes	Yes	Yes
Observations	1231	133	230	299	317	135
Adjusted R-squared	0.561	0.393	0.188	0.345	0.431	0.417

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6. Rates of House Price Appreciation and Credit Ratings.

This table presents the results of OLS regressions using deal data from 1997-2007. The dependent variable is the proportion of the deal's principal rated investment grade. The key independent variable, labeled Deal H.P.A. t-1 is a measure of house price appreciation in markets where individual loans were originated. The variable is aggregated to the deal level by size of the loan. Housing market diversification is a measure of the correlation of the housing markets in which the loans were originated. Geographic concentration is a Herfindahl index measuring the geographic concentration of loans in the deal. The text of the paper contains a detailed description of how the two measures of diversification are computed. The remaining independent variables are loan-level borrower attributes that have been aggregated to the deal level. The deal-level unemployment rate is included to control for macroeconomic conditions in local markets at the time of deal origination. We also include time fixed effects in the pooled regression to control for other macroeconomic factors that may change through time. Tables 1-3 contain summary statistics and an indication of the units of each of the variables used in the regression.

	Dependent Variable: Proportion of the Deal Rated Investment Grade					
	(1)	(2)	(3)	(4)	(5)	(6)
	1997-2007	2003	2004	2005	2006	2007
Deal H.P.A. $_{t-1}$	0.002*	0.008***	-0.002	0.003	0.002***	0.005***
	(2.12)	(3.92)	(1.40)	(1.35)	(3.77)	(2.98)
Market Diversification	-0.042	-0.290***	-0.098	0.064	0.078	-0.104
	(0.69)	(3.15)	(1.39)	(0.80)	(1.60)	(0.73)
Geographic Concentration	-0.065**	-0.168***	0.030	-0.026	-0.041	-0.098
	(2.29)	(4.08)	(0.42)	(0.35)	(1.06)	(0.79)
FICO	0.000***	0.000	0.001	0.000***	0.000***	0.000
	(3.95)	(0.20)	(1.40)	(3.37)	(5.80)	(1.36)
Loan-to-value	-0.001**	-0.002***	-0.002*	-0.000	-0.000	-0.003**
	(2.59)	(3.30)	(1.80)	(0.58)	(0.59)	(2.18)
ARM	-0.014*	0.018	0.024	-0.032*	-0.015	-0.027
	(1.90)	(1.16)	(1.05)	(1.74)	(0.78)	(1.54)
Owner Occ.	-0.007	-0.053	-0.038	-0.032	-0.070	0.178
	(0.22)	(0.55)	(0.37)	(0.66)	(0.82)	(1.48)
Full Doc.	0.011	0.017	0.023	0.025*	0.018	-0.020
	(1.24)	(0.63)	(1.36)	(1.86)	(0.94)	(0.54)
Purchase	-0.006	0.035***	-0.028	-0.042*	-0.006	0.110
	(0.44)	(2.88)	(0.69)	(1.88)	(0.22)	(1.67)
Unemployment	0.003	-0.017*	-0.017	0.009	-0.001	-0.083*
	(0.63)	(1.77)	(1.31)	(0.83)	(0.10)	(2.04)
Excess Spread	0.003	-0.009**	0.002	0.009**	-0.001	-0.008
	(1.01)	(2.23)	(0.72)	(2.50)	(0.19)	(0.98)
External Insurance Dummy	0.007	0.014***	-0.005	0.014*	0.014	-0.000
	(1.24)	(4.25)	(0.55)	(1.89)	(1.18)	(0.01)
Constant	0.778***	1.291***	0.899***	0.595***	0.708***	1.162***
	(11.70)	(6.72)	(5.82)	(4.32)	(5.84)	(3.33)
Std. Err. Clustered by Year	Yes	--	--	--	--	--
Std. Err. Clustered by Issuer	No	Yes	Yes	Yes	Yes	Yes
Observations	1231	133	230	299	317	135
Adjusted R-squared	0.463	0.199	0.095	0.131	0.108	0.315

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7. Rates of House Price Appreciation and Credit Ratings.

This table presents the results of OLS regressions using deal data from 1997-2007. The dependent variable is the proportion of the deal's principal rated AAA. The key independent variable, labeled Deal H.P.A. t-1 is a measure of house price appreciation in markets where individual loans were originated. The variable is aggregated to the deal level by size of the loan. Housing market diversification is a measure of the correlation of the housing markets in which the loans were originated. Geographic concentration is a Herfindahl index measuring the geographic concentration of loans in the deal. The text of the paper contains a detailed description of how the two measures of diversification are computed. The remaining independent variables are loan-level borrower attributes that have been aggregated to the deal level. The deal-level unemployment rate is included to control for macroeconomic conditions in local markets at the time of deal origination. We also include time fixed effects to control for other macroeconomic factors that may change through time. Tables 1-3 contain summary statistics and an indication of the units of each of the variables used in the regression.

