Market Dynamics among the ABX Index, Credit Default Swaps, and Mortgage-Backed Bonds

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ABSTRACT

Throughout the 2007-2008 financial crisis, the ABX index, which is a single credit default swap (CDS) contract written on a basket of subprime residential mortgage-backed securities (RMBS) bonds, was used as a gauge for the overall performance of the housing market and as an input for mark-to-market accounting. Some market participants and policymakers at the time, however, claimed that the ABX underrepresented the value of the associated RMBS because of speculative activity among traders. This paper investigates whether the ABX index reflected the credit performance of the underlying RMBS collateral from July 2007 to December 2010 by analyzing the arbitrage relationships among the ABX index, cash RMBS and asset-backed CDS (ABCDS) markets. In contrast with the extant literature on the ABX index, we show the ABX responds to information in the remittance report around release dates, but that noise (or uninformed) trading was prevalent between reporting dates, causing spreads to deviate from fundamental values until new credit information was released. Further, we show that the ABCDS-bond basis is driven primarily by credit performance measures of the underlying mortgage pool for the AAA subindex, suggesting that both markets were pricing in credit risk, but asymmetrically, as the deleveraging effect of the bond market is larger than changes in the ABCDS spreads. Lastly, we find information quality – the degree of reporting differences between trustees and third-party vendors – almost solely accounts for price differences between the ABCDS and the ABX. Our findings suggests that arbitrage activity between informed and un- or mis-informed investors, rather than speculation, drove ABX prices apart from ABCDS (and cash RMBS). Our findings have direct implications for regulatory and accounting policy since both regulators and GAAP have not altered reporting requirements since the crisis.

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I. Introduction

The credit derivative market has grown dramatically over the last decade, as products evolved to transfer credit risk between parties and as financial innovations allowed market participants to trade standardized contracts on a variety of underlying securities. One such innovation is the ABX index, which is a credit default swap (CDS) contract written on a portfolio of residential mortgage-backed securities (RMBS). The first index launched in January 2006 and instantly became a gauge for the subprime housing market.

Shortly after its launch, the ABX became the most liquid and actively traded mortgage product available. Due to accounting standard FAS No. 157,[6] many institutions began using its market price as an input into the valuation of securitized mortgage products, such as Goldman Sachs who used it to value collateralized debt obligations (CDOs) on its balance sheets. As the crisis began to unfold in early 2007, speculation in the ABX was cited as the reason many institutions took billions of dollars in write-downs.[7] At the time, many claimed that the value of the assets was significantly higher than suggested by the ABX. For instance, the Bank for International Settlements (BIS) suggested in June 2008 that the ABX underrepresented asset values of AAA-rated RMBS tranches by roughly sixty percent.[8] In part the BIS was correct because the ABX used the first-loss tranches in the referenced deals. But others claimed the ABX overstated default rates because speculative activity drove prices down to unreasonable levels (see, e.g. Stanton and Wallace (2011)).

The link between the price of the ABX and the balance sheets of financial institutions and firms that held mortgage related products as well as the lack of consensus about how the ABX was valued relative to the underlying deals leads to our central research question: did the ABX index reflect the credit risk and the collateral performance of the underlying constituents? To answer this question we position our empirical analysis in an arbitrage framework and examine the market and credit risk price dynamics of the cash and synthetic residential mortgage-backed security (RMBS) markets throughout the 2007-2008 financial crisis.

The ABX index is linked to two other securities: RMBS bonds and single-name asset-backed CDS contracts (ABCDS). The ABX index is a single CDS contract based on a portfolio of single-name ABCDS, each of which is written on a single RMBS bond. If markets are efficient, then the law of one price would suggest that securities with similar cash flows will trade at similar prices. All three securities in our study have cash flows based on the same assets: the underlying mortgages in the RMBS deals. As a result, theory would suggest that there is a close relationship among the market prices of all three securities.

However, as Grossman and Stiglitz (1980) point out, markets cannot be informationally efficient if information is costly. As it pertains to RMBS, investors in these securities cannot directly observe the performance of the underlying mortgages. Instead, they must make inferences from monthly reports released by the deal trustee, which contain imperfect information. Information

[6] Under accounting standard FAS No. 157, firm are required to value assets at "fair value" by using the most reliable data inputs available if an identical asset did not trade in an active market.
[7] "$500 Billion in Writedowns by Firms." Bloomberg News, August 12, 2008.
[8] Fender, Ingo, and Peter Horndahl. "Overview: a cautious return of risk tolerance." BIS Quarterly Review, June 2008 at http://www.bis.org/publ/qtrpdf/r_qt0806a.pdf.

uncertainty impacts the interactions between informed and noise traders across the three markets. Based on the definition that noise is trading on noninformation as if it were information from Black (1986), we examine how information risks and expectations of noise trading impact markets and price discovery in the context of Shiller (1984). Most of our attention is focused on the informational frictions of the RMBS sector and the contractual features of the three securities that affect the level of noise trading.

To answer our central research question, first we must understand the credit risk price discovery process across the three markets. Given the high level of information costs in the RMBS sector, we cannot assume that all of the related markets reflect information at the same speed. Because noise traders are necessary for informational arbitrage (Black, 1986), knowing which markets adjust to new information and which markets fail to adjust gives us insight into the level of noise trading in each market and the interaction between informed and noise traders.

This paper contributes to the literature in price discovery and information arbitrage by focusing on relatively unexplored markets: subprime RMBS bonds and related credit derivatives. While most extant studies on price discovery focus on markets characterized by standardized channels of information transmission (i.e. SEC corporate filings), we examine a market in which there is poor information quality and a lack of uniform reporting requirements, which limit the ability of traders to act efficiently on information as it is released.

We use a vector error-correction model (VECM) on daily data to test the spread co-movement of individual cash bonds and their ABCDS contracts to see if information is reflected in one market before the other. Then, we examine the impact of the collateral performance information contained in the monthly reports on both markets and price discovery by including an indicator variable for the information release date. Our results suggest that information flows to the bond market before the single-name ABCDS market. We separately analyze the ABX and ABCDS markets using the same methodology. Furthermore, when examining the ABX versus a portfolio of ABCDS, we find that price discovery generally occurs in the ABX market. But interestingly, the ABX generally has a positive reaction to the information released in the remittance reports. This indicates that uninformed trading between report dates drove spreads below what fundamentals would suggest, but informed traders responded to the collateral performance information and brought spreads more in line with fundamentals.

Given the importance of noise traders in asset pricing, we estimate the potential impact of noise trader supply and demand shocks across markets as these would theoretically impact the asset prices (Shiller, 1984). In the absence of transaction data, we analyze the unexplained variation of a credit risk model to see if there is a common factor that drives credit spreads that is not suggested by theory. We collect the residuals from weekly fixed-effect panel regressions for each class of security across ABX credit rated subindexes, controlling for credit, contractual, and market factors, and then perform a principal component analysis (PCA) on their covariances. PCA will reveal whether there are systematic components in the residuals that lie outside of our econometric model. This is similar to the approach taken by Collin-Dufresne, Goldstein, and Martin (2001) and Longstaff and Myers (2014), which both examine the determinants of credit spread changes and find that the residuals from the structural model contain a common systematic component that is likely driven by local supply and demand shocks that are independent of credit and liquidity variables.

Overall our results indicate that noise trading is more prevalent in the ABX index, followed by single-name ABCDS contracts, and lastly, the cash RMBS bonds, which is what theory would suggest. The RMBS market is characterized by high information uncertainty and short-selling constraints. Investors with negative opinions, who may be pessimistic based on either information or noninformation, would be forced out of the RMBS market and into the ABCDS markets to act on those views (Miller, 1977). Further, in the presence of cost constraints, investors may prefer the ABX to single-name ABCDS contracts because the ABX is a composite security, which diversifies idiosyncratic risks and lowers adverse-selction costs (Subrahmanyam, 1991; Gorton and Pennachi, 1993).[9]

Lastly, we examine what factors influence the relative price differences among these securities. This gives us a better understanding of the interactions between informed and noise traders in an informational arbitrage context. We run monthly fixed-effect panel regressions on the basis (spread differences between cash RMBS bond and ABCDS contract) and tracking error (spread difference between a portfolio of ABCDS and its corresponding ABX subindex) by credit rating. We find that fundamental and structural variables drive basis. Market factors, such as funding costs and counterparty risk, impact arbitrage between cash bonds and single-name ABCDS, while collateral performance measures are significant based on credit rating. For the AAA tranches, our measure for deal loss is the only collateral measure that is a significant basis driver. For the lower tranches, the change in subordination and the acceleration feature are important determinants. However, when looking at the arbitrage relationship between the ABX index and a portfolio of ABCDS contracts, we find it is driven primarily by information quality. This indicates there is information arbitrage activity in the synthetic markets and leads us to conclude that there is a role for price differences, but one driven more by information arbitrage than speculation per se.

We have three main findings. First, we find that on average price discovery occurs in the cash RMBS bond market, which is contrary to extant literature on the corporate CDS and bond markets (Longstaff et al., 2005; Blanco et al., 2005; Bai and Collin-Dufresne, 2013). Further, when we examine the impact of the monthly remittance reports, we discover that information flows to the bond market first, and there is a significant response, which is on average negative across all vintages and subindexes. We believe informational frictions in the RMBS sector lead to the contrasting results between our study and the corporate credit literature. Further, when analyzing the incorporation of information in the ABX and ABCDS markets, we find that the ABX market responds first, and the impact of new credit-related information is significantly positive across all vintages and subindexes.

Second, our results indicate that deteriorating collateral performance causes the basis between AAA-rated cash bonds and ABCDS to narrow. This suggests that these markets were, in fact, pricing in credit risk, albeit asymmetrically. As collateral performed more poorly, the uncertainty of receiving cash flows increases. Investors would demand more credit protection, causing ABCDS spreads to increase. The only option bond holders had to respond to poor performance of the deal was to sell

[9] A composite security is a single instrument that is backed by a portfolio of securities. They are also called basket securities as the single security is made up of a "basket" of underlying securities. Composite securities may be considered redundant because an investor can recreate the composite security by holding each of the securities in the same proportion as the underlying portfolio.

their bonds, causing yields to increase. The fact that the basis narrows indicates that the deleveraging effect of bondholders is greater for these markets.[10]

Third, our results indicate reporting quality influences arbitrage activity in the synthetic markets. Highly experienced investors in the RMBS sector, having prior knowledge about reporting discrepancies among remittance reports and data vendors, would not have solely relied on third-parties for information. However, less experienced investors that were not aware of the intricacies of the RMBS sector might be more inclined to trust these third party sources. Also by being less experienced, they may be less inclined to access the credit markets via single-name ABCDS contracts. Since not all investors were equally informed, informational arbitrage drove the relationship between the single-name ABCDS market and the ABX. Additionally, the competing influences of price discovery in the cash and ABX sectors created noise in the market.

Our paper makes three significant contributions to the literature. First, this is the only paper to look at whether the ABX index reflected the credit performance of the underlying mortgage collateral in an arbitrage framework using the ABX index, the single-name ABCDS contracts, and the individual cash RMBS bonds. Gorton (2009) introduced the arbitrage framework, but focused solely on the relationship between the cash RMBS bonds and the ABX index. In this study, we examine all the arbitrage relationships, including the intermediate single-name ABCDS upon which the ABX is based. That is, we look at the relationship between the cash bonds and the individual ABCDS contracts, which is referred to as the basis, as well as the relationship between a portfolio of individual ABCDS contracts and the ABX index, which we refer to as the tracking error of the ABX index. Also, this is the first to both dynamically estimate such relationships and also account for data quality in the related markets.

Second, this study is the first to develop a direct measure for such information quality. Barry and Brown (1985) use the amount of information available across securities as measured by observed returns, and offer two other proxies: length of time a security is listed on an exchange and the dispersion of analyst forecasts to account for information availability. Other studies from the field of accounting have developed accrual based measures designed to indicate the quality of accounting information on reported earnings (Jones, 1991; Dechow, Sloan, and Sweeny, 1995; and Kothari, Leone, and Wasley, 2005). However, these proxies rely on accounting information, which is uniform and standardized. Ours, in contrast, is based upon actual deviations between data reported by various industry sources.

Our measure exploits the fact that there is no uniform set of definitions for performance metrics nor is there a U.S. GAAP reporting standard for the monthly remittance reports produced for each RMBS, which is the initial source for all deal and tranche level performance data. Furthermore, third-party data vendors take the historical data, standardize the data, and offer the data in a variety of formats and platforms to investors.[11] We calculate information quality as the coefficient of variation in aggregate losses across three deal level data sources: remittance reports, ABSNet, and BlackBox

[10] This result parallels Bai and Collin-Dufresne (2013), which identifies this deleveraging effect in the corporate credit markets as a driver of the negative CDS-bond basis during the financial crisis.

[11] Data vendors include ABSNet, BlackBox Logic, Bloomberg, CoreLogic, LPS/BlackKnight, and Intex, among others.

Logic. Losses should be the same across all databases since the information is coming from the same primary source: remittance reports. Often, however, it is not.

According to a 2012 survey of 115 ABS and MBS investors by Principia Partners, LLC[12], 52% of U.S. investors use 5 or more sources of performance data.[13] The fact that investors use multiple sources for performance data speaks to the difficulty in interpreting and analyzing the information released regarding the ongoing performance of MBS deals as well as determining its reliability across deals and data sources. Because performance metric definitions vary across deals, some vendors attempt to cleanse the data to facilitate a direct comparison.[14] Despite this effort on the data provider side of standardization, investors still must supplement this with their own assessment of the information to ensure its validity, which can be a timely and arduous task.[15]

Even though this study focuses on the deals in the ABX index from July 2007 through December 2010, the MBS market has not made much progress in becoming more standardized. Inconsistency with regards to deal features and definitions and the lack of reporting standards still plague the sector today. The information channels are still as convoluted and obscure as they were during the crisis, which means investors continue to face varying information structures and high information acquisition costs, making evaluating securities inefficient and costly. As a result, understanding the dynamics of structured finance products, their arbitrage relationships, and the evaluation of these securities and their credit risks in the cash and derivatives markets is of great importance to investors, accountants, issuers, financial institutions, and regulators.

Third, to the best of our knowledge, this is the first paper to consider cash flow triggers as a priced risk in cash RMBS bonds and their related credit instruments. Most extant models focus on expected default, recovery rates, and prepayment speeds. While these are important attributes, we analyze tranche level credit support along with three cash flow triggers that, when breached, reprioritize the cash flow waterfall of a MBS deal, focusing only on those specific tranches used to price the ABX. The impact of cash flow trigger breaches varies depending on the credit rating on the tranche: lower credit rated tranches may be more sensitive to credit performance measures that divert cash flows away from junior tranches to those with higher seniority. The two cash flow features we analyze are the acceleration feature and the aggregate loss trigger. We believe these collateral credit measures are more relevant to individual bond performance than deal level values of outstanding principal of different categories of loans, such as 30, 60, or 90+ day delinquent, foreclosure, real estate owned (REO), or bankruptcy loans, which is what most extant studies use.

This paper is structured as follows: Section 2 reviews the relevant literature. Sections 3 through 5 provide the institutional background and mechanics of the three linked securities, starting with RMBS bonds, then the single-name ABCDS followed by the ABX index. They are presented in this order to provide a firm foundation about the information flow and the dynamics of the bond cash

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12 "Structured finance perspectives: Trends in ABS, MBS & CDOs Loan Level & Collateral Performance Data." Principa Partners, 2012, at: https://www.ppllc.com/OurNews/Articles/Principia_ABS_Loan_Level_Performance_Data_Report.pdf

13 Remittance reports are used by 83% of U.S. investors.

14 The definition for aggregate loss is the same across all databases used in this study.

15 According to the head of ABS investment at an EU bank who participated in Principia Partner's 2012 survey, the process of "standardizing definitions and data reporting continue to be an inefficient process due to the lack of minimum standards or consistency amongst all participants, whether issuers or data providers."

flows because the ABCDS contracts are essentially insurance on those cash flows and the ABX index is constructed as a portfolio of ABCDS contracts. Section 6 is a description of the methodology and data. Section 7 presents the empirical results, and Section 8 concludes the paper.

II. Literature Review

Essentially, the ABX is a composite security that represents a basket of single-name ABCDS, which individually are designed to mimic the cash flows of the underlying cash RMBS bond. Therefore, the values of both the ABX and single-name ABCDS are closely linked to the cash flows of the RMBS bonds that are constituents of the ABX index. Bundling securities this way appears to be a redundant activity as investors could achieve the same position by buying or selling protection on the underlying RMBS bonds that compose the ABX index. Other examples of seemingly redundant securities include S&P 500 futures, closed-end funds and real estate investment trusts. Considering the apparent redundancy of these securities, their popularity is interesting and puzzling.

Subrahmanyam (1991) and Gorton and Pennachi (1993) show that a composite security and the underlying constituents coexist because the composite security diversifies firm-specific information, lowering adverse selection costs, which attracts liquidity traders who are able to build portfolios at lower costs. Within an imperfectly integrated markets framework, Fremault (1991) and Kumar and Seppi (1994) study the impact composite securities have on market quality. Fremault (1991) shows that index arbitrageurs, who have access to both markets, will increase informational efficiencies across markets. Kumar and Seppi (1994) place more emphasis on imperfect information linkages between markets and find that more informationally fragmented markets will exhibit greater mispricing. Both conclude that index arbitrage activity and informed trading competition will increase with the introduction of the composite security, resulting in higher liquidity in the individual cash securities.