	Dependent Variable: Proportion of the Deal Rated AAA					
	(1) 1997-2007	(2) 2003	(3) 2004	(4) 2005	(5) 2006	(6) 2007
Deal H.P.A. $_{t-1}$	0.001	0.016**	-0.006*	0.007***	0.002**	0.006**
	(1.06)	(2.75)	(2.07)	(3.99)	(2.41)	(2.63)
Market Diversification	-0.054	-0.494**	0.080	-0.075	-0.056	-0.039
	(1.17)	(2.44)	(0.63)	(1.09)	(0.85)	(0.29)
Geographic Concentration	-0.085**	-0.234***	0.178	-0.204***	-0.034	-0.059
	(2.84)	(3.10)	(1.41)	(3.58)	(1.06)	(0.44)
FICO	0.001***	0.000	0.001**	0.001***	0.001***	0.001**
	(3.75)	(0.92)	(2.55)	(4.17)	(11.92)	(2.39)
Loan-to-value	-0.001***	-0.004***	-0.003*	-0.001	-0.001	-0.002*
	(3.40)	(4.45)	(2.07)	(1.20)	(1.47)	(2.02)
ARM	-0.031	0.016	-0.007	-0.096***	-0.031*	-0.044*
	(1.77)	(0.55)	(0.20)	(3.33)	(1.76)	(1.90)
Owner Occ.	0.012	0.158	-0.015	-0.027	-0.126	0.018
	(0.26)	(0.75)	(0.10)	(0.57)	(1.44)	(0.09)
Full Doc.	0.023*	0.042	0.053	0.035*	0.028	0.043
	(2.22)	(0.68)	(1.49)	(1.97)	(1.40)	(1.02)
Purchase	-0.011	0.040*	-0.033	-0.052**	-0.021	0.104
	(0.90)	(1.95)	(0.67)	(2.15)	(0.75)	(1.68)
Unemployment	0.003	-0.019	-0.055**	0.032**	-0.032*	-0.131***
	(0.46)	(1.25)	(2.68)	(2.33)	(1.92)	(3.14)
Excess Spread	-0.002	-0.011**	-0.000	-0.000	-0.008	-0.008
	(0.70)	(2.29)	(0.00)	(0.01)	(1.49)	(0.73)
External Insurance Dummy	0.050***	0.074***	0.034*	0.070**	-0.025	0.088**
	(4.46)	(4.88)	(1.84)	(2.68)	(1.08)	(2.15)
Constant	0.523***	1.002***	0.741***	0.138	0.284	1.072**
	(4.89)	(5.45)	(3.03)	(0.73)	(1.71)	(2.28)
Std. Err. Clustered by Year	Yes	--	--	--	--	--
Std. Err. Clustered by Issuer	No	Yes	Yes	Yes	Yes	Yes
Observations	1231	133	230	299	317	135
Adjusted R-squared	0.563	0.454	0.222	0.375	0.441	0.455

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8. Housing Market Fundamentals and the Cost of Funds.

This table presents the results of OLS regressions using deal data from 1997-2007. The dependent variable is the spread of coupon rates being paid to bond investors over 1-mth libor. Deal coupon spread is calculated for tranches that pay floating coupon payments to bond investors. The coupon spread is aggregated to the deal level using tranche sizes as weights. The implied-to-actual rent ratio is a measure of how "expensive" a housing market is relative to its 25-year average. Housing market diversification is a measure of the correlation of the housing markets in which the loans were originated. Geographic concentration is a Herfindahl index measuring the geographic concentration of loans in the deal. The text of the paper contains a detailed description of how the two measures of diversification are computed. The remaining independent variables are loan-level borrower attributes that have been aggregated to the deal level. The deal-level unemployment rate is included to control for macroeconomic conditions in local markets at the time of deal origination. We also include time fixed effects to control for other macroeconomic factors that may change through time. Tables 1-3 contain summary statistics and an indication of the units of each of the variables used in the regression.

	Dependent Variable: Deal Coupon Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
	1997-2007	2003	2004	2005	2006	2007
Implied-to-Actual Rent Ratio	-0.564**	1.290	-0.090	-0.333	-0.474***	-3.239***
	(2.58)	(1.00)	(0.28)	(1.39)	(3.70)	(5.16)
Market Diversification	-0.305	-1.194	-0.953***	0.200	0.382*	1.653***
	(0.86)	(1.13)	(3.90)	(0.72)	(1.72)	(3.97)
Geographic Concentration	0.441*	-0.374	-0.206	-0.011	0.525**	2.555***
	(1.84)	(0.72)	(1.08)	(0.07)	(2.19)	(5.54)
FICO	-0.000	0.002	-0.002*	-0.001	-0.002***	-0.001
	(0.45)	(0.78)	(2.01)	(1.01)	(3.02)	(0.70)
Loan-to-value	0.003	0.008	0.002	-0.002	-0.002	0.002
	(1.05)	(1.58)	(0.72)	(0.82)	(0.97)	(0.36)
ARM	-0.459**	0.118	-0.208**	-0.644***	-0.380***	-0.384***
	(2.78)	(0.32)	(2.22)	(4.78)	(3.16)	(3.60)
Owner Occ.	-0.617**	-1.482	-0.510	-0.021	-0.240	0.029
	(2.30)	(0.46)	(1.47)	(0.12)	(1.16)	(0.05)
Full Doc.	0.072	0.020	-0.073	0.026	0.003	0.203
	(1.30)	(0.11)	(1.53)	(0.41)	(0.05)	(1.52)
Purchase	-0.006	0.185	0.053	0.232***	0.166**	-0.309
	(0.07)	(0.89)	(1.08)	(3.11)	(2.30)	(0.98)
Unemployment	-0.018	-0.191	0.081	0.150***	0.065	0.334*
	(0.60)	(1.29)	(1.25)	(2.98)	(1.46)	(1.84)
Excess Spread	-0.066**	-0.091*	-0.152***	-0.061**	-0.015	-0.057
	(2.72)	(1.89)	(3.36)	(2.27)	(0.72)	(1.25)
External Insurance Dummy	-0.026	-0.134**	-0.074**	-0.055*	-0.015	0.033
	(0.66)	(2.25)	(2.60)	(1.94)	(0.22)	(0.48)
Constant	2.302***	0.818	2.980**	1.178*	2.021***	2.790
	(3.86)	(0.38)	(2.61)	(1.81)	(3.47)	(1.36)
Std. Err. Clustered by Year	Yes	--	--	--	--	--
Std. Err. Clustered by Issuer	No	Yes	Yes	Yes	Yes	Yes
Observations	1229	132	230	299	317	134
Adjusted R-squared	0.378	0.043	0.362	0.264	0.218	0.447

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9. Rates of House Price Appreciation and the Cost of Funds.

This table presents the results of OLS regressions using deal data from 1997-2007. The dependent variable is the spread of coupon rates being paid to bond investors over 1-mth libor. Deal coupon spread is calculated for tranches that pay floating coupon payments to bond investors. The coupon spread is aggregated to the deal level using tranche sizes as weights. Deal H.P.A. t-1 is a measure of house price appreciation in markets where individual loans were originated. The variable is aggregated to the deal level by size of the loan. Housing market diversification is a measure of the correlation of the housing markets in which the loans were originated. Geographic diversification is a Herfindahl index measuring the geographic concentration of loans in the deal. The text of the paper contains a detailed description of how the two measures of diversification are computed. The remaining independent variables are loan-level borrower attributes that have been aggregated to the deal level. The deal-level unemployment rate is included to control for macroeconomic conditions in local markets at the time of deal origination. We also include time fixed effects to control for other macroeconomic factors that may change through time. Tables 1-3 contain summary statistics and an indication of the units of each of the variables used in the regression.