The more imperfectly integrated the markets are the more limits to arbitrage there will be, which will hinder index arbitrage activity and informed trading competition. Short-selling costs is a well-documented limit to arbitrage (e.g. Tuckman and Vila, 1992; Dow and Gorton, 1994; Duffie, 1996; among others). Vayanos and Weill (2008) show that short-sellers find it optimal to borrow the asset that is easier to locate and will concentrate their short-selling activity in the more liquid asset, which is self-fulfilling. In other words, the asset that is the easiest to locate will often times be the more liquid asset, and the short-selling activity will render the asset more liquid.

In the RMBS bond market, while short-selling is permissible, it is extremely difficult because RMBS bonds are difficult to locate and borrow. To short-sell, an investor must first locate a RMBS bond. Once a bond is located, the short-seller would then have to borrow it and find a buyer. Provided he is able to short-sell, eventually he would have to cover his short-sell. In order to do so, he would then have to find the same exact bond to buy. Search frictions, such as these, are additional costs the short-seller must incur (Duffie, Gárleanu, and Pedersen, 2002, 2005). As a result of high short-selling constraints in a market with divergence of opinions, asset prices will reflect the views of only the optimistic as pessimistic investors are kept out of the market (Miller, 1977). Pessimistic investors will be forced into the ABCDS and ABX markets. Based on theory, the composite security should be the most liquid, suggesting the ABX will be the most liquid, garnering the most short-selling activity and attracting liquidity traders, followed by the single-name ABCDS contracts, and lastly the cash RMBS bond market.

Gorton (2009) cites the concentrated short-selling activity in the ABX index as one of the reasons that problems in the subprime mortgage market instigated a global financial crisis. He theorizes that with the creation of the ABX index, market participants were able to trade based on negative expectations of mortgage related structured products for the first time, but they were limited to the broad mortgage market because the ABX index was the only instrument available for shorting. Although Gorton (2009) does not consider the ability to express negative opinions in the ABCDS market, which was available before the creation of the ABX index, his broader point of concentrated short-selling activity remains important. Lower adverse selection and search costs attracted short-sellers to the ABX index whereas high idiosyncratic, deal-specific risk may have kept short-sellers out of the single-name ABCDS market.

Another limit to arbitrage is information costs, such as increased information risk, information acquisition costs, and longer holding periods before prices converge (Shleifer and Vishny, 1997; Mitchell, Pulvino, and Stafford, 2002). Informationally efficient markets are impossible as long as information is costly (Grossman and Stiglitz, 1980). The more unreliable or imperfect the information is, the higher the costs associated with processing the data and making informed inferences. And when it takes longer for prices to adjust to information, markets are deemed less efficient.

In the RMBS bond market, investors cannot observe the performance of the underlying mortgages. Instead, they must rely on monthly remittance reports that contain imperfect information and must make inferences about the cash flows of the bond from the data provided. These reports are often incomplete, change formats and content over time, and provide varying degrees of information depending on the trustee. To help facilitate the use of the data, various data vendors attempt to create databases with normalized data to make data more comparable across deals. In theory, this would reduce search and information costs for arbitrageurs. However, the lack of reporting standards and the lack of uniform performance definitions in the RMBS market makes it difficult for vendors to calculate consistent and standardize measures across deals for investors to use. In practice according to the Principia Principal survey, more than 60% of investors use four or more data sources to evaluate the performance of the underlying mortgages and make inferences about future cash flows. Continuously monitoring and evaluating all of these information sources is a costly process in both time and resources, which hinders market efficiency and creates mispricing.

When there are high levels of information uncertainty, it may be optimal for an investor to follow the behavior of the investors who precede him rather than incur the costs associated with processing information (Bikchandani, Hirshleifer, and Welch, 1992, 1998). This is one possible explanation for the results found in the extant ABX literature. Stanton and Wallace (2011) find that the AAA rated subindexes were not priced to "reasonable" assumptions of default or recovery rates. Instead, prices were highly correlated with the short interest of financial institutions, which serves as a proxy for insurance demand imbalances. However, they do not consider information risks. Information costs for the underlying RMBS deals were substantial because of the imperfect and incomplete information released in the remittance reports. This may have led investors to observe and follow the behavior of other traders in the financial sector, which would appear as speculative activity.

When information uncertainty is taken into account, we posit that the ABX is not impacted by speculative activity per se, but rather by noise trading, which is necessary for informational arbitrage. When there is a high degree of information uncertainty due to unreliable or imperfect information, investors find it difficult to determine the quality of their private signals. Given the high costs and uncertainty associated with the information, it may be optimal for them to follow the public, yet noisy, signals of preceding traders.

For rational arbitrage to occur, markets need informed investors and noise traders. If a market contains informed investors only, trading will not occur because both are trading on the same information. Noise trading must occur so that informed investors are willing to trade (Black, 1986). We find that noise trading is more prevalent in the ABX market than the single-name ABCDS and cash RMBS bond markets and we also find that informational arbitrage is concentrated in the ABX market. This supports the view that informed investors who are aware of the problems with remittance reports and are able to make more informed inferences from the data, perhaps due to having more experience in the sector over longer periods of time than most investors, appear to take advantage of the noise trading in the ABX index to conceal their private information and exploit mispricing.

Given the high levels of information uncertainty in the RMBS market, the beginning assumption of our analysis cannot be that markets are informationally efficient. Instead, it is necessary to examine the dynamics between noise traders and informational arbitrageurs in price discovery across markets to see how each market incorporates information and why prices adjust or fail to adjust. Provided prices are cointegrated, indicating they are linked via arbitrage, Hasbrouck (1995) uses a vector error correction model (VECM) to study how price discovery occurs in multi-security and multi-market setting. In this setting, information may lead to unequal price changes among securities. One security may update to information first, establishing a new equilibrium price, and other securities or markets may correct to arrive at the same equilibrium price, subject to bounds created by market frictions. Blanco, Brennan, and Marsh (2005) adopt this methodology to examine how credit risk is priced into corporate bond and CDS markets and find that credit price discovery occurs in the CDS market, which is consistent with other empirical studies on corporate credit risk (e.g. Longstaff, Mithal, and Neis, 2005; Bai and Collin-Dufresne, 2013).

Theoretically, a new equilibrium occurs only when a security price adjusts to new fundamental information. In credit markets, there are three types of pricing models to explain the determinants or fundamental factors of credit risk: structural, reduced-form, and hybrid models. In structural models, it is assumed that the investor has the same information as the firm manager and that credit risk is a function of financial leverage, volatility of assets, and the risk-free rate (e.g. Merton, 1974). Reduced-form models rely on an information set that is less-detailed, similar to the set observed by the market, which is based on reasonably available information (Jarrow and Protter, 2004).

Duffie and Lando (2001) combine the two models in an incomplete information framework. Investors cannot observe firm assets directly. Instead, they must make inferences about asset performance from periodic and incomplete accounting reports. Using this hybrid model, Callen, Livnat, and Segal (2009) find that accounting information contained in financial statements is the main source of information for CDS markets. If CDS spreads reflect accounting information, then we should expect ABCDS spreads, and by extension ABX spreads, to reflect information about mortgage collateral performance contained in the remittance report.

Both Stanton and Wallace (2011) and Fender and Scheicher (2009) find little evidence to indicate that the ABX was pricing in the credit performance of the underlying mortgages, but both implicitly assume there is complete information contained in the remittance reports. Dungey, Dwyer, and Flavin (2013) apply a latent variable model to ABX returns to identify common, vintage, credit, and idiosyncratic effects. They find that all four factors have a time-varying influence on return volatility of all subindexes, but the common and vintage factors become increasingly more important as the crisis unfolded with the greatest increase in magnitude for the higher rated subindexes. Their results suggest that credit performance played a role in ABX prices, but that systematic risk played a more dynamic role, where it was relatively unimportant in the good states of the economy (before 2007), but came to the forefront in the bad states of the economy (post 2007).

For composite securities in structured finance, bundling provides the benefit of diversifying idiosyncratic risks, but tranching provides the additional benefit of reallocating default risk. Redistributing cash flows provides greater protection to higher rated securities and less protection for lower rated ones. For the highest rated securities, losses are confined to the worst states of the economy because they have concentrated systematic risk. In other words, they can be considered catastrophic bonds (Coval, Jurek, and Stafford, 2009; Collin-Dufresne, Goldstein, and Yang, 2012). Because of the additional benefits of reallocating default risk, Collin-Dufresne et al. (2012) suggests that senior tranches are not redundant securities, but instead provide a vehicle for pricing catastrophic credit risks. The AAA rated tranches included in the ABX were the first loss tranches of the referenced deals, so they contain less concentrated systematic risk. As a result of bundling and tranching, we expect each ABX subindex, depending on credit rating, to have different degrees of response to explanatory variables, which increases or decreases monotonically.

Of the current ABX studies, only Gorton (2009) considers ABX pricing form an arbitrage perspective, but is limited in scope. His study examines only one ABX credit subindex, the ABX 2006-1 BBB, comparing it to its underlying cash RMBS bonds and showing that spreads increase dramatically at the end of July 2007, which is "consistent with perceived changes in the repo market in the summer of 2007" (p. 571). This leads him to conclude that increased counterparty risk and illiquidity, which caused disruptions in the repo market, broke down the arbitrage relationship between the ABX index and the RMBS bond. We find similar, but more broad-reaching results.

III. The Structural Features of Typical RMBS

Many RMBS features are dynamic, rather than static. Many studies use the more static features and performance measures of MBS deals, such the proportion of fixed to adjustable rate mortgages and the amount of 90+ day delinquent loan principal balance as a percent of the overall pool balance, as indications of deal and bond performance (e.g. Stanton and Wallace, 2011; Demiroglu and James, 2012). Although overall collateral measures change month to month, there are more dynamic features within the deal that change the cash flow structure. Traditionally, structured products allocated fixed amounts of principal and interest to investors, but modern RMBS do not. Instead, they rely on a dynamic set of procedures to allocate more or less depending upon pool performance. This makes using a standard ratio of overall pool characteristics a less reliable measure of deal and bond performance. This section describes the salient dynamic features of RMBS certificates we consider in our analysis.

A residential mortgage backed security (RMBS) is a type of asset-backed security (ABS) that is secured by a pool of individual consumer mortgages. The loans in a pool usually have sufficient similar characteristics, such as credit quality and maturity, that their performance can be modeled in the aggregate. For private-label residential mortgage backed securities (RMBS), the pool is primarily composed of non-conforming loans.

The process of pooling transforms heterogeneous loans into a homogeneous asset, by essentially, diversifying away individual borrower risks. A MBS can be backed by one pool or multiple pools. The actual composition of each pool depends on the specific deal and will be described in its prospectus and any supplements to the prospectus.

Each loan in a pool has monthly principal and interest payments. These cash flows can be structured or "tranched" in such a way that they can back a variety of RMBS certificates with varying degrees of prepayment and credit risks. Not all fixed income investors are alike, typically differing with respect to desired investment return and risk preferences. Some investors may prefer investments with low credit risk, while others prefer higher credit risk.

The most common tranche structure is the senior-subordinate structure, which is designed to allocate credit risk similar to the capital structure of a firm. The "senior" tranches have less credit risk than the "junior" or "subordinated" tranches. The prioritization of cash flows creates various performance attributes, attracting different investors who value the varying degrees of risk and allowing the RMBS issuer to maximize the value of the underlying cash flows (i.e. sales proceeds).

The cash flow structure of a deal is generally referred to as the waterfall, which is comprised of a principal waterfall and an interest waterfall. The rate and timing of cash flows from the underlying pool of mortgages impacts the structure of each waterfall. Generally, the waterfalls start as a sequential payment structure. That is, each month principal received from the underlying pool of mortgages is paid to investors of the tranches entitled to receive that principal. In general, once the senior tranches are paid, then the next tranche will receive principal payments out of the monthly cash flows received from the underlying mortgages. The interest waterfall is also sequential. Each month interest received from the pool is paid to investors starting with the most senior classes then to the subordinated classes. If there is not enough interest available that month to be paid to all, then the lower tranches may not receive interest.

One difference between the principal and interest waterfalls is the duration at which junior tranches will not receive cash flows. With the principal waterfall, junior tranches typically will not receive principal until senior tranches are paid off, which could take several months or years. Whereas, with interest waterfalls, junior tranches will generally receive interest in the first month of the deal and continue to receive interest each month, unless there is not enough interest to cover the senior coupon payments. In this way, "Subordinated" or junior tranches are structured to absorb the first losses and protect the more "senior" tranches.

Given that there always exists an expected non-zero level of losses in any pool of mortgages, RMBS deals offer additional credit enhancements (CE) to help mitigate the risk. For the 80 deals in the ABX index, the most common CE are provided by the combined use of overcollateralization (OC), shifting interest, and reserve fund trapping (which includes excess spread). Such credit enhancements are common across securitized asset classes.

Each tranche has a seniority level called an attachment point. The attachment point is the amount of protection from losses that is provided by subordinated tranches. For example, a tranche with an attachment point of 10% means the deal can withstand losses up to 10% before the tranche will experience losses. That is, the subordinated tranches will absorb the losses before the current tranche sustains any. A lower attachment point indicates less protection while a higher attachment point indicates more protection. Changes in subordination levels or attachment points would be of great importance to investors. The bottom tranche of offered certificates, however, does not attach to the first dollar of losses. Like a corporation, the RMBS sells an "equity" interest called a residual. If losses are less than expected, the residual can be worth a substantial sum.

While the sum of the offered and non-offered certificates and the residual should equal the present value of the loans at the time of the offering, the difference between the total value and the offered certificates adds overcollateralization (OC) to the offered certificates. Each deal strives to maintain a target level of OC throughout the life of the offered certificates. Usually the OC will be fully funded at issuance in what is called an upfront structure, although deals may be structured to "trap" OC over the first months of existence if desired. If losses occur during a period, OC will absorb those losses. If there are any excess cash flows in later periods, they will be allocated to restore OC up to the target level. Any excess beyond that amount will flow to the reserve funds or be distributed to the residual and will not be used to increase OC above its target.

Shifting interest allocates principal to various classes depending upon pool performance. If the pool is performing well after some period, principal may be allocated to junior classes that pay the highest interest to investors, benefitting residual holders. If the pool is not performing well, principal may be directed exclusively to senior certificates to maintain their safety relative to other certificates. The purpose of the shifting interest mechanism is to more evenly distribute and allocate prepayments and liquidation proceeds to the senior classes, such that the subordination level is "shifted" back to its target level.

Reserve funds are comprised of cash funds and excess spreads. Cash funds have an upfront structure as they are typically fully funded at issuance from net sales proceeds. On the other hand, excess spread accounts can be continuously funded throughout the life of the deal. Excess spread refers to the difference between the interest earned on the underlying mortgages and the total cost of the deal, which includes coupons paid, servicing fees, servicing advances, and other administrative expenses. It is a function of interest rate levels and prepayments (both involuntary and voluntary). When interest rates rise, there tends to be an increase in delinquencies and defaults, which reduces excess spread. Prepayments reduce the amount of outstanding principal balance on the underlying loans, which impacts excess spread. Ideally, early in the life of a deal losses are low, which will increase excess spread as the deal is receiving more interest on the underlying loans than it is paying out, adding protection to bonds in the event of future losses.

If there is an interest shortfall, which occurs when the interest received on the underlying mortgages is less than the expenses, then the excess spread account can be used to recover the shortfalls. If there is remaining excess interest after recovering these losses or if there are no losses, then the excess spread account may be paid to the residual. Once the excess spread account is exhausted interest shortfalls may be unrecoverable.

Structural features add an additional layer of complexity to forecasting the cash flow waterfalls of a deal. These provide further protection to senior classes and increase the risk to subordinated classes by directly changing the prioritization of the cash flows. To get a thorough understanding of a RMBS deal, an investor must read through hundreds of pages of legal contracts and understand the asset and liability structure. There is no requirement, however, that the entirety of the cash flow structure be made public, so investors do not always have the complete details of the operations of the RMBS.

Complete or partial information on the waterfall is used to reverse engineer the deal so that investors can run scenario analyses on deal cash flows. Scenario analyses involve developing models based on the loan or pool characteristics and the contractual features that prioritize cash flows over time, and combining those with assumed information about future interest rates and collateral performance, such as prepayments, default speeds, and recovery rates to generate forecasts. Understanding the relationships among the pool of loans, the waterfall structure, and expected economic performance provides investors with useful information on where and how to invest money, depending on their investment objectives and strategy.

We focus on two dynamic RMBS features in this paper: the aggregate loss trigger and the acceleration feature.[16] Both of these features divert cash flows from lower tranches to higher seniority tranches if certain constraints are breached.[17]

A. Stepdown Triggers

Most deals contain stepdown provisions. Stepdown provisions convert a cash flow structure from a sequential pay to a *pro rata* basis after the "stepdown date." Because junior certificates will not have to wait for seniors to be paid fully before receiving principal themselves, stepdown can be very valuable to them – and the lack of stepdown very costly. For junior tranches, if stepdown occurs then principal payments begin for all tranches and subordination levels for senior tranches are reduced. Principal payments will shorten the weighted average life (WAL) of junior tranches, making them less sensitive to changes in credit performance of the underlying mortgages and interest rate levels.

Because deals contain a stepdown provision that would increase credit risk for senior tranches and decrease credit risk for junior tranches, deals also contain stepdown triggers that prevent stepdown

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[16] The delinquency trigger is not included in our analysis as it was not an important determinant of credit risk in our model, but our variable construction is included in the appendix.