	Dependent Variable: Deal Coupon Spread					
	(1)	(2)	(3)	(4)	(5)	(6)
	1997-2007	2003	2004	2005	2006	2007
Deal H.P.A. $_{t-1}$	0.000	-0.049*	-0.026***	0.007	0.006***	-0.033***
	(0.04)	(1.67)	(3.14)	(0.67)	(3.40)	(3.38)
Market Diversification	-0.489	0.305	-0.016	-0.028	0.075	0.770*
	(1.57)	(0.25)	(0.05)	(0.06)	(0.33)	(1.77)
Geographic Concentration	0.228	0.407	0.734*	-0.300	0.261	0.294
	(1.18)	(0.73)	(1.94)	(0.94)	(1.37)	(0.92)
FICO	-0.000	0.002	-0.002**	-0.000	-0.001**	-0.000
	(0.41)	(0.68)	(2.57)	(0.68)	(2.26)	(0.24)
Loan-to-value	0.003	0.015**	0.003	-0.002	-0.000	-0.005
	(1.05)	(2.66)	(1.23)	(0.87)	(0.15)	(1.27)
ARM	-0.487**	0.151	-0.035	-0.678***	-0.434***	-0.548***
	(2.91)	(0.41)	(0.30)	(4.77)	(3.67)	(5.68)
Owner Occ.	-0.554*	-2.124	-0.573	0.006	-0.209	0.825
	(1.99)	(0.62)	(1.71)	(0.03)	(1.18)	(1.56)
Full Doc.	0.067	0.123	-0.011	0.035	0.012	-0.063
	(1.34)	(0.70)	(0.23)	(0.58)	(0.24)	(0.60)
Purchase	-0.024	0.033	-0.011	0.219***	0.126	-0.125
	(0.26)	(0.12)	(0.17)	(2.85)	(1.57)	(0.35)
Unemployment	0.031	-0.123	-0.070	0.195***	0.038	0.819***
	(0.73)	(0.83)	(1.00)	(4.24)	(0.76)	(3.17)
Excess Spread	-0.054*	-0.090*	-0.165***	-0.046	-0.004	-0.048
	(1.89)	(1.87)	(5.34)	(1.72)	(0.22)	(1.32)
External Insurance Dummy	-0.024	-0.139**	-0.069**	-0.054**	0.002	0.115
	(0.58)	(2.14)	(2.45)	(2.39)	(0.05)	(1.40)
Constant	2.302***	0.818	2.980**	1.178*	2.021***	2.790
	(3.86)	(0.38)	(2.61)	(1.81)	(3.47)	(1.36)
Std. Err. Clustered by Year	Yes	--	--	--	--	--
Std. Err. Clustered by Issuer	No	Yes	Yes	Yes	Yes	Yes
Observations	1229	132	230	299	317	134
Adjusted R-squared	0.378	0.043	0.362	0.264	0.218	0.447

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 10. Loan Attributes Sorted by Lagged H.P.A. and Investment-Grade Ratings.

This table presents the value of loan attributes after having sorting deals into quintile portfolios based on key deal attributes. Deals are first sorted into 5 portfolios based on the proportion of the deal rated investment grade. Each of the 5 house price appreciation portfolios is then sorted into 5 portfolios based on one-year lagged rates of house price appreciation. The double sort results in 25 portfolios. The sorts use the entire sample of 1,251 deals originated between the years 1997-2007. Panel A reports the average value of FICO scores for each of the 25 portfolios. Panel B reports average loan-to-value ratios for each of the 25 portfolios. Panel C reports debt-to-income ratios for each of the portfolios. Panel D reports the average percentage of loans that have adjustable rates for each of the portfolios. The range of the proportion of the deal rated investment grade is reported in brackets. The range of lagged rates of house price appreciation reported in brackets is the range for the first investment grade quintile. The F-test statistic has (4, 1226) degrees of freedom when testing for equality in the row and column factors, and (16, 1226) degrees of freedom when testing for equality in the interaction of the two factors.

Panel A: FICO Scores by H.P.A.t-1 and Investment Grade Quintiles

	HPAt-1 Quintile 1 [-2.39-3.94]	HPAt-1 Quintile 2 [3.95-7.78]	HPAt-1 Quintile 3 [7.79-12.51]	HPAt-1 Quintile 4 [12.51-17.04]	HPAt-1 Quintile 5 [17.08-23.51]	ANOVA Tests of Equality $H_o : FICO_i = \overline{FICO}$	
% Invest Grade Quintile 1 [.719-.905]	619.27	620.01	626.49	622.68	623.38	H.P.A.	p<.001
% Invest Grade Quintile 2 [.906-.933]	628.78	620.03	624.75	624.39	628.10	Inv. Grade	p<.062
% Invest Grade Quintile 3 [.934-.953]	620.12	622.00	625.47	624.97	634.63	H.P.A*Inv. Grade	p<.001
% Invest Grade Quintile 4 [.954-.970]	607.45	617.29	622.67	624.78	632.15		
% Invest Grade Quintile 5 [.971-1.00]	632.60	615.17	619.72	621.95	634.29		

Panel B: Loan-to-Value Ratios by H.P.A.t-1 and Investment Grade Quintiles

	HPAt-1 Quintile 1 [-2.39-3.94]	HPAt-1 Quintile 2 [3.95-7.78]	HPAt-1 Quintile 3 [7.79-12.51]	HPAt-1 Quintile 4 [12.51-17.04]	HPAt-1 Quintile 5 [17.08-23.51]	ANOVA Tests of Equality $H_o : LTV_i = \overline{LTV}$	
% Invest Grade Quintile 1 [.719-.905]	84.36	86.71	87.74	87.01	86.88	H.P.A.	p<.001
% Invest Grade Quintile 2 [.906-.933]	85.53	84.45	85.75	85.05	86.15	Inv. Grade	p<.001
% Invest Grade Quintile 3 [.934-.953]	84.28	84.29	84.15	85.11	84.76	H.P.A*Inv. Grade	p<.001
% Invest Grade Quintile 4 [.954-.970]	80.54	81.51	81.37	82.76	86.91		
% Invest Grade Quintile 5 [.971-1.00]	74.21	80.30	80.50	82.01	84.24		

Panel C: Debt-to-Income Ratios by H.P.A.t-1 and Investment Grade Quintiles

	HPAt-1 Quintile 1 [-2.39-3.94]	HPAt-1 Quintile 2 [3.95-7.78]	HPAt-1 Quintile 3 [7.79-12.51]	HPAt-1 Quintile 4 [12.51-17.04]	HPAt-1 Quintile 5 [17.08-23.51]	ANOVA Tests of Equality $H_o : DTI_i = \overline{DTI}$	
% Invest Grade Quintile 1 [.719-.905]	42.22	41.89	42.27	41.49	41.82	H.P.A.	p<.001
% Invest Grade Quintile 2 [.906-.933]	41.58	41.32	41.66	41.37	41.28	Inv. Grade	p<.001
% Invest Grade Quintile 3 [.934-.953]	40.39	40.21	41.11	39.93	41.15	H.P.A*Inv. Grade	p<.001
% Invest Grade Quintile 4 [.954-.970]	37.58	39.89	40.10	40.57	41.35		
% Invest Grade Quintile 5 [.971-1.00]	38.17	37.69	39.47	40.14	40.51		

Panel D: Percent of Mortgages with Adj. Rate by H.P.A.t-1 and Investment Grade Quintiles

	HPAt-1 Quintile 1 [-2.39-3.94]	HPAt-1 Quintile 2 [3.95-7.78]	HPAt-1 Quintile 3 [7.79-12.51]	HPAt-1 Quintile 4 [12.51-17.04]	HPAt-1 Quintile 5 [17.08-23.51]	ANOVA Tests of Equality $H_o : ARM_i = \overline{ARM}$	
% Invest Grade Quintile 1 [.719-.905]	0.759	0.818	0.830	0.847	0.874	H.P.A.	p<.001
% Invest Grade Quintile 2 [.906-.933]	0.718	0.766	0.838	0.844	0.892	Inv. Grade	p<.001
% Invest Grade Quintile 3 [.934-.953]	0.730	0.746	0.798	0.852	0.883	H.P.A*Inv. Grade	p<.001
% Invest Grade Quintile 4 [.954-.970]	0.544	0.715	0.815	0.801	0.876		
% Invest Grade Quintile 5 [.971-1.00]	0.482	0.745	0.669	0.754	0.822		

Table 11. Default Rates Sorted by Loan Attributes and Contemporaneous H.P.A.

This table presents deal level default rates after having sorting deals into quintile portfolios based on key deal attributes. Default rates are calculated as the percent of loans in the deal that are in foreclosure or have defaulted by the end of the year following the year in which the deal was originated. Deals are first sorted into 5 portfolios based on rates of house price appreciation in the year following deal origination. Each of the 5 house price appreciation portfolios is then sorted into 5 portfolios based on key loan attributes such as FICO scores, LTV ratios, DTI ratios and the percentage of loans that have adjustable rates. The double sort results in 25 portfolios. The sorts use a sample of 1,116 deals originated between the years 1997-2006 (we do not have realized default rates for the sample of deals originated in 2007). Each panel reports default rates sorted by the key attributes. The range of the deal attribute for each portfolio is reported in brackets. The range of realized rates of house price appreciation reported in brackets is the range for the first quintile portfolio of each attribute. The F-test statistic has (4, 1091) degrees of freedom when testing for equality in the row and column factors, and (16, 1091) degrees of freedom when testing for equality in the interaction of the two factors.