[17] It is important to note that although a tranche may be rated AAA, it is not necessarily the first entitled to principal payments. For some deals, there is sequential payment structures within the AAA rated tranches. In other words, the most-senior AAA tranche will receive payments first. When it is paid off, then payments will start for the second AAA tranche, and so on. For this reason, when discussing cash flow payments in the sections that follow, we will make reference to higher priority tranches and subordinate or lower tranches instead of senior and junior tranches. This is an important distinction when describing the AAA tranches included in the ABX index because not all of the AAA tranches have the highest payment priority. As a result, they may be sensitive to changes in prioritization of cash flows as lower rated tranches would be, although the impact will be less as the weighted average life (WAL) of these AAA tranches will not be lengthened as much as the more junior tranches.

from occurring. The stepdown trigger feature provides additional protection in the event that the deal has poor performing collateral for senior tranches. If a trigger is breached, meaning collateral is performing poorly, then stepdown will *not* occur and subordination levels for senior tranches will remain intact.

A step down trigger is essentially a credit performance test. Before stepdown can occur, the performance tests must be passed to ensure the collateral is not deteriorating and/or underperforming. The typical credit performance tests applied to stepdown are the delinquency trigger and the aggregate loss trigger tests. The tests are applied each month, and if both tests are passed, then the deal will be allowed to "step down," which effectively allows for the reduction of the senior class credit support. If at least one test fails, no stepdown will occur. That is, senior tranche subordination levels will not be reduced and cash flows will remain in a sequential pay structure, as principal will continue to be paid to those senior classes entitled to it.

Delinquency triggers are typically based on the amount of Office of Thrift Supervision (OTS) 60+ day delinquencies, which are commonly called seriously delinquent loans (SDQ). The exact definition of what constitutes a 60+ day delinquent loan varies across deals. While the definition of delinquency may differ, the general idea of the delinquency trigger is the same: the balance of delinquent loans as a percent of the current pool balance greater than a threshold percent is taken as a *per se* indication that the balance of delinquencies is higher than expected. There are two types of threshold percentages. One is a constant or static percent for each bond class that is set forth in the deal documents. The other is a dynamic threshold that is calculated based on the product of the current subordination percent and a constant percent. As the collateral of the deal performs and credit support changes due to prepayments and losses, the dynamic threshold will change month to month.

Cumulative loss triggers are more straightforward. This trigger compares the deal's aggregate realized loss amount as a percent of the initial pool balance to a loss schedule, which is outlined in the deal documents. The magnitude of losses on the underlying collateral depends on the market value of the house when it is liquidated plus any costs associated with the disposal of the asset, such as servicer advances and legal fees. Similar to the delinquency trigger, exceeding a specific loss level is taken as a *per se* indicator that the deal is not performing as expected.

The individual triggers provide different information about the underlying collateral. Delinquencies generally provide information about borrowers' willingness and ability to pay and may be triggered by a decline in housing prices, rise in interest rates, or change in borrowers' individual financial status, such as unemployment. Depending on the secondary housing market, however, delinquent loans may never be liquidated – i.e., if the borrower can sell the house before foreclosure – so a loss will never be realized. Nonetheless, if a loan is so far delinquent that collection is deemed unlikely then it may be written off, which would still result in a loss. Investors are concerned with both the potential for losses as well as actual losses, which is why deals typically contain both triggers.

That being said, in this paper, we focus on the distance-to-loss stepdown provision, instead of the distance-to-delinquency. We constructed a distance-to-delinquency variable based the each deal's definition of 60 day delinquent; however, when added to our credit risk models, it was not a significant determinant of credit spreads. We dropped the variable to have a more parsimonious model, and excluded its description and variable construction from the paper in the interest of brevity, but both can be found in Appendix A.

B. Acceleration Feature

The acceleration feature is related to OC, which is maintained by excess cash flows. That is, if there is more interest received from mortgage payments than paid out as bond coupons, then the excess interest will flow to the OC account in order to keep the OC at its target amount. If excess cash flows cannot maintain the OC, a swap agreement may be utilized to maintain the target level. If neither excess cash flows nor a swap agreement can restore the OC target, then the deal experiences an OC deficiency, which is the difference between the target OC and the current OC amount.

Each deal will have an OC target percent, which the deal is required to maintain according to the deal documents. The target OC balance is calculated by multiplying the target percent by the deal size. Target OC levels can change during the life of a deal. If a deal reaches its stepdown date without having a trigger event (either a loss or delinquency breach) then the target OC level will adjust according to a schedule outlined in the deal documents. The reduction in target OC frees up cash flow for the bonds, and is usually interpreted as a positive sign for junior tranches, as they are more likely to receive principal due to the increase in cash flow.

If the deal has an acceleration feature, which all of the ABX deals do, then when an OC deficiency occurs, all excess cash flows will be diverted to those bond classes entitled to principal payments in order to accelerate bond amortization. Accelerated amortization reduces the interest paid out on bonds. If less interest is paid, there is a greater chance that excess interest can be restored, which can be used to restore the OC to its target level. The diversion of cash flow away from subordinate classes lengthens the life of these tranches (WAL increases), making them more sensitive to changes in credit performance and interest rates.

Both senior and junior tranches will be impacted by acceleration. Under accelerated amortization, the senior certificates are paid off more quickly, meaning they will return less than originally expected because the interest component of return is lower. For junior bonds, the acceleration feature is attractive because as senior bonds are paid off and retired then the probability that the junior bonds will see a return of (the dwindling) principal increases.

IV. Single-name ABCDS

Credit default swap (CDS) contracts are essentially insurance contracts, providing protection against a credit event. In general, a CDS transaction has two parties: protection buyer and protection seller. The protection buyer, who is short credit risk, pays a periodic premium to the protection seller, who has a long credit risk position. Said another way, the protection buyer has an exposure similar to a short bond position while the seller's exposure is like being long the bond. In return for the periodic premiums, the protection buyer receives payments if there is an adverse credit event.

CDS contracts are most commonly associated with the corporate bond market, where CDS contracts are written on specific issuers or firms. Protection buyers pay a periodic premium to the seller, and in return the buyer of protection receives payment if credit events occur, which are clearly defined in the Master Agreement as bankruptcy, failure to pay, or debt restructuring.

In the mid-2000s, the CDS market was extended to contracts written on asset-backed securities (ABS), creating the ABCDS market. The introduction of ABCDS transformed the ABS sector from a long-only, relatively illiquid market to one which allowed investors to take short positions or hedge current exposures with enhanced liquidity.[18] Although the general definition of ABCDS is a CDS contract written on any bond of an ABS, for purposes of this paper, we will refer to ABCDS as CDS contracts written on specific tranches or bonds of RMBS deals since this paper focuses on the RMBS deals in the ABX Index.

RMBS (and all ABS) have complex and heterogeneous structural features, which means the probability of receiving bond payments depends not only on the amount and timing of payments from the underlying mortgages, but also on the current priority distribution of cash flows to other bond classes within the deal and on the current cash flow structure that can be altered by various contractual features (e.g. stepdown provisions or acceleration features). In addition, mortgage cash flows have unique characteristics and risks that generic CDS contracts cannot accommodate. Among these are amortization, prepayments, principal writedowns, and interest shortfalls. A further complication is that interest shortfalls can be recovered at a later date.

To accommodate these characteristics and additional risks, ABCDS contracts follow a "pay-as-you-go" (PAUG) structure in order to replicate the cash flows of the underlying bond. First, it is important to note that unlike corporate CDS, ABCDS reference specific bonds or tranches, instead of issuers or entities.[19] This is because only the prepayments, writedowns, and shortfalls of a specific bond are relevant to the two parties in the transactions, so credit events need to be defined based on actual referenced cash bond. For corporate CDS, the definition of credit event consists of bankruptcy, failure to pay, or debt restructuring. However, since RMBS are issued by bankruptcy remote special purpose entities (SPEs) and ABCDS contracts are written on specific bonds, credit events are defined differently. The common types are writedowns, interest shortfalls, and a distressed rating downgrade.[20]

The buyer of the ABCDS contract is buying protection against the credit event, so when one occurs, the buyer receives a payment from the ABCDS seller. Notable to the RMBS market is the reversibility of writedowns and shortfalls, which accrue over time and may be recoverable. When this occurs, the ABCDS buyer must make a payment to the seller. As a result, there are three payment legs under the PAUG structure: one fixed and two floating. Under the fixed leg, the ABCDS buyer makes fixed premium payments based on their notional amount to the seller in exchange for credit risk protection or insurance. The fixed leg continues as long as the CDS buyer maintains the contract, so

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[18] A catalyst for the exponential growth of the ABCDS market was the release of standard pay-as-you-go (PAUG) documentation introduced by the International Swaps and Derivatives Association (ISDA) in June 2005. The new template eliminated most of the uncertainty surrounding the definition of a credit event for ABS bonds, which gave investors the confidence to begin trading in this market. All of the CDS in the ABX are PAUG. A complete description of the differences between PAUG and traditional CDS is beyond the scope of this paper. For background on PAUG, see e.g. Whetten, Michiko. "Synthetic ABS 101: PAUG and ABX.HE." Nomura, March 7, 2005.

[19] For example, in a corporate CDS transaction, the CDS references a firm or issuing entity, so when an investor buys protection (or sells short credit risk) on a 5-year senior CDS on Ford Motor Company, he is buying protection against Ford's credit risk, not any one specific bond. When an investor buys an ABCDS on a Washington Mutual MBS AAA bond or tranche, he receives credit protection against an adverse event on that specific Washington Mutual bond, not on Washington Mutual itself.

[20] See Whetten 2007. Writedown means whether the cash bond has been written down due to losses or prepayments. Interest shortfalls occur when there is a difference between the expected coupon (i.e. Libor + spread) and the coupon received. Distressed rating downgrade occurs if any rating agency downgrades the bond to CCC/Caa2 or below or withdraws its rating entirely. Also note that sponsor bankruptcy is not a credit event because the trust is a bankruptcy remote SPE.

whether a credit event occurs or not, the buyer must make his premium payment. The first floating leg represents any payments made as a result of a credit event. In this case, the protection seller makes a payment to the protection buyer for an amount designated by the credit event. For example, if the credit risk is an interest shortfall, then the seller will make a payment to the buyer for an amount equal to the shortfall.[21] The second floating leg payment will only occur when there is a reverse credit event, so that the buyer of protection makes payments to the seller.

Unlike a cash bond, where the only way to close out a position is to sell the bond, there are four options for unwinding an ABCDS contract: exercising a clean-up call, termination, novation, and an offsetting position. ABCDS on RMBS typically trade with clean-up call provisions, which gives the buyer the option to break his contract if a coupon step up is triggered.[22] A clean-up call provision is valuable to the ABCDS buyer because it allows them to avoid paying an increased premium if coupon step up occurs. Termination occurs when one party pays his counterparty the market value of the CDS. Novation requires finding a third-party that will buy the CDS and take over the current owner's premium payments. And lastly, an investor can enter into an offsetting position in a similar CDS. This option exposes the investor to counterparty risk and basis risk (the risk that the new contract is not a perfect hedge). For the first two options, gains or losses on closing out the CDS position are realized upfront, whereas the fourth option, an offsetting position, gains or losses are realized overtime.

V. The ABX Index

Since the ABX index was a widely followed index used as a gauge for the performance of the entire subprime housing sector as well as an input for mark-to-market accounting, the 80 deals in the ABX index should have been scrutinized as well. Their structural and contractual features should have been well understood, the credit performance of their underlying collateral should have been widely followed, and the mispricing between their cash and synthetic credit markets should have been closely watched for any potential arbitrage opportunities. Still, understanding additional idiosyncrasies in the construction and mechanics of the ABX index is critical to understand any relative mispricing between the cash bonds and ABCDs and the tracking error between ABCDS and the ABX series.

The index sponsor, Markit Group, launched the first semi-annual ABX index in January 2006 (the 2006-1 vintage) with a plan to issue a new index on a rolling six-month basis. After the launch of a new series, all previous indexes were to continue trading until maturity. Other credit indexes that traded at the time (like the CDX) had a similar roll feature, but the ABX was different. Markit designed each series with collateral from the previous six months, so that each roll would have a unique vintage

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[21] As mentioned later, most ABCDS contracts have fixed cap arrangements, which limits the amount the buyer would be required to pay in the event of an interest shortfall. The fixed cap limits the interest shortfall payment to the amount of the premium, which means that the inflow to the seller (the premium payment) completely offsets the outflow (the shortfall interest payment to the buyer). This is advantageous to the ABCDS seller as he would have no "out-of-pocket" expenses, despite there being a credit event.

[22] Coupon step up occurs when the reference obligation is not called for redemption before a set date, which is outlined in the ABCDS documents, before its legal final maturity.

profile.[23] Essentially, each vintage would reference a certain period of mortgage origination, which gave it the unique characteristic of reflecting any trends in mortgage quality.[24]

The Markit Group constructed the index with the help of a consortium of sixteen investment banks, who were also the licensed dealers of the ABX.[25] To determine which RMBS deals would be included in a vintage, Markit Group gave a list of the largest subprime RMBS deals from the previous six months to each of the investment banks to rank. Markit used these rankings to choose which deals to include based on specific criteria to "ensure" diversification.[26] Their criteria required that no more than four deals could come from the same issuer, only six deals could have the same servicer, the principal amount had to be larger than $500 million, and a minimum requirement of 90% first lien loans from borrowers with a FICO credit score of at least 660.[27] Of the deals that met this criteria, the investment banks would rank deals that were thought to represent the most liquid deals in the RMBS market.

Collectively there are four vintages within the ABX index: ABX 2006-1, ABX 2006-2, ABX 2007-1, and ABX 2007-2.[28] Markit constructed each vintage from 20 RMBS deals issued in the previous six months. For example, ABX 2006-2, which was the second vintage launched in July 2006, contained 20 deals from the first half of 2006, while ABX 2007-1 began trading in January 2007 and contained 20 deals from the second half of 2006.

Within each vintage there are five credit subindexes based on the initial ratings (AAA, AA, A, BBB, -BBB) of the selected tranches or bonds of the 20 referenced RMBS deals. In other words, five bonds with a different credit rating were selected from each deal and included in their corresponding subindex for a total of 100 bonds in each vintage (i.e. 20 bonds in each subindex). If the individual bonds were subsequently downgraded (or upgraded), the subindexes were not updated to reflect the change. This means that an AAA rated subindex could potentially contain all lower rated bonds if every one was downgraded after the launch of the subindex. Each subindex acted as a single CDS contract based on the 20 underlying RMBS bonds. To establish the same credit exposure without the index, a trader would need to buy one single-name ABCDS contract on each referenced underlying RMBS bond for a total of 20 contracts. The arbitrage activity among these three securities establishes the mechanism needed to study the market's evaluation of subprime mortgage risk in the ABX index.

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[23] In the interest of avoiding confusion, we will refer to each individual ABX index as a vintage, instead of an index. Confusion may occur because each vintage has subindexes based on credit rating. For example, this means moving forward that the first ABX index (ABX 2006-1) will be called the first vintage. All credit rated subindexes of the vintages will be referred to as simply subindexes with reference to the vintage for which they belong. Any mention of the ABX index hereafter will be referring generally to all four vintages.

[24] Markit's plan of successive 6 month rolls was halted after the fourth vintage launched in July 2007. The issuance of RMBS deals declined in the second half of 2007, and of the ones that were issued, not enough qualified for a new vintage roll. As a result, there were no subsequent vintages.

[25] These banks were Bank of America, Barclays, Bear Stearns, BNP Paribas, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, Greenwich Capital, JP Morgan, Merrill Lynch, Morgan Stanley, Lehman Brothers, RBS, UBS, and Wachovia.

[26] There were no restrictions on the originators of the underlying loans. This lead to the potential for high concentration on a small number of originators, given that finance companies, like New Century or Long Beach Mortgage Company, acted as subprime lending conduits to larger financial institutions.

[27] See Markit Group ABX.HE Index Rules (URL: http://www.markit.com/Documentation/Product/ABX)

[28] The first set of numbers, either 2006 or 2007, indicate the year the vintage was launched, and the number after the hypen marks whether the index began trading in January (noted by a 1) or in July (noted by a 2).

In theory, changes in price of a subindex were determined by the net cash flows of the underlying RMBS bonds. The PAUG structure was based on two payment legs. The first was a fixed leg determined by the sponsor before the index traded based on the approximate present value of the monthly inflow of fixed, no-default coupon payments[29] of the mortgages in the underlying MBS tranches, adjusting for prepayments (Fender and Scheicher, 2009). The second leg of the cash flows was a floating leg that was determined by expectations of principal writedowns or interest shortfalls. Markit Group indexed the price to $100. As a result, on the first trading day, the cash flows from the fixed and the floating legs were equal and canceled each other out and the subindex was launched with a starting price of $100. Equation (1) provides a simplified formula for the ABX index price calculation.

$$ABX\ Index\ Price = \$100 + PV\ of\ Coupon\ Payments - PV\ of\ Writedowns\ \&\ Shortfalls \quad (1)$$

Theoretically, after the index launched at $100, the price would change by expectations of future writedowns and shortfalls.[30] If the price is below (above) $100, then writedowns and shortfalls have increased (decreased) relative to the coupon rate (i.e. spreads have widened (narrowed) relative to the fixed rate). A lower (higher) price means the cost of credit protection has increased (decreased) because of anticipated credit deterioration (improvement). For protection, cash flows are exchanged both upfront and on a monthly basis. The initial payment is based on the dollar amount of protection the buyer wants, which is called the notional amount. The percent difference between the indexed price of $100 and the current price is multiplied by a factor that adjusts for the amount of principal that is outstanding on the underlying deals. The factor changes monthly as the underlying tranches amortize overtime (e.g. mortgage payments are made, loans become delinquent, homes are foreclosed or become real-estate owned). Equation (2) shows the calculation of the initial upfront payment.

$$Upfront\ Payment = \frac{(\$100 - ABX\ price)}{\$100} \times Factor \times Notional \quad (2)$$

Figure 1 shows the price performance by vintage. The graphs show the unbalanced nature of the indexes. The ABX 2006-1 index was launched on January 19, 2006, so it has a longer history than the ABX 2006-2, which was launched on July 19, 2006. The ABX 2007-1 was launched on January 19, 2007, and the ABX 2007-2 was launched on July 19, 2007, which makes it the index with the shortest amount of history.