Panel A: Deal Level Default Rates by H.P.A.t+1 and FICO Quintiles

	HPAt+1 Quintile 1 [-5.73-3.21]	HPAt+1 Quintile 2 [3.22-8.56]	HPAt+1 Quintile 3 [8.57-12.84]	HPAt+1 Quintile 4 [12.86-16.63]	HPAt+1 Quintile 5 [16.64-23.10]	ANOVA Tests of Equality $H_o: Default_{.,j} = \overline{Default}$	
FICO Quintile 1 [532-610]	0.1142	0.0731	0.0571	0.0504	0.0444	H.P.A.	p<.001
FICO Quintile 2 [610-617]	0.1355	0.0708	0.0517	0.0468	0.0464	FICO	p<.001
FICO Quintile 3 [617-625]	0.1413	0.1247	0.0578	0.0557	0.0396	FICO*H.P.A.	p<.001
FICO Quintile 4 [625-636]	0.1541	0.1240	0.0567	0.0533	0.0389		
FICO Quintile 5 [636-755]	0.1367	0.0672	0.0454	0.0427	0.0365		

Panel B: Deal Level Default Rates by H.P.A.t+1 and Loan-to-Value Quintiles

	HPAt+1 Quintile 1 [-2.02-7.53]	HPAt+1 Quintile 2 [7.57-9.77]	HPAt+1 Quintile 3 [9.79-11.72]	HPAt+1 Quintile 4 [11.74-15.15]	HPAt+1 Quintile 5 [15.17-21.99]	ANOVA Tests of Equality $H_o: Default_{.,j} = \overline{Default}$	
LTV Quintile 1 [37.87-79.47]	0.0569	0.0584	0.0459	0.0448	0.0354	H.P.A.	p<.001
LTV Quintile 2 [79.49-81.87]	0.1321	0.0714	0.0515	0.0451	0.0427	LTV	p<.001
LTV Quintile 3 [81.88-85.21]	0.1235	0.0862	0.0554	0.0512	0.0385	LTV*H.P.A.	p<.001
LTV Quintile 4 [85.26-88.57]	0.1297	0.1475	0.0718	0.0547	0.0382		
LTV Quintile 5 [88.58-100]	0.1591	0.1490	0.0754	0.0503	0.0500		

Panel C: Deal Level Default Rates by H.P.A.t+1 and Debt-to-Income Quintiles

	HPAt+1 Quintile 1 [-5.72-9.35]	HPAt+1 Quintile 2 [9.40-12.56]	HPAt+1 Quintile 3 [12.57-15.31]	HPAt+1 Quintile 4 [15.33-17.30]	HPAt+1 Quintile 5 [17.34-23.10]	ANOVA Tests of Equality $H_o: Default_{.,j} = \overline{Default}$	
DTI Quintile 1 [6.97-39.39]	0.0666	0.0492	0.0501	0.0452	0.0352	H.P.A.	p<.001
DTI Quintile 2 [39.41-40.49]	0.1016	0.0519	0.0523	0.0401	0.0423	DTI	p<.001
DTI Quintile 3 [40.50-41.27]	0.1113	0.0627	0.0535	0.0548	0.0393	DTI*H.P.A.	p<.001
DTI Quintile 4 [41.28-42.25]	0.1397	0.1550	0.0925	0.0554	0.0440		
DTI Quintile 5 [42.26-45.33]	0.1444	0.1273	0.0759	0.0492	0.0454		

Panel D: Deal Level Default Rates by H.P.A.t+1 and % ARM Quintiles

	HPAt+1 Quintile 1 [-2.77-7.22]	HPAt+1 Quintile 2 [7.30-9.84]	HPAt+1 Quintile 3 [10.10-13.46]	HPAt+1 Quintile 4 [13.48-16.38]	HPAt+1 Quintile 5 [16.42-21.99]	ANOVA Tests of Equality $H_o: Default_{.,j} = \overline{Default}$	
ARM Quintile 1 [0-.707]	0.0571	0.0563	0.0420	0.0375	0.0348	H.P.A.	p<.001
ARM Quintile 2 [.708-.797]	0.1149	0.0603	0.0503	0.0405	0.0413	ARM	p<.001
ARM Quintile 3 [.798-.847]	0.1256	0.0980	0.0585	0.0549	0.0425	ARM*H.P.A.	p<.001
ARM Quintile 4 [.848-.896]	0.1633	0.1375	0.0770	0.0558	0.0480		
ARM Quintile 5 [.897-1.00]	0.1723	0.1308	0.0688	0.0522	0.0456		