[FIGURE 1]

As the graphs show, the subindexes do not move dramatically until mid-July 2007 at which point all begin to decline precipitously. Moving from the first vintage to the last, the decline is stronger in magnitude, which suggests the market perceived the underlying mortgages in the later vintages as

[29] Markit Group capped the fixed coupon rate at 5.00%. If the market expected that the present value of losses on the underlying RMBS deals would be greater than 5.00%, then the fixed coupon would be set at 5.00% and the subindex would trade below par to account for the additional expectation of losses.
[30] The index could launch below $100 if the fixed coupon rate was capped at 5%.

containing more risk than the previous ones. Table I reports the summary statistics for deal level collateral performance measures from vintage launch through December 2010. The outstanding amount of 30-day delinquent, 60-day delinquent, and foreclosed loans as a percent of the total ending mortgage pool balance increase with each launch. The amount of 90+ day delinquent loans in each deal increased dramatically from the first vintage with 6.85% to the last vintage with 10.07%.

[TABLE I]

Unwinding an ABX index position is similar to a single-name ABCDS. If the buyer wants to close out his trade, he has three options: termination, novation, or an offsetting position. If an investor wants to terminate his position, he must pay the opposite party the market value of the ABX index. Novation requires the investor to find a third-party to take over payments. Lastly, the investor can take an offsetting position on the ABX index. If he is long the ABX, he can sell it, and vice versa. Like with the ABCDS contract, the offsetting position option exposes the investor to additional counterparty risk, but unlike the ABCDS, the new contract will be written on the specific subindex in question, so there are no additional risks associated with different contract features or collateral.

The ABX index uses a PAUG template like ABCDS contracts. The difference is the ABX index is attempting to mimic the cash flows of an underlying portfolio of bonds, not just a single bond. For the ABX, there is no distressed credit downgrade rating, but there are writedown and shortfall credit events. If there is a credit event, the protection buyer receives payments from the seller. For example, on November 27, 2006, Markit Group determined there was an interest shortfall on one RMBS deal that affected the BBB and BBB- bonds in the ABX 2006-1 vintage.[31] The interest shortfall per million at the index level was $105.35 and $142.02 for the BBB and BBB- subindexes. If for some reason these events were reversed, the protection buyer had to repay the seller.

Although the ABX index and the single-name ABCDS were designed to reflect the credit fundamentals of the underlying RMBS cash bonds, there was room for spreads to reflect outside factors, not related to collateral performance, since the index itself could be traded. During the crisis, there was little agreement on whether the ABX index was trading in line with fundamentals or technicals. In 2007, traders and portfolio managers were quoted saying that the prices of the ABX index were not justifiable based on fundamentals. For example, in a Reuters News article[32] in late October 2007, Glenn Schultz, an analyst at Wachovia Capital Markets, discussed the impact the ABX index had on the valuation of the underlying RMBS bonds. He said, "With a lack of ongoing dealer support, global macro momentum traders may prefer to unwind their short positions. This would relieve some of the technical pressure on ABX valuations and allow a more correct value to emerge based on credit fundamentals and structural protections relative to collateral performance." Such comments suggest that technical factors drove the change in index prices. However, one month earlier in a September 2007 Reuters News article,[33] Derrick Wulf, a portfolio manager at Dwight Asset Management Co., stated that "there seems to be agreement in the market that remittance reports will get worse but now it's become a function of severity -- how much worse can it get?" This implies instead that fundamental factors were a major consideration in ABX trading.

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[31] The bonds were from the Long Beach Mortgage Loan Trust 2005-WL2 deal.
[32] "New ABX Hedge Tool May Face Retirement," October 25, 2007. Reuters News.
[33] "ABX Tumbles Ahead of Key Loan Data," September 21, 2007. Reuters News

All of which lead us to our primary research question: did the ABX index reflect the collateral performance of the underlying RMBS constituents? We answer this by examining the changing dynamics among the spreads of three linked securities of the ABX index - cash RMBS bonds, single-name ABCDS contracts, and the ABX itself in an arbitrage framework. First, we examine how credit risk is priced into each market on a daily basis to examine how information flows to each market. Then we estimate the potential impact of noise trading on credit spreads across markets. And lastly, we focus on monthly changes in basis and tracking error to determine the cross-sectional determinants of credit risk in each market, while taking into consideration differences between the markets and the securities themselves. Doing so, leads us to a financial model that, we believe, better captures the rational behavior of market participants. In the following sections, we will describe the model framework and data in more detail.

VI. Methodology and Data

A. Theoretical Framework

The beginning assumption in most studies is that markets are informationally efficient. The price of an asset at any given point in time should be a reasonable estimate of the intrinsic value because rational, profit-maximizing, and competitive market participants incorporate all relevant information based on past events and events the market expects to take place to predict the future market value of the asset. In this way, the price of the asset should equal the present value of expected future cash flows discounted at the market discount rate, which should equal the expected return of the asset. Generally, this is taken to mean that markets reflect relevant information quickly, and prices adjust accordingly, which assumes that information is complete and costless to acquire, interpret, and analyze.

However, as Grossman and Stiglitz (1980) point out, information is costly, which means informationally efficient markets are impossible. If markets were perfectly efficient, then there would be no incentive to become informed and earn a return from the information. Further, as Black (1986) points out, for markets to work there must be noise, otherwise, we could not observe prices. Informed traders need less-informed or noise traders. As noise trading increase, it becomes more profitable for traders to become informed and trade on information because they can conceal their private signals in the noise (Kyle, 1985).

As an alternative to the efficient market model, we consider the Shiller (1984) model that allows for informed traders and noise traders. Equation (3) represents the demand for an asset by the informed traders. It may be beneficial to think of ρ as the return noise traders expect.[34] If it is the same as the expected return informed traders expect, then informed traders will not demand any of the asset ($Q_t = 0$). The risk premium that informed investors demand to hold all of the asset is represented by φ. Based on these conditions, Shiller (1984) proposes Equation (4) as an alternative to the efficient markets model. The total asset value demand by noise traders per share is Y_t. For the

[34] Shiller (1984) interprets ρ as the "expected real return such that there is no demand for shares by the smart money." (p. 477)

model to achieve equilibrium, the sum of the demand by informed investors and the demand by noise traders should equal 1, indicating that all of the asset is owned in the market.

$$Q_t = \frac{\left(E_t R_t - \rho\right)}{\varphi} \tag{3}$$

$$P_t = \sum_{k=0}^{\infty} \frac{E_t CF_{t+k} + \varphi E_t\left(Y_{t+k}\right)}{\left(1+\rho+\varphi\right)^{k+1}} \tag{4}$$

In Equation (4), the price of the asset equals the present value of expected future cash flows[35] plus a proportion of expected future noise trader demand discounted at the new discount rate of $\rho+\varphi$. Note that both the relevant amount of future noise trader demand and the discount rate depend on φ, which is interpreted by Shiller (1984) to be the risk premium required by informed traders to hold the asset. Any factor limiting arbitrage would likely impact the risk premium demanded by informed investors. Specifically for purposes of this paper, we are interested in information costs as an arbitrage limit, so we generally interpret φ as how costly information is to acquire, process, and forecast accurately.

If the risk premium demanded by informed traders is zero, indicating that information is complete and readily available to the public at no (or at, the very least, a reasonable) cost, then the resulting equation is the efficient markets model. A zero risk premium would indicate that there is no incentive or positive return to be earned by becoming more informed. Essentially the market is already perfectly informed. However, as the risk premium for informed traders becomes larger, meaning information is incomplete and becoming more costly, the expectation of noise trader demand becomes more important and the discount rate increases.

We hypothesize that for our three securities - cash RMBS bonds, single-name ABCDS contracts, and the ABX - expectations of future noise trader demand varies according to the nature of the market. In the cash RMBS bond market, investors are limited to long-only positions and must fully fund their investments upfront. In contrast, ABCDS contracts and the ABX require partial upfront funding, which depends on whether the security is trading at a premium or a discount, and ongoing premiums. If the credit protection is selling at a premium (discount), then the seller (buyer) of protection must make a payment to the buyer (seller). The full funding requirement and the short-selling constraints would prevent many noise traders from entering the market, when they could enter into the single-name ABCDS and ABX markets at lower costs and also to express negative expectations through buying credit protection.

Because of these cost and short-selling constraints, the demand by noise traders for cash RMBS should be limited. In the extreme case, if aggregate noise trader demand is zero and expectations of future demand is on average zero, then $\rho+\varphi$ will equal the discount rate under efficient markets, and informed traders will own all of the asset. As a result, it is optimal for informed

[35] For RMBS bonds, the cash flows are the coupon payments. For ABCDS and ABX, cash flows are payments in the case of a credit event.

investors to do their due diligence, using remittance reports, loan level data, and all available sources, to determine if bonds are under- or overvalued. Thus, earning a positive return on their information and forcing asset prices to their intrinsic value.

For the RMBS bond market, it is more reasonable to expect that noise traders exist, but are not prevalent. In which case, prices will deviate from fundamentals, but the noise will be random, not persistent, and centered on zero. Noise traders in this example may be institutional investors who face investment mandates regarding the quality of the asset they are permissible to hold. As noise in the broader market becomes negative, these investors may be either required to or feel pressure to sell regardless of fundamentals. This negative investor demand through selling of bonds would impact the price of the bonds, making them undervalued to the price that an otherwise perfectly efficient market would suggest. This would give informed investors more incentive to uncover value-relevant information and trade on it.

For the ABCDS contracts and the ABX, it is difficult to determine the potential demand by noise traders because both securities are partially funded upfront. However, as a composite security that diversifies idiosyncratic risk, thus lowering adverse selection costs, theory predicts that the ABX will attract liquidity traders (Subrahmanyam, 1991; Gorton and Pennachi, 1993). Further, short-sellers are attracted to the more liquid asset because it is the easiest to locate, so short-selling activity should be concentrated in the liquid asset (Vayanos and Weill, 2008). Therefore, if noise traders focus their activity in single-name ABCDS contracts and the ABX, it is reasonable to assume most noise trading is concentrated in the ABX index because it is a composite security.

While the Shiller (1984) model is simplified, it has important implications for our study. If we assume markets are informationally efficient, we fail to capture the complexity of rational behavior. Merton (1987, p. 485) discusses the importance of allowing for varying information structures in economic models. He states, "it may… be reasonable to expect rapid reactions in prices to the announcement through standard channels of new data (e.g. earnings or dividend announcements) that can be readily evaluated by investors using generally-accepted structural models." But some information takes time to acquire and disseminate. Empirical models that do not explicitly account for varying information structures and the costs associated with acquiring information and acting on it may suggest the appearance that investors are not acting rationally in the traditional sense, but in reality, it is the model that does not capture the complex nature of rational behavior.

In the RMBS market, information is imperfect and there is no uniform channel for information transmission as there are no GAAP standards. As late as 2012, a survey by Principia Partners[36] found that investors continue to consider it difficult to gather, interpret, and analyze RMBS collateral data. The Principia survey concluded, in part:

- 60% of investors used four or more different performance data sources[37];

[36] "Structured finance perspectives: Trends in ABS, MBS & CDOs Loan Level & Collateral Performance Data." Principa Partners, 2012 at https://www.ppllc.com/OurNews/Articles/Principia_ABS_Loan_Level_Performance_Data_Report.pdf

[37] The survey identified investors relying on the following vendors: ABSNet Lewtan; ABSPerpetual.com; ABSXchange S&P Cap. IQ; BlackBox Logic; Bloomberg; CoreLogic; Interactive Data (IDC); Intex; MBS Data; Moody's Analytics; Morgij Analytics; Trepp; and Veros.

- 80% said that it was a challenge to normalize performance data across multiple different data sources;
- 90% said it was not easy using or managing loan level data due to the lack of standards in its disclosure.

The differences that arise between the base data and the data provided by vendors present investors with a classic problem of heterogeneous, or asymmetric, information. We compare hand collected aggregate net loss data from monthly RMBS remittance reports to two separate data sources: ABSNet and BlackBox. We construct an "information quality" proxy by calculating the coefficient of variation for aggregate losses as the quotient of the standard deviation and the mean of aggregate losses from the three data sources.

The implications for our information proxy are straightforward in the context of RMBS trading. First, even if we assume that all RMBS deals released high quality information about the performance of the underlying collateral, we would expect there to be mispricing between the cash and ABCDS markets simply because of short-selling constraints in the presence of heterogeneous investor beliefs. Investors with negative views on the future performance of the collateral unable to express their beliefs in the cash market would turn to the ABCDS market to establish short positions. But investors who are the most optimistic about the bond will own the cash bond, so bond prices would be higher than the fundamentals would indicate, meaning yields would be lower than otherwise should be and ABCDS (and ABX) premiums would increase as investors exhibit increasingly negative views (Miller, 1977). We would not expect the collateral performance of the underlying deals to impact the spread relationship between the ABX subindexes and their corresponding ABCDS portfolios because there are no short-selling market constraints.

Still, the collateral performance information provided by vendors to investors cannot be assumed to be of similar quality and consistency across all RMBS deals.[38] Our information quality proxy, therefore, assumes that RMBS investors recognize securities with poor information quality and behave rationally in the sense that they demand higher returns for the riskier (lower quality information) securities. Such recognition will drive the mispricing between the cash and synthetic (ABCDS and ABX) markets even wider, but in an entirely rational manner. Therefore, by including a proxy for information quality, which can be interpreted as the cost associated with information, we can better understand the dynamics between informed traders and noise traders in price discovery across markets and how markets incorporate or fail to incorporate certain information.

B. Empirical Models

The purpose of this study is to examine whether credit performance of RMBS deals explains the prices of securities with cash flows related to the RMBS deal. Furthermore, it examines the extent to which the arbitrage relationships among the cash RMBS bonds, ABCDS contracts on the ABX constituents, and the ABX subindexes affect how (and whether) the ABX subindexes incorporated information about the performance of the underlying mortgages. Given the level of information

[38] Or across time, but that is beyond the scope of the present paper.

uncertainty and the costs associated with that uncertainty, we cannot assume markets are informationally efficient. Instead, we begin our empirical analysis by examining the price discovery process across the three different markets to examine how each market incorporates information and why price adjust or why prices fail to adjust.

To explore the pricing dynamics between informed and noise traders, we use the vector error-correction model (VECM) methodology of Blanco, Brennan, and Marsh (2005), hereafter referred to as BBM, in two steps. First, we run the exact BBM regressions for the ABCDS in our sample and the underlying RMBS bonds as well as ABX and the constituent ABCDS portfolios. Then we modify the BBM methodology to try to identify the additional information content of report dates to the respective investors in these markets.

Both models rely on the fact that securities closely linked by arbitrage, subject to transaction cost constraints, will share a common component, which is the "fundamental" or implicit price. Information can be impounded into the price in multiple markets, which in this study are the cash RMBS bond and related synthetic markets. Innovations or updates to the common component are considered the price discovery process because they are permanent changes in the equilibrium price. In a multi-security setting, information may lead to unequal price changes among securities. For the security in which the new equilibrium price is discovered, other securities or markets may error correct to arrive at the same equilibrium price, subject to bounds created by market frictions. We include a report date indicator in the cointegrating relationship for both the unmodified and modified VECMs. According to our discussions with bond traders, it was difficult to find a quote the day before a report date because no one wanted to enter a position until new information was released. We believe this lack of trading is a short structural break every month around the report, which is accounted for by the report date indicator in the cointegrating relationship.

Equations (5) and (6) represent the VECM used to examine whether price discovery occurs in the ABCDS or the cash RMBS bond market without consideration of the release of the remittance report (i.e. no report date indicator variable). The term in parenthesis in both equations represents the error of the price relationship between the ABCDS market and the RMBS bond market. The coefficient on this common explanatory variable can be interpreted as how the traders in each market respond to the price discrepancy or the error between markets. For example, λ_1 can be interpreted as how traders are reacting in the ABCDS market to relative mispricing between the securities. Likewise, λ_2 represents how traders are responding in the cash RMBS bond market to price discrepancies. In other words, the λ's represent the speed of adjustment or price discovery of the market. The second and third part of the equations represent autoregressive terms, which control for the temporary short-run deviations from the implicit price or common factor caused by market imperfections.

If the cash RMBS bond market is contributing to the price discovery of credit risk, then λ_1 will be negative and significant as the traders react to relative mispricing by trading in the ABCDS, or in other words, error correction occurs in the ABCDS market. Likewise, if price discovery occurs in the ABCDS market, then λ_2 will be positive and significant, as traders respond by trading in the cash RMBS bond market.

$$\Delta ABCDS_{i,t} = \lambda_1 \left(ABCDS_{i,t-1} - \alpha_0 - \alpha_1 RMBS_{i,t-1} - \alpha_2 \mathrm{Re}portDate \right) + \sum_{j=1}^{p} \gamma_1 \Delta ABCDS_{i,t-j} + \sum_{j=1}^{p} \delta_1 \Delta RMBS_{i,t-j} + \varepsilon_{1t} \qquad (5)$$

$$\Delta RMBS_{i,t} = \lambda_2 \left(ABCDS_{i,t-1} - \alpha_0 - \alpha_1 RMBS_{i,t-1} - \alpha_2 \text{Re}portDate \right) + \sum_{j=1}^{p} \gamma_2 \Delta ABCDS_{i,t-j} + \sum_{j=1}^{p} \delta_2 \Delta RMBS_{i,t-j} + \varepsilon_{2t} \quad (6)$$

Equations (7) and (8) follow the same error-correction model, but include an explanatory variable designed to estimate how each market incorporates information released in the remittance reports. One requirement of the ABX sponsor is that deal remittance reports be released on the 25th of every month. If the 25th is a holiday or a weekend, then the report is released the next business day.

Since all of the reports are released on the same day, we created a report date indicator variable that is equal to 1 on the trading day before, on, and after the report date. We include the trading day before in case any information was leaked prior to release, and the trading day after to capture any residual information transmission since the information is complex and may require some time to process. This modification allows us to examine how information released in the monthly remittance reports is incorporated into market prices through trading behavior. The coefficients on the report date indicator variable β_1 and β_2 describe the contribution to the common factor due to information transmission from the remittance report.

$$\begin{aligned} \Delta ABCDS_{i,t} = {} & \lambda_1 \left(ABCDS_{i,t-1} - \alpha_0 - \alpha_1 RMBS_{i,t-1} - \alpha_2 \text{Re}portDate \right) \\ & + \beta_1 \text{Re}portDate + \sum_{j=1}^{p} \gamma_1 \Delta ABCDS_{i,t-j} + \sum_{j=1}^{p} \delta_1 \Delta RMBS_{i,t-j} + \varepsilon_{1t} \end{aligned} \quad (7)$$

$$\begin{aligned} \Delta RMBS_{i,t} = {} & \lambda_2 \left(ABCDS_{i,t-1} - \alpha_0 - \alpha_1 RMBS_{i,t-1} - \alpha_2 \text{Re}portDate \right) \\ & + \beta_2 \text{Re}portDate + \sum_{j=1}^{p} \gamma_2 \Delta ABCDS_{i,t-j} + \sum_{j=1}^{p} \delta_2 \Delta RMBS_{i,t-j} + \varepsilon_{2t} \end{aligned} \quad (8)$$

Equations (9) through (12) represent the same VECM framework, but are applied to the two synthetic securities: the ABX index and the ABCDS portfolio of index constituents. In these equations, the single common explanatory factor in parenthesis is the random walk relationship between the ABX index and the ABCDS portfolio. In Equations (9) and (11), λ_1 can be interpreted as the ABX index pricing credit due to traders responding to the relative mispricing between the ABX and the ABCDS portfolio. If λ_1 is negative and significant, then price discovery occurs in the ABCDS market and the ABX market is responding in the next period. Likewise in Equations (10) and (12), λ_2 describes how traders are responding in the ABCDS market to price discrepancies. If λ_2 is positive and significant, then price discovery occurs in the ABX market and the ABCDS market is responding in the next period.

$$\Delta ABX_{i,t} = \lambda_1\left(ABX_{i,t-1} - \alpha_0 - \alpha_1 ABCDS_{i,t-1} - \alpha_2 \text{Re}portDate\right) + \sum_{j=1}^{p}\gamma_1 \Delta ABX_{i,t-j} + \sum_{j=1}^{p}\delta_1 \Delta ABCDS_{i,t-j} + \varepsilon_{1t} \tag{9}$$

$$\Delta ABCDS_{i,t} = \lambda_2\left(ABX_{i,t-1} - \alpha_0 - \alpha_1 ABCDS_{i,t-1} - \alpha_2 \text{Re}portDate\right) + \sum_{j=1}^{p}\gamma_2 \Delta ABX_{i,t-j} + \sum_{j=1}^{p}\delta_2 \Delta ABCDS_{i,t-j} + \varepsilon_{2t} \tag{10}$$

$$\Delta ABX_{i,t} = \lambda_1\left(ABX_{i,t-1} - \alpha_0 - \alpha_1 ABCDS_{i,t-1} - \alpha_2 \text{Re}portDate\right) + \beta_1 \text{Re}portDate + \sum_{j=1}^{p}\gamma_1 \Delta ABX_{i,t-j} + \sum_{j=1}^{p}\delta_1 \Delta ABCDS_{i,t-j} + \varepsilon_{1t} \tag{11}$$

$$\Delta ABCDS_{i,t} = \lambda_2\left(ABX_{i,t-1} - \alpha_0 - \alpha_1 ABCDS_{i,t-1} - \alpha_2 \text{Re}portDate\right) + \beta_2 \text{Re}portDate + \sum_{j=1}^{p}\gamma_2 \Delta ABX_{i,t-j} + \sum_{j=1}^{p}\delta_2 \Delta ABCDS_{i,t-j} + \varepsilon_{2t} \tag{12}$$

If the cash and derivative markets are perfectly integrated, credit performance measures would not impact the basis or ABX tracking error spreads because the bonds, ABCDS contracts, and the ABX have similar cash flows. However, since the markets are not perfectly integrated, price discovery may be exploited in one market over the other leading to relative value/arbitrage trading opportunities. Specifically, given that the cash market has short-selling constraints, which prohibits investors with negative views from acting on their beliefs, price discovery may occur in the derivative market first, arbitraging cash market values.

To gauge the potential impact of noise trader supply and demand shocks, we use a principal component analysis (PCA) on the residuals from a credit risk model that controls for collateral, contractual, and market variables. First, we run a fixed-effects panel regression of weekly changes in spreads on our credit performance and contractual measures as well as market variables that affect credit risk.. These regressions are represented by Equations (13) through (16).

$$\Delta Yield_{i,t}^{Rating} = \beta_0 + \beta_1 \Delta Yield_{i,t-1}^{Rating} + \sum \beta X_{i,t,Credit}^{Rating} + \sum \beta X_{i,t,Contract}^{Rating} + \sum \beta X_{i,t,Market}^{Rating} + \varepsilon_{i,t}^{Rating} \tag{13}$$

$$\Delta CDS_{i,t}^{Rating} = \beta_0 + \beta_1 \Delta CDS_{i,t-1}^{Rating} + \sum \beta X_{i,t,Credit}^{Rating} + \sum \beta X_{i,t,Contract}^{Rating} + \sum \beta X_{i,t,Market}^{Rating} + \varepsilon_{i,t}^{Rating} \qquad (14)$$

Equations (13) and (14) examine the changes in the individual bond spreads and the single-name ABCDS spreads across credit ratings, respectively. Equations (15) and (16) look at the changes in spreads of a portfolio of ABCDS contracts and the ABX index, respectively. We include Equation (15) on the portfolio of ABCDS to account for any diversification effects that the ABX index may provide for which the single-name ABCDS regression results from Equation (14) do not account.

$$\Delta ABCDS_{i,t}^{Rating} = \beta_0 + \beta_1 \Delta ABCDS_{i,t-1}^{Rating} + \sum \beta X_{i,t,Credit}^{Rating} + \sum \beta X_{i,t,Contract}^{Rating} + \sum \beta X_{i,t,Market}^{Rating} + \varepsilon_{i,t}^{Rating} \qquad (15)$$

$$\Delta ABX_{i,t}^{Rating} = \beta_0 + \beta_1 \Delta ABX_{i,t-1}^{Rating} + \sum \beta X_{i,t,Credit}^{Rating} + \sum \beta X_{i,t,Contract}^{Rating} + \sum \beta X_{i,t,Market}^{Rating} + \varepsilon_{i,t}^{Rating} \qquad (16)$$

Then for each market, we perform a PCA on the residuals to gain a better understanding of the unexplained variation in credit risk. If the credit, contractual, and market variables that are suggested by theory do not explain a majority of the changes in weekly spreads, then the PCA will reveal if there are systematic components in the residuals that lie outside of the credit risk model. If the first or second principal components explain a significant portion of the unexplained variation, then we suggest that this can be attributed to noise trader demand. That is, investors are trading on neither fundamental or mortgage market related, but rather they are trading on non-information or nonfundamental information as if it were information.

Lastly, we analyze changes in monthly basis and tracking error. We previously discussed the many market frictions affecting the relationship between those three markets, including differences in contract designs and asymmetric information regarding cash (and, therefore, also derivative synthetic) RMBS performance. As a result of such frictions, our modeling strategy estimates basis spread differences between the contracts while controlling for relevant characteristics between the markets that could give rise to natural differences in prices. Only after we properly control for such differences can any residual be considered an element of irrational market behavior.

When analyzing the arbitrage relationship between the cash and derivative securities, we look at factors impacting the ABCDS-bond basis. The ABCDS-bond basis, represented by Equation (17), is the difference between the particular ABCDS spread (denoted $ABCDS_t$ at time *t*) and the spread of the corresponding RMBS bond's yield over LIBOR (denoted $bond_t$ at time *t*).[39] Market participants would then search for arbitrage opportunities by examining differences between these spreads. A positive basis, meaning the ABCDS spread is higher than the bond's credit spread, indicates that the

[39] All of the constituent bonds of the ABX index are floating rate and therefore, by convention, their spread is defined over LIBOR. For fixed rate RMBS bonds the spread would be over the Treasury yield with a closely matched maturity.

ABCDS is undervalued relative to the bond. A negative basis means that the bond is undervalued relative to the ABCDS.[40]

$$Basis_t = ABCDS_t - Bond_t \tag{17}$$

As discussed previously, there are little to no differences or frictions between the markets for the relevant constituent single-name ABCDS contracts and the ABX. The only drivers of mispricing we expect are transaction costs because a single ABX subindex is equivalent to a portfolio of 20 single-name ABCDS. For an investor with a strategy that desires exposure to the 20 ABX subindex constituent RMBS bonds, it is more efficient to establish a position with the ABX and incur the costs of one transaction, rather than establish positions in 20 separate ABCDS contracts and incur costs with each transaction. Because basis is the general term that describes the relationship between a cash and a derivative security, we call the spread difference between the ABX index and its ABCDS portfolio "tracking error," instead of basis to more clearly and properly distinguish between the basis in the cash RMBS-ABCDS spread relationship.

We define tracking error as the difference between an ABX subindex and a bond weighted portfolio of factor adjusted ABCDS contracts written on bonds referenced in the ABX subindex[41], shown in Equation (18). Factor adjustments are used to reflect amortization and any writedown of bond principal. A positive (negative) synthetic pricing spread would indicate that the ABX subindex is overvalued (undervalued) relative to the ABCDS portfolio.

$$TrackingError_{i,t} = ABX_{i,t} - \frac{1}{n}\sum_{j=1}^{n} ABCDS_{j,t} \tag{18}$$

In Equation (18), $ABX_{i,t}$ is the spread of the i^{th} subindex of the ABX at time *t* and the following term is the average spread at time *t* of the *n* different ABCDS that make up that subindex.

To explore the basis and tracking error relationships, we separately regress monthly levels of each mispricing term on their lagged values, collateral performance measures, contractual difference variables, and market factors. The regression specifications are:

$$\begin{aligned} Basis_{i,t}^{Rating} &= \beta_0 + \beta_1 Basis_{i,t-1}^{Rating} + \sum \beta X_{i,t,Credit}^{Rating} \\ &+ \sum \beta X_{i,t,Contract}^{Rating} + \sum \beta X_{i,t,Market}^{Rating} + \varepsilon_{i,t}^{Rating} \end{aligned} \tag{19}$$

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[40] The arbitrage trade for a positive basis would be to sell the basis. That is, sell the cash bond and sell the ABCDS, which is the equivalent of establishing a short credit position and a long credit position, respectively. For a negative basis trade, an investor would go long the basis by buying the ABCDS and buying the cash bond, which is the same as gaining a short credit exposure and a long credit exposure, respectively.

[41] See the ABX definition in Markit Group Index Annex Archives (URL:http://www.markit.com/Documentation/Product/ABX)

$$TrackingError_{i,t}^{Rating} = \beta_0 + \beta_1 TrackingError_{i,t-1}^{Rating} + \sum \beta X_{i,t,Credit}^{Rating} + \sum \beta X_{i,t,Contract}^{Rating} + \sum \beta X_{i,t,Market}^{Rating} + \varepsilon_{i,t}^{Rating} \quad (20)$$

Credit features account for the performance of the underlying mortgage collateral and the changing dynamics of the cash flow waterfall due to deal mechanisms. Further, we include contractual feature controls because even in markets with frictions, non-zero basis or non-zero synthetic pricing spreads are not necessarily an indication of mispricing between markets. Contractual factors are related to the differences in contract features between the securities that gives rise to a relatively normal spread difference between the securities. Market factor variables are related to changes in activity in the markets, which would drive mispricing beyond what would be considered "normal" due to the contractual differences.

C. Data

In order to compute our spread variables, we collected data on the cash bond, ABCDS, and ABX spreads for the period of the inception of the ABX to December 2010. We start at the inception because we want to test whether the ABX did track the relevant constituents at some time, even if such tracking departed as the financial crisis gained momentum.

We obtained the daily ABX spreads and prices on the constituent subindexes from Bloomberg and the Markit Group for the entire period. Markit also provided daily ABCDS quotes from major market participants for the period. Markit filters the quotes to remove extreme outliers and stale observations. If there are at least 3 quotes left after the filtering process, Markit averages the remaining quotes and reports the composite spread. Bond yields were obtained from Thomson Reuters for the 400 RMBS referenced tranches in the ABX index, but those are only available from July 2007 to December 2010.

The cash bonds typically (even during the pre-crisis period) traded in OTC markets at wide spreads of 6% or more on a normal trading day. We hoped to include multiple measures of cash bond prices in order to illustrate the range of daily pricing and use that to calibrate tracking error. In our efforts, we also collected marks from Interactive Data Corp. (IDC) for the same time period. We sought to obtain marks from a third source to triangulate our estimates, but were unable to find a third due to consolidation in the industry since the 2000s. One important difference between the IDC and Thomson Reuters series is that Thomson Reuters provides bond prices and yields whereas IDC provides bid and ask quotes. Still, analyzing the price data from the two sources helps to illustrate the opaque and illiquid nature of the market. Thomson Reuters reports only one price, while IDC reports the bid and ask quotes. Therefore, to compare the two data sources, we took the month-end price from Thomson-Reuters and matched it with the month-end mid-point from IDC over our 42 sample months.[42]

[42] For some of the observations, IDC provides both the bid and ask, otherwise only bid is available. If the ask is unavailable, the midquote is set equal to the bid.

The difference between the two series is statistically different from zero in 28 of the 42 months. In 7 of the 42 months, the difference is statistically positive, meaning IDC prices are higher than Thomson Reuters. While in 21 of the 42 months, the difference is statistically negative, indicating IDC prices are on average lower. Nineteen of the 21 months occurred consecutively from March 2008 to September 2009.[43] Thus, the differences become wider as the crisis progresses, and narrows as it subsides.[44]

To further illustrate the pricing challenges of the cash RMBS bond market during the sample period, we plot the monthly average price difference (IDC less Thomson Reuters) for each ABX subindex across the four vintages in Figure 2. With each successive vintage, price differences become less volatile overtime due to fewer bonds outstanding toward the end of the sample period. Vintages 1 and 2 have the longest duration of pricing differences. With the exception of the AAA subindexes, the price difference is mostly negative from July 2007 through mid- to late-2009. When the price difference is negative, the pricing marks obtained from IDC are lower than Thomson. After early- to mid-2009, monthly price differences for these two vintages hover around zero. For the third and fourth vintages, price differences are negative through late 2008 at which point all credit subindexes, except the AAA, have price differences that converge to zero. Bonds in the lower rated subindexes in these vintages are written off more quickly than in the first two vintages, which results in the early convergence.

[FIGURE 2]

While, lacking a third source, we cannot be sure we are able to capture the entirety of the relevant range. Also, by being limited to prices – rather than yields – we cannot implement the IDC marks into the estimates we show here. We have reason to believe that limiting our analysis to one set of marks biases our results to rejecting *rational* tracking, rather than accepting irrational tracking. That is, if we can estimate basis with our single yield series, such estimation constitutes reliable evidence that cash RMBS, ABCDS, and the ABX tracked one another in a rational manner.

D. Collateral Performance

D.1. Credit Performance Variables

Our research questions center on the credit performance of the underlying mortgages in a RMBS deal while taking into account the unique structural features contained within each deal. Since this is the first paper to use measures of cash flow dynamics to explain the pricing of credit

[43] One potential explanation for the negative mean difference may be the valuation methodologies between Thomson Reuters and IDC. Pricing documentation from Thomson Reuters states that they use prices obtained from market participants, trades, and dealer quotes as well as use historical and projected prepayment speeds and loss scenarios to determine a fair market value. IDC provides much more detail into their valuation methodology. In the absence of an actual transaction, IDC will provide an independently determined valuation, which depends on the verification of tranche cash flows to confirm deal structure. The verification process involves inputting actual pool and loan level collateral information from the trustee into Intex to generate tranche cash flows, which then will be compared to actual cash flows. If the information on cash flows and deal structure cannot be confirmed or obtained, IDC will discontinue providing marks until it can be verified. For both sources, it is important to note that we are unable to determine whether the data provided is based on actual transactions, indicative quotes by dealers and market makers, or independent, in-house valuations.

[44] These results are not reported for brevity, but are available upon request.

performance in cash and derivative markets, we will describe our variable construction methodology in great detail.

Information on the credit performance of the underlying RMBS deals comes from monthly aggregate RMBS deal-level remittance reports. The remittance reports illustrate the amounts to be paid to investors as well as collateral and other relevant deal/pool performance on a monthly basis. For all ABX deals, the report is released on the 25th of every month. If the 25th falls on a weekend or holiday then it is released on the next business day. Each report provides aggregate details about the performance of the collateral (i.e. mortgages), the relevant triggers, and other details about each RMBS deal.