Data Appendix

Deal Structure Data from ABSNet and Bloomberg

ABSNet, a subscription based subsidiary of Standard and Poor's, contains deal-level information on securitization deals from numerous asset classes, including prime, Alt-A and subprime residential mortgage-backed securities. ABSNet's primary service is in tracking the performance of aggregate loan pools, but it also reports summary information on the structure of securitization deals at the time of origination. Deal-level summary information includes the name of the deal originator, the original balance of the deal in total, and the original balances, credit rating, and coupon of each tranche in the deal. In most cases, the deal summary also contains information on the existence of credit supports like overcollateralization, and sometimes contains data on the existence of interest rate swaps, and other forms of third party credit support like external insurance.

We supplement the ABSNet deal summary data using Bloomberg. In particular, we use Bloomberg to identify the type of bond associated with each tranche. Differing bond types include interest or principal only bonds, or bonds that are associated with the equity tranche of a deal. Bond type can vary, even within a deal. Understanding the bond type is necessary when computing deal subordination rates because interest only tranches should not be included in the capital structure of a deal. We also use Bloomberg to confirm the types of credit support associated with each deal. Some deals in the later stages of our sample had third party credit enhancement in the form of credit insurance.

LoanPerformance Data

LoanPerformance, a subsidiary of First American Trust, is the primary source of information on subprime and Alt-A loans at the borrower-level. LoanPerformance claims to cover over 90% of the loans included in subprime and alt-a securitization deals. The database contains detailed information on subprime loans at the time of origination and tracks the performance of individual loans through time. Most relevant for our purpose is loan-level information on the original loan balance, FICO score, loan-to-value ratio, debt-to-income ratio, and loan type. Also crucial to our analysis is the location of the borrower, which is reported at the ZIP-code level.

Because the unit of analysis is at the deal level, we are required to aggregate loan level data to the deal level. In this way, deal structure is computed as a function of the average loan characteristics. We compute value-weighted sums, where the weights are determined by the size of each individual loan relative to the size of the total deal. The loan level data for attribute *i* of loan *k* in deal *j* is aggregated to the deal level as follows:

$$Loan\ Attribute_{i,k,j} = Attribute_{i,k} * \left[\frac{loan\ principal_k}{\sum_{k=1}^{N} principal_k} \right].$$

House Price Appreciation and Local Area Economic Conditions

The Fiserv Case Shiller Weiss repeat-sales house price data is available at the zip code level. Repeat sales indexes capture changes in house prices by comparing how home prices have changed among a sample of repeat sales transactions. In this way home quality is kept constant. An extensive literature exists on the estimation of repeat sales house price indexes, beginning with Bailey, Muth, and Nourse (1963) and substantially improved by Case and Shiller (1989). The most notable drawback of repeat sales indexes is that they are estimated with considerable error in smaller samples. Also, some states, referred to as non-disclosure states, are not required to report public housing transactions. Thus, there are some zip codes for which repeat sales price indexes are not available. Our house price appreciation variable is aggregated to the deal level by computing the loan-weighted growth in the house price index in the year prior to deal origination. Where available we use ZIP-code level appreciation rates. If a ZIP-code index is not available, we use the Case Shiller MSA-level index. If a loan is in a ZIP-code or MSA where no index is available we use the state-level repeat sales index published by OFHEO.

The Bureau of Labor Statistics reports unemployment rates at the state level. State unemployment data is aggregated to the deal level by computing the loan-weighted average state unemployment rate at the time of loan origination.

Appendix A1: Rates of House Price Appreciation and Credit Ratings by Year.

This table presents the results of an OLS regression that is estimated separately for the 2003, 2004, 2005, 2006, and 2007 samples. Independent variables have differing units. To facilitate interpretation of the relative magnitudes of each of the variable coefficients, each of the dependent and independent variables has been standardized by their respective standard deviation as follows:

$$\frac{Variable_i - Mean of Variable_i}{Std.Dev._i}$$

The re-scaling results in each variable having mean zero and unit standard deviation. The dependent variable is the proportion of the deal's principal rated AAA. The key independent variable, labeled Deal H.P.A. t-1 is a measure of house price appreciation in markets where individual loans were originated. The variable is aggregated to the deal level by size of the loan. Market diversification measures the covariance of housing market returns in housing markets where the loans in each deal are concentrated. Geographic diversification is a Herfindahl index computed for each deal where the weight of the index for each deal is the percent of deal principle concentrated in each of the 51 states (Washington DC enters as a separate state). The text of the paper contains a detailed description of how our measure of market and geographic diversification is computed. The remaining independent variables are loan-level borrower attributes that have been aggregated to the deal level. The deal-level unemployment rate is included to control for macroeconomic conditions in local markets at the time of deal origination. Tables 1-3 contain summary statistics for each of the variables prior to being standardized. Standard errors are clustered by deal issuer.