A variety of vendors seek to standardize and release the data from these reports, but we have found that their releases are often inaccurate compared to the original reports. Thus, we rely on the original data for our baseline analysis and use differences from (and among) several of the vendors' numbers to quantify our "information quality" variable.

We have two baseline performance measures based on subordination levels. The first is the monthly **change in subordination percent** for each tranche. The subordination percentages are collected directly from the remittance reports by taking the difference between the current subordination percent from the previous month. Subordination percentages change overtime as the credit support for each tranche is impacted by collateral performance. Senior tranches will have higher amounts of subordination to protect against losses while junior tranches will have the least amount. We include monthly change to account for increases/decreases in credit protection for each tranche. A positive (negative) value means there is an increase (decrease) in subordination, indicating there is a larger (smaller) cushion to absorb any losses the deal may experience. In the absence of short-selling constraints, both bond yields and CDS spreads should rise as subordination decreases to account for the increase in credit risk.

Assuming short-selling constraints in the cash markets inhibit investors from acting on any negative expectations, we expect a negative relationship between changes in subordination and the basis. The logic is that as the credit support provided by subordination declines, investors will demand more insurance to protect them against losses without seeing as dramatic of a price response in the cash market due to the short-sale constraints. This will drive ABCDS spreads up relative to the RMBS credit spread, which increases the basis.

The second measure based on subordination is a **current loss indicator variable** that is equal to one if the bond is currently absorbing the losses for the deal, and a zero otherwise. Each bond has an attachment point, which is the level of subordination that is available to absorb losses. Once subordination reaches zero, then that particular bond no longer has protection and will take on the losses. Being a current loss bond has direct implications on credit spreads. If the bond is currently taking on losses, then the expected cash flows received would decrease as the likelihood of not receiving cash flows is higher, and as a result, bond yields will increase. In the ABCDS market, if a bond is currently experiencing losses and is very thin, bond holders would not demand credit protection. As a result, the basis would narrow. Therefore, we expect a negative relationship between the current loss indicator variable.

Our next two baseline credit performance variables of interest deal with critical cash flow triggers unique to each deal: the acceleration trigger and the loss trigger (and our calculated distance to this trigger).

The **acceleration feature** variable translates the acceleration status reported in the remittance reports to a dummy variable, which takes on the value one if the current OC value drops below the target amount and zero otherwise. The expected coefficient differs depending on the credit rating of the subindex. We expect a positive relationship between the acceleration feature and yields on the lower tranches because an active feature means that cash flows are being diverted away from the lower tranches. To the extent that bond market participants are able to express these negative views in the cash market, we should see bond prices decline and yields increase. If short-selling constraints prevent this, then investors can alternatively establish short credit positions in the derivatives markets by buying protection, driving ABCDS spreads up. As a result, we expect to see a positive relationship between the acceleration feature and the basis as investors use ABCDS positions to buy protection on the lower rated tranches, and those spreads rise relative to the underlying cash bonds. The opposite should generally be the case for senior tranches that benefit from acceleration, but for the fact that the expected life of such tranches will be shorter than expected previously. Since we only seek to measure the rationality of the basis, decomposing the benefit of greater certainty and the drawback of shorter maturity is beyond the scope of the present work.

The **distance-to-loss trigger** is calculated as the difference between a threshold value and the actual percent of net cumulative losses; this is represented by Equation (21). We examined each deal's prospectus, supplement, and pooling and servicing agreement (PSA) and documented the definition of loss for each deal, and collected upward sloping loss percent schedules. The loss threshold percent for each deal i and month t, $Threshold_{i,t}$. Aggregate loss is generally defined as the cumulative realized loss amount reduced by any subsequent recoveries, and the percent is calculated as the ratio of aggregate net losses to the initial pool balance, $Agg.Realized\ Loss\ Percent_{i,t}$.

$$\text{Distance-to-}Loss\,Trigger_{i,t} = \left(Threshold_{i,t} - Agg.Realized\ Loss\ Percent_{i,t}\right) \qquad (21)$$

When the trigger is breached, the measure becomes negative. That mathematical specification is appropriate because it is possible for the deal to *pass* this trigger test after it has previously *failed* it. If the trigger is no longer in effect, then cash flows will return to the lower rated tranches. As a result, the distance past trigger breach would be important to investors as it may indicate whether payments will both halt for some classes or resume to classes that are currently locked out.[45]

We expect a negative relationship with distance-to-loss trigger. When the distance is positive, then investors should have an expectation of higher cash flows compared to if the distance was negative. As the distance becomes shorter and then negative, then the expected cash flows would

[45] As discussed above with respect to cusping securities, the volatility of losses and recoveries in the local region around the breach level can lead to securities trading like options. While interesting, such optionality is beyond the scope of the present study that merely limits itself to accounting for tracking error rather than valuing certificates.

decline, causing spreads to increase. Again, provided that short-selling constraints prevent investors from expressing their negative view of lower expected cash flows in the cash RMBS market, then the ABCDS should responds more, driving basis wider.

Another credit performance measure we consider takes into consideration the difficulty of interpreting the information provided in the trustee reports, which adds another dimension of economic uncertainty. As aforementioned, third-party data vendors aggregate and maintain monthly deal performance variables for large portions of the MBS universe to provide investors access to historical MBS performance data in one convenient location. The primary source for all of the data collected by the data vendors comes from the monthly remittance report, so in theory, the data provided by all third-parties should be the same, however they are not, which allows us to create a variable to measure information quality.

Although the aggregate loss definition is consistent across most of the deals, potential problems arise for investors due to poor **information quality**. We measure quality of information by looking at the discrepancies in aggregate loss among the three data sources we use for deal level collateral performance information - ABSNet, BlackBox Logic, and the actual hand-collected remittance reports for each deal. The coefficient of variation across the three deals as described in Equation (22) is calculated for each deal, i, for each month, t, in the sample.

$$Poor\ Info\,Quality_{i,t} = \frac{\sigma\left(Aggregate\,Loss\right)}{\mu\left(Aggregate\,Loss\right)} \tag{22}$$

In Equation (22), $\sigma\left(Aggregate\,Loss\right)$ is the standard deviation of the aggregate losses on deal i in month t and $\mu\left(Aggregate\,Loss\right)$ is the mean of the aggregate losses on deal i in month t.

A high coefficient of variation means that there are large differences across the data sources, indicating there is poor information quality. While a low coefficient of variation means the three data sources are relatively similar in the numbers they record, which is a sign of good information quality, there should be a temporal trend in the measure. Any measure of quality based on aggregate losses will tend to start low and trend higher based on the fact that early in the life of a deal there are little to no losses recorded, but as time passes more losses will be recorded. To the extent that investors recognize the information risk, we expect a positive correlation, which suggests that as information becomes less reliable (i.e. a higher poor information quality proxy), then the CDS basis would widen, as investors demanded more credit protection because short-sell constraints prevent them from demanding more return in the cash bond market.

The predicted relationships between each of these credit measures and spreads for cash RMBS bonds, single-name ABCDS contracts, and the ABX are summarized in Table IV.

D.2. Characteristics and Time-Series Properties

Figures 3 through 7 plot the subordination percentages over time for each credit rating. Each figure contains four panels, one for each vintage. Each gray line in a panel represents the individual subordination percentages for each of the 20 bonds in the ABX subindex and the thick black line is the average across the 20 bonds. As is evident in Figure 3, the first vintage has the highest current percent of subordination, but with each vintage subordination levels decrease overall. This same trend is evident in all subindexes.

[FIGURES 3-7]

Over time within a vintage, subordination begins the sample period on a decline, but then increases slightly toward the end of the period for the AAA rated bonds and for a few of the AA bonds (Figure 4). That may occur due to prepayments or a decrease in monthly losses, which increases the excess spread for the month. For the A, BBB, and BBB- subindexes (Figures 5, 6, and 7), most bonds experiences an overall decrease in subordination until it reaches zero, indicating the bond no longer has any credit support from the lower tranches and will be the next in line to receive losses. This is how we identified current loss bonds. If bond A had a subordination percent of zero and the next highest bond had a nonzero subordination percent, then we coded the bond A as the current loss bond with an indicator variable that takes on the value of 1, and zero otherwise.[46]

For the BBB and BBB- subindexes, subordination percentages decline quickly to zero for the majority of bonds, especially for the successive vintages, suggesting that subordination levels were not high enough to sustain losses from the deteriorating credit collateral performance across vintages. For these subindexes, bonds were quickly written down as losses completely wipe them out. During 2009, these two credit rating subindexes across vintages lost more than half of their bonds.

For most tranches, only changes in subordination percent will be a tranche level measure. For three deals, the loss thresholds are tranche specific, but for all others they are at the deal level.[47] Figures 8 and 9 show these measures over time graphically for each vintage. Each gray line represents a deal for a total of 20 gray lines per vintage. For the deals with tranche specific measures, only the mid-level (the A-rated) tranche was plotted. The thick black line shows the average across all deals over time.

[FIGURES 8-9]

For the distance-to-loss trigger[48], most deals begin the sample period in July 2007 above zero, indicating no trigger event. Over time, the majority of deals across all four vintages cross threshold values, represented by lines below zero, signifying a breach of trigger. One interesting aspect of these graphs is the wide range of performances across deals within the same vintage. Tables II and III show the mean and standard deviations for the distance-to-loss trigger variable as well as the poor information quality measure for every deal in the vintages issued in 2006 and 2007, respectively.

For deals with tranche specific distance trigger measures, these were averaged across tranches and then averaged over time. There is no discernable pattern for deals within a vintage or across vintages, but the range for each variable is considerable. It is this heterogeneity of performance measures for deals within the same vintage from which the market had to ascertain information. Given

[46] The next more senior bond for a deal is not necessarily the bond included in the next highest credit rated ABX subindex. Instead, we examined the original subordination levels for each tranche within the deal to determine tranches above and below the tranches included in the subindexes.

[47] FFML 2006-FF4, GSAMP 2006-HE5, and SVHE 2006-OPT5

[48] Recall that aggregate loss variable used in the distance-to-loss measures is calculated as the ratio of aggregate net losses to the initial pool balance.

that Markit Group designed each vintage to be comprised of mortgages with the same origination and with the same collateral criteria, there is little similarity in the performances, so it is reasonable to expect that market participants were pricing this varying economic uncertainty in performance exhibited by the deals within the index.

[TABLE II]

[TABLE III]

Graphically, returning to Figure 8, the variation across deals within a vintage may be most clearly seen in the distance-to-loss trigger. By the end of the sample period in December 2010, the distance to loss trigger for each vintage has a range of 0.1520, 0.2206, 0.2612, and 0.2608 for the first vintage to the last vintage, respectively. Further, the distance to loss trigger measure exhibits a nonlinear trend. In the beginning of the sample period there is little change in the measure, but as the financial crisis progresses the change in distance to loss accelerates during the first quarter of 2008. Around the beginning of 2010, the trend flattens again as the distance to loss measure becomes more stable. During this time, market participants knew collateral was performing badly, but were concerned with how much worse it would get. To account for the speed and the acceleration of the distance to loss, we include its change and squared term as variables in our empirical analysis. The acceleration in deal losses would be of great concern to investors, especially those in the higher rated tranches as the economic uncertainty surrounding the deteriorating collateral increased.

E. Contractual Features

Fundamental or contractual features are essentially differences in the "nuts and bolts" of a security, which should give rise to a "normal" level of mispricing between securities. In other words, there should be relatively stable differences in prices between securities simply because of security characteristics. We will note here that there are more technical differences between cash bonds and ABCDS contracts than between ABCDS and the ABX. As mentioned in previous sections, ABCDS contracts and the ABX index have many of the same features, so the primary driver of ABX tracking error due to technical reasons arises because of transaction costs. To establish the same credit exposure as an ABX subindex, an investor would have to purchase 20 individual ABCDS contracts, which is 19 more transactions than simply buying or selling the index. As a result, the main emphasis in this section will be on the difference between the cash and ABCDS markets due to upfront funding costs, interest shortfall caps, and counterparty risk.

Funding costs are an important decision-making input for investors and will impact how an investor determines their strategy for gaining any preferred exposure. In the cash bond market, investors are restricted to long-only positions and must fully fund the entire investment upfront, but no ongoing payments are required to maintain exposure. This is in contrast to the single-name ABCDS market and the ABX index where full funding is not required. Instead, the ABX index trades with an initial cash exchange upfront which is the difference between par and the price of the index. If the ABX is priced below par, the buyer makes a payment to the seller, and if the index is priced above par, the seller makes a payment to the buyer. After several PAUG template releases by the International Swaps and Derivatives Association (ISDA) in 2005 and 2006, the single-name ABCDS market moved to trading with an upfront cash exchange, similar to the ABX index, and both synthetic markets require ongoing payments in the form of fixed coupons.

If we assume investors use the repo market for funding, then the funding feature of cash bonds is not valuable to the buyer at rates above LIBOR, but the funding feature of ABCDS and ABX is.[49] As a result, for par-priced or above par-priced bonds, the ABX and ABCDS spreads should trade tighter to the cash bond market, thus the basis should be lower or more negative. If bonds are trading below par, which all of the bonds in our sample do, the basis should be lower because there is less to fully fund or finance in the cash market.

We control for the funding requirement by including a variable that is the difference between the general collateral repo rate and 3 month LIBOR, which were collected from the website of the Federal Reserve Bank of St. Louis.[50] This variable should have a negative relationship with the basis. If the difference between rates is increasing this indicates that financing the cash bond is becoming more expensive, resulting in a lower basis. If the difference between rates is decreasing, then financing is becoming cheaper, resulting in a wider basis.

The last structural factor we discuss is **counterparty risk**. Only investors who establish positions in the credit derivative markets are exposed to counterparty risk, which is the risk that the opposite party fails to uphold its contractual obligations. For an ABCDS or ABX index buyer, there is not only risk that the underlying bond(s) will experience a credit event, but also risk that the protection seller defaults. This risk may be exacerbated if the protection sellers have an increased default correlation to the referenced assets on which they are writing protection, which was a concern during the financial crisis.[51] For example, the risk that Bear Stearns would not be able to uphold its contractual obligations was a concern for CDS participants as Bear experienced liquidity problems caused by mortgage related products in early 2008. One portfolio manager was quoted saying, "With Bear having such a large CDS counterparty position, you don't want to have that $45 trillion market come apart." When asked about an all-out boycott of Bear Stearns CDS, one trader at UBS stated, "Overall counterparty risk is a concern, but no one is saying no, they are just taking a wait-and-see approach."[52]

Counterparty risk is also a concern for the protection sellers in both ABCDS and the ABX index, but to a lesser degree. The protection seller is not only at risk that the buyer will cease making payments, thus prematurely terminating the contract, but also at risk the buyer will be unable to make payments if a reverse credit event occurs, thus breaching contract. If the ABCDS spread increased since the initial sale of credit protection, the seller will be required to record an actual loss.

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[49] Other factors, such as margin requirements and "haircuts" further complicate the model, so we acknowledge them, but do not include them for the sake of parsimony in our empirical specifications.

[50] We also ran the model using 1 month and 6 month LIBOR, for robustness, and reached similar results. These are available upon request.

[51] This is referred to as "wrong way risk" or WWR. WWR is now commonly controlled for in CDS studies (see, e.g. Du, et. al. (2016)), but the first published paper to refer to an exposure as being "wrong way" was Finger (2000).

[52] Both quotes are from a March 14, 2008 Dow Jones Capital Market Report, "Fears About Banking System Mount on Bear Stearns."

To control for counterparty risk, we calculate a counterparty risk proxy, similar to that introduced in Morkoetter, Pleus, and Westerfeld (2012). We calculate the arithmetic mean of CDS spreads of the 15 banks of market makers in the ABX index, which is represented by Equation (21).[53]

$$Counterparty\ Risk_t = \frac{\sum_{i=1}^{15} CDS_{i,t}}{15} \tag{21}$$

We use the 5-year CDS spreads from Markit, which is filtered using the same process as the ABCDS spreads. We assume the counterparties of the ABX index are the 15 banks that are designated to be market makers of the ABX index. Identifying the counterparties in single-name ABCDS transactions is not possible. Since we are analyzing the basis between bonds from deals in the ABX index and the CDS written on those bonds, we assume that the 15 banks that are designated market makers in the ABX index also participate in the single-name ABCDS market as protection sellers. There should be a negative relationship between counterparty risk and the basis. As concerns that protection sellers may be unable to uphold their end of the contract, investors will demand less credit protection, which will decrease the CDS spread, causing the basis to trade tighter.

The predicted relationships between each of these factors that control for contractual differences between the cash and synthetic markets and spreads for cash RMBS bonds, single-name ABCDS contracts, and the ABX are summarized in Table IV.

F. Market Factors

Market or trading factors cause deviations away from the "normal" basis. Factors such as short-selling constraints (related to the depth of the market for CDS-based insurance) and broader market risk would be expected to affect basis and synthetic pricing spreads.[54] Those changes between the cash and synthetic credit derivative market based on these factors convey information about changes in the activity of market participants and may indicate an arbitrage activity.

Short-selling constraints in the RMBS cash bond market may prevent negative views about the performance of the underlying collateral from being fully reflected in the price. Similar to Stanton and Wallace (2011), we include a **short interest ratio** to serve as a proxy for insurance demand imbalances. However, we calculate it as the market value of shares sold short over the average daily trading volume for the month using the financial services ETF (Ticker: XLF). The short interest ratio can be interpreted as the days to cover a short position. The higher the ratio, the longer it takes a short seller to completely close their short positions if asset prices begin to increase. As a result, this ratio

[53] There are 16 banks in the consortium that assist in the construction of the ABX index, but RBS Securities and Greenwich Capital were owned by the same parent company, so there is only one CDS written on them. That is why there are only 15 CDS in the counterparty risk proxy.

[54] While we acknowledge that liquidity is an important factor that can limit arbitrage, we do not explicitly include variable for it in our model because that is endogenous to many of the factors already included. For instance, funding costs are inextricably related to liquidity.

can be interpreted as a bearish signal if it increases, and a bullish signal if it decreases. In other words, we expected a positive relationship to the basis. The intuition behind this measure is that if the market is bearish on the financial sector, then there would be an increase in demand for insurance to protect against losses due to mortgages. We collect data on the short interest and daily trading volume of the financial services ETF (Ticker: XLF) from Bloomberg.

Broader market risk is also a factor that can impact the demand for credit protection. The rationale behind this control variable is that if the general market declines, it negatively impacts the balance sheets of financial institutions. Further, it may reflect market expectations of a recession, which would impact borrowers' ability to make payments on their mortgages. We include **returns of the S&P 500 index** to account for the impact of a broader market risk calculated with data from Bloomberg.

The yield curve describes the fixed income market's expectations of future changes in economic growth and inflation, so we include a **yield curve slope** variable, defined as the difference between the 10- and 1-year constant maturity Treasury rates. Expectations in growth and inflation would influence prepayment and defaults, which would impact the expectation of cash flows received by the deal from the underlying mortgage pool. Further, we include the **monthly change in the 10-year constant maturity Treasury rate**, which was obtained from FRED, to control any cash flow discounting effects.

The predicted relationships between these market measures and spreads for cash RMBS bonds, single-name ABCDS contracts, and the ABX are summarized in Table IV.

G. Descriptive Statistics

Table V presents the summary statistics used in the regression analysis that follows. All variables are calculated on a month-end basis from July 2007 to December 2010. We include ABCDS and bond spreads from which the basis is calculated for reference. These three variables are the most interesting. The average basis is 6,164.13 percent with a standard deviation of 6. While this may seem unreasonable, the mean, minimum, and maximum ABCDS and bond spreads confirm this. Further, we confirmed with ABS traders during the financial crisis that such spreads were observed in the market environment at the time. Traders were trying to value and model increases in expected default beyond historical averages as well as value disrupted cash flows as deal triggers were breached, reprioritizing waterfalls. The ABX tracking error variable is narrower with an average of 202.22 percent, which is to be expected, as this is the relative mispricing between the ABX index and its corresponding portfolio of ABCDS.

[TABLE V]

One concern regarding our collateral performance measures may be that they are too closely correlated. That is, all of the features within a RMBS deal are functions of each other, so it may be difficult to isolate the effect of one without introducing multicollinearity with respect to others. Tables VI and VII present the variables included in the basis and tracking error regressions. For the tranche level data, which are found in Table VI, only three relationships have an absolute value correlation of greater than 0.5. Lagged basis and basis are highly correlated at 0.84; short interest ratio and counterparty risk are negatively correlated at 0.75; and counterparty risk and funding costs are positively correlated at 0.59. However, none of the collateral performance measures are highly correlated with each other, suggesting that each captures a different effect.

[TABLE VI]

The correlation for the variables in the tracking error models are presented in Table VII. Similarly to the variables in the basis regressions, these variables are relatively uncorrelated. Again, short interest ratio and counterparty risk as well as counterparty risk and funding cost are highly related, as was the case in the basis regressions. The only other variable with a high degree of correlation is the relationship between tracking error and lagged tracking error, which are highly correlated at 0.90. None of the factor adjusted bond weighted collateral performance measures are highly correlated with one another, leading us to believe that each captures a different aspect of the MBS performance.

[TABLE VII]

VII. Empirical Results

A. VECM Results

We begin by examining the price discovery process across the cash and ABCDS markets by using the vector error-correction model (VECM) defined in BBM using daily data. First, we tested for cointegration in the relationship between ABCDS and bond spreads with structural breaks on the remittance report dates. Using the Johansen et al. (2000) testing procedure to account for the structural breaks on the report dates for each individual constituent, we construct asymptotic critical values based on the proportion of the sample that occurs for each break. Then for those relationships that are cointegrated, we run the exact specification as BBM on each of the individual constituents of each subindex. Lastly, we modify the models by adding an indicator variable for the report release date to identify how the information from the remittance reports flows to the markets. Both models rely on the fact that the securities are closely linked by arbitrage.

Recall that for both models, the λ's are interpreted as how the traders in each market respond to the price discrepancy between markets. If price discovery occurs in the bond market, we expect λ_1 to be negative and significant as the bond market adjusts to any price discrepancy or error between markets and the ABCDS market lags behind. If price discovery occurs in the ABCDS market, λ_2 will be positive and significant as the ABCDS market adjusts to mispricing between securities. The results for the unmodified BBM models (Equations (5) and (6)) are presented in Table VIII and the modified BBM (Equations (7) and (8)) are presented in Table IX.

Because each subindex contains 20 bonds, we present the result in three panels in Table VIII to make them as clear and concise as possible. First in Panel A of Table VIII, we report the total number of cointegrated relationships for each subindexes in our sample. The second column is the number of constituents available in our data while the third column is the number of cointegrated relationships of those available in our data.

Cointegration appears to depend on vintage and credit rating with the bond-ABCDS relationship becoming less cointegrated as newer vintages are rolled out and as credit ratings decline. The constituents in the AAA and AA rated subindexes for all four vintages are mostly cointegrated at 95-100%. For the A rated subindexes, the bond-ABCDS relationships for constituents in the first vintage are mostly cointegrated at 95%, but then decline across vintages (2006-2 with 84%; 2007-1 with 79%; 2007-2 with 80%). The same trend can be seen in the BBB and BBB- subindexes across vintages. For the BBB subindexes, the first vintage has 68% of our sample cointegrated, and for the second, third and fourth vintages, it declines to 32%, 22%, and 25%, respectively. Likewise for the BBB- subindexes, 53% of our sample is cointegrated for the first vintage, and then that percentage falls to 17%, 26%, and 28% for each successive vintage, respectively.

In the remaining columns of Panel A (Columns 4 through 7), we show the mean and median values of the speed of adjustment coefficients for each market for only those bond-ABCDS relationships that are cointegrated. These values include both significant and insignificant coefficients.

[TABLE VIII]

The mean value for $\lambda_1$is mostly negative, with the exception of ABX 2006-2 BBB. For this subindex, the median value is negative, indicating that there are some bond-ABCDS relationships that are positively skewing the mean. Interestingly, λ_2 is not generally positive. In fact for all subindexes in the first vintage (2006-1), with the exception of the BBB- subindex, the coefficient mean and median are negative, which suggests there are some relationships that are skewing the results negatively. For the remaining vintages, the higher rated subindexes have negative coefficient values for λ_2 but as the credit rating decreases this value becomes positive.

Panel B of Table VIII shows a count of those coefficients that are significant at the 10% level. The second column is a count of all the cointegrated relationships where only $\lambda_1$is significant and negative, indicating price discovery occurs in the bond market. The third column is the number of all the cointegrated relationships in which only λ_2 is significant and positive, which means price discovery occurs in the ABCDS market. If both coefficients have the correct sign and are statistically significant, they are reported in the fourth column. If any of the bond-ABCDS results have a coefficient that is significant, but with the wrong sign, it is classified as ambiguous as the interpretation is unclear and is listed in the fifth column. Lastly, if neither coefficient is significant, it is in the sixth column with the header "Neither."

Generally speaking, it appears that the bond market contributes to credit risk price discovery. For the AAA subindexes, neither market contributes, but as credit rating declines, it appears that information begins to flow to the bond market first, thus, contributing to price discovery. In the lowest credit ratings (BBB and BBB-) for vintages 2-4, the ABCDS market plays a significant role. Also, as credit rating declines, for some bond-ABCDS relationships both markets contribute. For these results, we were interested to see which market dominants price discovery, so we calculated the Hasbrouck and Granger-Gonzalo measures, following BBM. Panel C in Table VIII presents these results. None of the 7 relationships where both markets contribute show a clear dominance by the ABCDS market, as indicated by both the Hasbrouck and Granger-Gonzalo measures being greater than 0.50.

Next, we examine the impact of the information release of the monthly remittance report, which are Equations (7) and (8). These results are reported in Table IX. In Panel A we, again, report the mean and median speed of adjustment coefficients for only those subindex constituents with cointegrated bond and ABCDS spreads, but we also include the mean and median values for the coefficients on the report date indicator variables. Adding the report date indicator variable did not materially change the mean and median values for the speed of adjustment coefficients.

Here, we continue our interpretation of the results regarding speed of adjustment before moving to the information flow of the remittance reports (β_1, β_2). Panel B reports the market contributions of price discovery for each security. Again, we find that the bond market generally responds first. We note here that this finding is in contrast to what has been found in the corporate credit literature (Blanco, Brennan, and Marsh (2005), Bai and Collin-Dufresne (2011)) where typically the CDS market leads the cash bond market. However, when we take the processing of remittance report information into consideration, below, we are able to come up with a coherent story for why price discovery seems to lead in the RMBS cash bond market.

[TABLE IX]

For those bond-ABCDS relationships in which both markets contribute to price discovery, we report whether the Hasbrouck and Granger-Gonzalo measures both indicate ABCDS dominance or lead to opposite conclusions. Again, the measures give us conflicting results, leading us to believe that both markets contribute with neither one being more dominant than the other on a consistent basis.

For the report date variable, $\beta_1$indicates how information flows to the ABCDS market based on the release of the remittance report, and β_2 is for the bond market. There are no distinct patterns for these values. For β_1, the mean and median for the higher rated subindexes are mostly non-positive while the lower rated subindexes are mostly positive. For β_2, the mean and median are generally positive. Panel D provides more insight into these results. In this panel, we count the number of relationships in which only one of the two markets responds to the information in the reports (ABCDS Market Only and Bond Market Only) and the number of relationships where both markets respond. Then we break it down further to compare the direction of the response.

The second and third columns show the number of relationships in which the ABCDS market is the only one to respond. Column two shows a positive response (β_1<0) and column three shows a negative response (β_1>0). The fourth and fifth columns are constructed similarly, but for those relationships in which the bond market is the only market to respond. Column four shows a positive response in the bond market (β_2<0), and column five is for a negative response in the bond market (β_2>0). For those relationships where both markets respond, we distinguish those that respond the same way and those that respond differently. If both markets respond positively, it is reported in column 7. If they respond negatively, it is reported in column 8. For columns 9 and 10, both markets are responding differently. In column 8, the ABCDS is a positive response while the bond market is negative and vice versa for column 9.

The most notable result from this panel is that the bond market responds more often and the reaction is generally a negative one. Only for the first vintage does the ABCDS market seem to respond to the reports, and even that reaction is generally positive. With each successive vintage, fewer of the relationships show an "ABCDS only" response to the remittance report information. When looking at times when both markets respond, the result tends to be that both markets respond negatively (5 out of the 10 instances when both respond), especially for the second and fourth vintages and for lower credit ratings.

All of these results lead us to conclude that information flows to the bond market first. One potential explanation for this is that bondholders were waiting for the information in the remittance report then deleveraging in response to the deteriorating collateral performance of the deal. Those long the cash bonds would have to sell at depressed prices in order to entice others to buy, sending the yields higher to reflect the increased credit risk. While this may be a surprising result, considering the extant corporate bond-CDS basis literature concludes that price discovery occurs in the CDS market, we believe it to be entirely plausible given that the RMBS market is different from the corporate bond market in that the channel for transmitting information lacks conformity across securities. The monthly remittance reporting formats differ by trustee and can change at random, whereas investors in the corporate bond market rely on SEC filings, which follow a standard format, ensuring that the same basic information is available for each corporation.

For price discovery in the two synthetic markets (the ABCDS and the ABX index), we repeat the analysis, using the spread of a portfolio of ABCDS for more direct comparison to the ABX index. All of these relationships are cointegrated. The results for the unmodified VECM are presented in Table X and are from Equations (9) and (10). In these results, a negative and significant λ_1 indicates that price discovery occurs in the ABCDS market, while a positive and significant λ_2 suggests that price discovery occurs in the ABX market. These results suggest that credit risk price discovery occurs mostly in the ABX market, especially in the later vintages and lower credit ratings. Only in the first vintage does the ABCDS market seem to contribute significantly for subindexes, with the exception of the AAA subindex. For the second and third vintages, the ABCDS market contributes to price discovery for the AA subindex only. We also report the Hasbrouck (HAS) and Granger-Gonzalo (GG) measures, following BBM. We include the lower, mid, and upper HAS measures. If the lower HAS (GG) measure is greater than 0.5, then the ABX market is dominant.

[TABLE X]

The results of the modified VECM with the report date indicator variable are given in Table XI and are for the regression specifications found in Equations (11) and (12). The results for the speed of adjustment coefficients are similar to the unmodified VECM and both the HAS and GG measures confirm that the ABX market is dominant in price discovery. Perhaps, what is most noticeable is how reactive the ABX market is to remittance report information, as indicated by β_1. In most of the subindexes of the ABX index, the response is significantly positive.[55] It appears that information from remittance reports flow to the ABX market rather than the ABCDS market, but the positive response suggests that the ABX is overpriced relative to the fundamental information in between report releases. This result would suggest that the ABX experiences more noise trading between reports, but

[55] A positive (negative) response would have a negative (positive) coefficient because the dependent is change in spread in the respective markets.

the market responds to the fundamental information when it is release, which anchors the price somewhat back to a fundamental based price.

This is consistent with our hypothesis that noise trading is prevalent in the ABX, which allows informed investors, who are experienced with the lack of standardization of remittance reports, to take advantage of noise trading to exploit fundamental mispricings by engaging in informational arbitrage. In the next section, we further examine the potential impact of noise trading in each market.

[TABLE XI]

B. Noise Trading Analysis

Next, we run a fixed-effects panel regression of weekly changes in bond spread and the spread on the synthetic instruments on our collateral performance, contractual, and market measures based on ABX subindex rating. To account for the serial correlation in these panel data sets, we include a lagged dependent variable and correct the standard errors following the Baltagi and Wu (1999) methodology. We use weekly changes in spread from Wednesday to Wednesday to eliminate noise that may occur due to day of the week effects.[56] Further, in order to retain economic meaning of the model, we eliminate bonds that are on the "cusp" of experiencing losses as these are typically the target of long-short activity and experience dramatic changes in yields.[57] These typically have negative yields in the months they are considered on the "cusp." We identify "cuspy" bonds by looking at the Cook's Distance and eliminating those with Cook's distances that were three times the average distance. This at most eliminated 55 observations, which we assume are the observations when bonds become "cuspy." Next, we remove bonds with negative yields, which total approximately 15 observations. Removing these bonds did not drastically change our sample. Table XII presents the results for the regressions in Equations (11) and (12) for weekly changes in spreads for the bond market and the ABCDS market by credit rating. Table XIII reports the results from the regressions in Equations (13) and (14) for the portfolio of ABCDS and ABX spread weekly changes.

[TABLE XII]

[TABLE XIII]

The model captures most of the variation in bond spreads.[58] The average adjusted R^2 across credit ratings is 73%, with the highest being the AA-rated bonds at 77%, and the lowest for the A-rated bonds at 68%. These results are dramatically different than the results for the single-name

[56] While we are interested in examining the potential impact from noise trading demand, day-of-the-week effect noise would be temporary and short-term, which would most likely not impact the expectations of an informed trader enough to consider. We believe this is a conservative approach, which make any results we find more convincing.
[57] Since RMBS bonds are amortizing (generally from the top) and being written off (generally from the bottom), changes in these spreads should be even more dramatic, which would introduce additional noise. Cusping in the RMBS context refers to securities whose balance is dwindling due to payoff or writedown, and therefore on the "cusp." When there is little remaining balance in a certificate, yields can become incredibly volatile. Again, we believe eliminating this type of noise is a conservative approach.
[58] It has been suggested in the literature that the VIX is a determinant of corporate credit spreads, and some of the extant ABX studies include it in their analyses. As a result, we run separate models including changes in the VIX as an explanatory variable, and our results hold. In fact, the VIX has little explanatory power in the bond and ABCDS markets, and actually decreases adjusted R^2's for both markets. For the ABX results, R^2's are slightly higher with the VIX explaining mostly the lower credit rated subindexes. However, in the PCA analysis the results remain the same as when VIX is excluded.

ABCDS and the ABX. The model appears to capture very little of the variation in credit spreads for the extreme credit rated single-name ABCDS (AAA, AA, and BBB-), but for the A and BBB rated swaps, the adjusted R^2's are approximately 37% and 49%, respectively.

For the ABX index, the average adjusted R^2 is 17%. The AAA rated subindexes have the highest R^2 at 26%, and the AA rated subindexes have the lowest adjusted R^2 at 9%. Much of the explanatory power from these regressions appears to come from the market variables. The return on the S&P 500 is significant and negative for all subindexes, which is the sign we would expect. As the S&P 500 declines, indicating broader market deterioration, the ABX spread increases to reflect an increase in credit risk, perhaps due to anticipation of a recession, which would likely increase unemployment and increase missed payments. For the credit performance variables, the distance-to-loss trigger is significant in the higher rated subindexes, while information quality is significant in the A and BBB- rated subindexes only.

Considering the model explains less than 20% of the variation in ABX spreads and less than 50% of ABCDS spreads, we analyze the residuals to understand the factor structure of the unexplained variation. Following Collin-Dufresne, Goldstein, and Martin (2001), we perform principal component analysis (PCA) on the residuals of each model to see if there is a dominant systematic component.[59] After controlling for credit, contractual, and market variables, we do not expect there to be a dominant factor in the residuals.