	(1) Proportion of Deal Rated AAA 2003	(2) Proportion of Deal Rated AAA 2004	(3) Proportion of Deal Rated AAA 2005	(4) Proportion of Deal Rated AAA 2006	(5) Proportion of Deal Rated AAA 2007
Deal H.P.A.t-1	1.340**	-0.442*	0.594***	0.129**	0.460**
	(2.76)	(2.02)	(3.98)	(2.33)	(2.63)
Market Diversification	-0.324**	0.038	-0.051	-0.037	-0.026
	(2.40)	(0.47)	(1.09)	(0.81)	(0.29)
Geographic Diversification	-0.278***	0.178	-0.238***	-0.027	-0.068
	(3.22)	(1.32)	(3.64)	(0.72)	(0.44)
FICO	0.039	0.381**	0.328***	0.470***	0.240**
	(0.53)	(2.53)	(4.12)	(11.68)	(2.39)
Loan-to-value	-0.380***	-0.286*	-0.104	-0.087	-0.237*
	(4.76)	(2.00)	(1.20)	(1.45)	(2.02)
ARM	0.043	-0.028	-0.266***	-0.091*	-0.122*
	(0.59)	(0.30)	(3.28)	(1.84)	(1.90)
Owner Occ.	0.101	-0.006	-0.018	-0.085	0.012
	(0.71)	(0.05)	(0.57)	(1.44)	(0.09)
Full Doc.	0.105	0.115	0.082*	0.076	0.101
	(0.73)	(1.36)	(1.97)	(1.62)	(1.02)
Purchase	0.132*	-0.094	-0.135**	-0.047	0.269
	(2.07)	(0.75)	(2.19)	(0.67)	(1.68)
Unemployment	-0.196	-0.515**	0.339**	-0.302*	-1.339***
	(1.28)	(2.63)	(2.41)	(1.76)	(3.14)
Excess Spread	-0.262**	0.011	-0.011	-0.156	-0.168
	(2.58)	(0.07)	(0.10)	(1.35)	(0.73)
External Insurance Dummy	1.135***	0.525*	1.094**	-0.378	1.376**
	(4.76)	(1.82)	(2.68)	(0.98)	(2.15)
Constant	1.464***	0.813***	-0.672***	-0.844***	-1.732**
	(3.29)	(3.33)	(4.52)	(4.00)	(2.77)
Std. Err. Clustered by Issuer	Yes	Yes	Yes	Yes	Yes
Observations	133.00	230.00	299.00	317	135
Adjusted R-squared	0.450	0.217	0.373	0.441	0.455

Robust t statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix A2. Number of Deals per Underwriter.

Deal Underwriter	Number of Deals
Lehman Brothers	128
Greenwich Capital	108
Morgan Stanley	107
Bear Stearns & Co. Inc	103
Credit Suisse	96
Merrill Lynch	91
Deutsche Bank Securities Inc.	90
Goldman Sachs	76
Bank of America	67
Citigroup Global Markets Inc.	64
UBS	60
JP Morgan	58
Barclays	46
RBS Greenwich	38
Countrywide Securities Corp. JP Morgan (	23
HSBC	23
Residential Funding Corp.	10
Washington Mutual	9
Nomura	5
Salomon Smith Barney	5
Unknown	5
GMAC RFC	4
Prudential Securities	4
Baclays Capital Inc	4
Morgan Stanley & Co. Inc	3
Residential Funding Securities LLC	3
BNP Paribas	3
GMACM Mortgage Corp.	3
Countrywide Home Loans Inc	2
JPMorgan Chase Bank	2
Carrington	1
Utendahl Capital Partners	1
Chase	1
Saxon Asset Securities Company	1
Countrywide Securities Corp.	1
Donaldson Lufkin & Jenrette	1
Blaylock & Company	1
SG Americas Securities LLC	1
Lehman Brothers Holdings Inc.	1
CS First Boston Lehman Brothers	1
Banc One	1
Residential Asset Securities Corp.	1
Merrill Lynch Mortgage Investors Inc. De	1
Residential Funding Corp.RBS Greenwich	1
Bank of New York	1