Duffie and Singleton (1997) observe that a structural model with credit and liquidity factors explains only between 35% and 48% of U.S swap rates and that the unexplained variation in the residuals may be driven by supply or demand pressures that are independent of credit and liquidity. As a result, we interpret any dominant systematic factor in our PCA analysis as being supply and demand shocks due to noise traders. We perform separate PCA of the covariance matrix of the combined residuals from the models in Tables XII and XIII.[60]

The PCA results are presented in Table XIV. The second and third columns are the percentages of the residual variation explained by the first and second principal components (PC), respectively. The fourth column is the adjusted R^2 from the results in Tables XII and XIII, which represents the explained portion of spread variation. The fifth column is the unexplained portion, which is simply 1 minus the adjusted R^2. The last column is a simplified calculation of how much of the unexplained portion of spread variation is explained by the first PC. We propose that this is the potential impact of noise trader supply and demand on explaining credit spreads. To calculate this

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[59] Collin-Dufresne et al. (2001) find a dominant, systematic component in the residuals that is not captured by a structural credit risk model. They suggest that their results are driven by local supply and demand shocks that are not based on credit or liquidity factors. Longstaff and Myers (2014) examine credit risk of the equity tranche of collateralized debt obligations (CDO). Similarly, they perform PCA on the residuals and confirm the results of Collin-Dufresne et al. (2001).

[60] We use combined residuals, which is the overall error ($\varepsilon_{i,t}$) and the fixed-error component (u_i). The fixed-error component represents the impact on the changes in spreads of all unobserved variables that are constant across time. This would capture the effect of characteristics about the bond that do not change over time, such as underwriter of the RMBS deal, underwriter of the loans, or shelf registration. It is likely that noise trader demand is affected by these characteristics, which is why we use the combined residuals. For example, some investors may buy only deals of a specific institution, like Goldman Sachs, because of their reputation.

column, we multiplied the unexplained portion and the percentage explained by the first PC (i.e. Column 5 times Column 2).

[TABLE XIV]

For the weekly changes in bond spreads, the first component becomes more dominant as credit rating declines. The first principal component (PC) explains approximately 28% of the variation in residuals for the AAA rated bonds, and 69% of the BBB- bonds. This would be consistent with noise traders, such as speculative traders, concentrating their activity in the most risky assets with the expectation that the risk would be offset by a substantial return. Considering the credit risk model explains approximately 70% of changes in bond spreads and examining the simplified calculation of potential noise trader impact, we conclude that noise trading exists but is not dominant in the RMBS bond market.

In the ABCDS market, the baseline credit model does not explain much of the changes in spreads for the AAA, AA, and BBB- swaps. For these ratings, the first PC explains on average 36% of the residual variation. Given the low adjusted R^2 of the credit risk model and the relatively low percentages of residual variation explained by the first PC, we conclude that noise trading is more prevalent in the ABCDS market than the bond market. However, even though the adjusted R^2's of the baseline credit model are approximately the same for the ABCDS portfolios and the single-name ABCDS markets, the PCA results suggest that there is a systematic component in the residuals for the portfolios. The first PC is more dominant for the portfolios than for the single-name contracts, explaining more than 56% of residual variation for all ratings, except for the BBB- portfolio, which has a first PC that explains 39%. The simplified measure for potential impact of noise trader supply and demand shocks is higher across all credit ratings, except the A-rated, for the ABCDS portfolios than for the single name ABCDS. This leads us to conclude that the systematic component is more dominant in the portfolios than the single name, which suggests that noise trader shocks are more prevalent in trading portfolios than individual swaps.

For changes in ABX spreads, there is clearly a dominant first PC in residual variation for all ratings. The average percentage explained by the first PC is 87%. The first PC of the AA-rated subindexes explains the lowest percentage at 74%, while the first PC of the BBB subindexes explains the most residual variation at 94%. Given the overall average adjusted R^2 of 17% for the ABX weekly changes, this dominant first PC suggests that there is a systematic factor in the residuals. The potential explanatory impact of the systematic component of residual variation is much higher for the ABX index than for all the other markets. Overall these results suggests that noise trading is more prevalent in the ABX, followed by the portfolio of ABCDS, single-name ABCDS, and lastly, the cash RMBS bonds, which is what theory would suggest.

C. Basis Regressions

Next, we examine the arbitrage relationships between the cash and ABCDS markets by running a fixed-effects panel regression of month-end basis on our collateral credit performance measures, contractual difference variables, and market factors from July 2007 to December 2010. We include a lagged dependent to account for the serial correlation in the pricing process and correct for

AR(1) standard errors, following Baltagi and Wu (1999). The results are shown in Table XV and are for the regression specification in Equation (19). We estimate monthly basis in order to focus on the release of new information to market participants. If the bond and CDS markets are fully integrated, we expect the collateral performance and contractual variables to have no impact on changes in basis: both the cash bonds and ABCDS would move together with the addition of new information. Since the two investment types differ somewhat (i.e., due to key differences in contractual features and short-selling constraints for cash RMBS) we expect the basis to exist and to vary in magnitude with respect to some of our key variables of interest.

Although not statistically significant, the variables for changes in subordination and the acceleration feature have the expected signed coefficient (negative and positive, respectively). As subordination percentages decline, basis increases as the demand for credit protection increases for the lower tranches. The effects are statistically insignificant, but are increasing in magnitude moving down the capital structure of the deal. When the acceleration feature is triggered, excess cash flows within the deal are diverted away from junior tranches to those entitled to principal payments in an effort to accelerate bond amortization and restore OC. The acceleration feature exhibits strong monotonicity as credit rating declines, indicating that the lower rated tranches are more sensitive to this deal structural feature. The lowest rated tranches are expected to be the most sensitive to this feature as they are low in the priority structure. As the acceleration feature diverts cash flows away, the demand for credit protection on the lowest tranches increases, causing the basis to widen.

[TABLE XV]

The loss dummy is an indicator variable that takes on the value of 1 if the tranche is experiencing losses from the cash flows of the deal and a zero otherwise. As credit rating declines, though, the impact of tranches currently experiencing losses decreases the basis. This is an intuitive result. The lowest credit rated bonds will be the first to experience loss and will be completely wiped out first. If a current loss bond is not completely written off, but is very thin and trading for pennies on the dollar, bondholders will not be demanding credit protection. The loss indicator variable is capturing the change in demand for credit protection as losses accumulate and bond principal is written down.

The distance-to-loss variable is only significant in the AAA tranches. As this is the highest credit rating and under deteriorating collateral conditions, these bond holders would be concerned with the collateral performance of the underlying mortgage to see if their bonds will be hit by losses. Furthermore, as the bond approaches the loss threshold the demand for credit protection will increase driving the ABCDS spread up and increasing the basis.

Both the change in distance-to-loss and its squared variable are significant at the 1% and 10% levels, respectively. These two measures account for the speed and the acceleration of losses. Speed looks at the rate of change in distance-to-loss whereas acceleration is the change in the speed. When the change in distance to loss changes over time that is what we refer to as acceleration; in other words, it is the second order effect. For example, when losses start to accumulate, the change in distance-to-loss is small and the speed is low. Based on the graphs in Figure 8, the speed of change in distance to loss is relatively low at the beginning and at the end of the sample period. During mid-2008 the change in distance begins to accelerate until late-2009 where the speed becomes relatively constant again.

The poor information quality proxy is significant in the AAA rated bonds only and with a positive impact on basis. For the AAA rated-bonds, when information quality becomes poorer, basis widens, indicating informational inefficiencies have an asymmetric effect on the demand for credit protection from CDS contracts than the demand for greater return in bond yields. That is, the increase in ABCDS spread from the additional demand in credit protection is greater than the increase in bond spread from investors discounting the bond price to account for the risk associated for information quality.

The variables controlling for the contractual differences between the cash and ABCDS markets follow our expectations. Since cash bonds require full funding, we expect the costs associated with acquiring capital to be a significant decision input. When funding costs are higher, our funding cost proxy is lower and we expect the change in basis to be greater, resulting in a negative coefficient. Our regression results show that funding cost impact differs across credit rating. For the AAA-rated tranches, the coefficient is negative and significant, meaning as costs increase then basis will widen. For the lower three tranches, the coefficient is positive and significant for the BBB- tranche. This is most likely due to the fact that the lowest rated bonds were trading at a deep discount to par, which required much less funding.

The impact of counterparty risk is significant and positive on the basis at the AAA, BBB, and BBB- credit ratings and the magnitude increase as credit rating declines. This is consistent with our expectations. As counterparty risk goes up, spreads will increase in the synthetic markets. As a result, the basis will widen.

The short interest ratio can be interpreted as the days to cover a short position. The higher the ratio, the longer it takes a short seller to completely close their short positions if asset prices begin to increase. As a result, this ratio can be interpreted as a bearish signal if it increases, and a bullish signal if it decreases. The intuition behind this measure is that if the market is bearish on the financial sector, then there would be an increase in demand for insurance to protect against losses. We find a negative relationship between the short interest ratio and the AAA rated tranches, which is significant at the 1% level. This result suggests that there were no insurance demand imbalances, which directly contrasts with the results in Stanton and Wallace (2011). One possible reason for this is we use a broader measure for interest in the financial services sector, while they look at short interest as they relate to investment banks. It stands to reason that investors may demand protection on financial institutions other than investment banks because of their exposure to mortgage-related products, which makes our measure more robust. However, for the lower credit rated tranches, short-interest ratio has a positive coefficient, suggesting there is an increase in insurance demand to protect against losses for these securities. Another possible reason for the difference between our results and Stanton and Wallace (2011) could be that we control for additional factors, such as cash flow triggers, whether the bond is currently taking on losses, and contractual features.

To the extent that the S&P 500 reflects broader market risk, only the AAA and AA tranches are significantly affected. The coefficients are negative, indicating that when the S&P 500 declines in value, the basis is driven wider, suggesting that broader market risk may impact investor demand for credit protection.

D. Tracking Error Regressions

Lastly, we run fixed-effects panel regression of monthly changes in ABX tracking error, which is the pricing differences between the ABX index and the ABCDS contracts. The portfolio spread of ABCDS contracts is constructed based on bond weighted average of factor adjusted ABCDS spreads of the referenced bonds in the ABX subindex. As a result, all collateral performance explanatory variables are bond weighted average of factor adjusted measures of each bond's performance measure. Table XVI reports the result and are for the regression specifications from Equation (20).

[TABLE XVI]

The AAA subindexes have fewer monthly observations than the others because the last vintage (2007-2) has missing prices for the last few days for October, November, and December 2007. For AA, there is one missing month, due to missing prices toward the end of August 2007 for the last vintage (2007-2). Those dates occur around the height of the subprime crisis that froze the commercial paper markets in mid- to late-2007, at the height of the "first" subprime crisis. The lack of pricing data for the fourth vintage, which would have contained loans originated in the first half of 2007 when problems in the subprime market were becoming more public, is representative of the hectic markets and high levels of economic uncertainty surrounding the subprime credit markets, resulting in difficulties evaluating credit risk.

Since there are few substantial differences between ABCDS contracts and the ABX index, we expect there to be more arbitrage activity than seen between the cash and ABCDS markets. As there are fewer market frictions, we hypothesize that collateral performance and market factors have little impact on the mispricing between securities. Interestingly, the change in subordination percentages has a significantly negative coefficient, indicating that when subordination levels decline the difference between ABX prices and ABCDS prices increases.

Further, the poor information quality measure is significant at the 10% level for the AAA subindex and at the 1% level for the other subindexes. The coefficient is negative and increases in magnitude as credit rating declines. This result suggests that informed trading activity is concentrated in the derivative markets, perhaps more specifically in the ABX index. To the extent that investors utilize only data from vendors and not data directly from trustee remittance reports, these investors may not be informed enough to access the single-name market, so they abstain from the cash RMBS market and the ABCDS market and focus much of their activity in the ABX index. If the ABX index reflects the views of these investors, informed market participants will be able to distinguish between good and bad information quality and see if ABX prices reflect fundamentals or are noisy. Due to information dynamics, these uninformed investors overprice the credit risk in the ABX, and informed traders, utilizing good information, will recognize the "informational overshooting" and arbitrage the price away. As a result, informed traders supply credit protection via the ABX (sell the ABX since the credit risk is overpriced – spreads are high) and demand credit protection on the portfolio of ABCDS (buy the portfolio as the credit risk is undervalued – ABCDS spreads too low). Arbitrage activity brought on by the overvaluing of credit risk due to poor information quality about deal losses would narrow the pricing difference between the ABX and the synthetic portfolio, which would suggest that informed investors acted reasonably.

VIII. Conclusions

Because each ABX subindex is a single CDS contract, which has the same exposure of 20 ABCDS contracts written on the 20 cash bonds referenced by the ABX index, the three securities (the ABX, ABCDS, and the underlying RMBS bonds) should be priced and traded relative to each other as they all have cash flows based on the performance of the same collateral: the mortgage loans backing the RMBS deals. However, market frictions and, more specifically information costs, impact the level of informed and noise trading in each market, which facilitate mispricing among the markets.

During the financial crisis, the ABX index was not only a gauge for the performance of the entire subprime housing sector, but also an input for mark-to-market accounting mortgage related products. As such, it has been cited as the potential link between the subprime market and the global financial crisis (Gorton, 2009; Longstaff, 2010). Nevertheless, little research has been done on how the ABX index reflected the credit performance of its underlying mortgage collateral (Fender and Scheicher, 2009; Stanton and Wallace, 2011; and Dungey, Dwyer, and Flavin, 2013). This study is the first to look at the market dynamics among the ABX, the underlying ABCDS contracts, and the cash RMBS bonds by examining how each market responds to fundamental and market information and how interactions between informed and noise traders vary across markets using an arbitrage framework.

We contribute to the vast literature on price discovery and limits to arbitrage. First, we show that on average price discovery occurs in the RMBS market and that the information released by the trustee regarding the collateral performance of the underlying mortgages flows to the bond market first. This is in direct contradiction of the corporate bond literature. However, there seems to be good reason to expect this result as it suggests that RMBS bondholders and investors are actively paying attention to the information contained in the remittance reports.

Our results lead us to believe that the full funding requirement in the RMBS market coupled with the high information costs associated with making inferences from the monthly remittance reports and other collateral performance data available mitigated the impact of noise trading in the cash bond market. As a result, this market is composed predominantly of informed traders. We believe that if there was a more standardized channel for information transmission of underlying mortgage performance, similar to what the corporate bond market has with uniform financial statements on firm asset performance (e.g. 10Ks), then the market would not be dominated by informed investors. Additionally, we find that the ABX, on average, responds positively to the information released in the remittance reports each month. This suggest that trading in between report dates was likely driven by noise trading, causing ABX spreads to deviate from its fundamental value. Yet the informed investors recognize that the spreads are higher than the collateral performance of the underlying deals would suggests and trade to bring spreads more in line with fundamentals.

Second, we confirm that when markets are not fully integrated, mispricing will be present. By examining the relative pricing between the cash and ABCDS markets, we find that the basis is primarily driven by credit factors and contractual differences. Specifically, the lower rated subindexes reflect the changes in subordination and acceleration features, which explicitly impact junior tranches through declining collateral protection and reprioritization of cash flows. Those results are likely driven by the short-selling constraints in the RMBS cash market that inhibit investors from acting on any negative views they have on the securities.

Most notably, we find that the AAA rated subindex is only reflecting the change and acceleration of accumulating net losses within the deal in anticipating of losses reaching those tranches and is not impacted by any structural dynamics in the cash flow waterfall. This is in contrast with most of the extant literature on the ABX index, which finds that the ABX index is generally influenced by counterparty risk, broader market deterioration, and illiquidity, and that collateral performance is not a factor.

Further, we find that the quality of information provided by the remittance report is an important driver of relative pricing between the ABX index and its ABCDS portfolio. This result suggests that informed investors recognize that data vendors are not supplying the same data found in the remittance reports, but also recognize that the market is not pricing in the true fundamentals of the underlying mortgages. As a result, they exploit market pricing which appears to be based on poor information quality. For arbitrage to occur, however, noise traders must be present. We show that noise trader demand is likely concentrated in the ABX market, followed by the ABCDS, and lastly the cash RMBS bonds. The more noise trading demand, the more profitable informational arbitrage will be, provided that the arbitrageur does not have a relatively short investment horizon. To perform informational arbitrage, these investors sell the overvalued credit position and long the undervalued credit position, which eliminates some of the relative mispricing in the market between the ABX and the ABCDS contracts.

Our results have implications on future research and policy in the RMBS market, and the ABS market in general. With respect to financial research, models that do not account for the short-selling constraints in the cash market or the varying degree of information quality released by trustees across deals will fail to capture the rational behavior of investors. Unlike equity markets, which have standard information channels (e.g. standard 10K reports, earnings announcements), the ABS market has no uniform reporting standards and as a result, trustees will report collateral performance differently depending on the deal and data vendors may misinterpret trustee reporting as circumstances necessitate changes over time. As a result, when conducting research on this sector, attention must be paid to whether the database correctly reports what the trustee actually records in the remittance reports, which brings us to an important policy contribution.

We hope that our findings will provide impetus to policy makers to standardize a minimum level of reporting for RMBS, whether through identifying certain financial data to be reported or to mandate the application of XHTML protocol so that reporting can be properly aggregated. The financial crisis showed that the sector is far too large to remain non-standardized, though it is still exempt from GAAP and regulatory treatment, despite the widespread use of ABCDS as an input for mark-to-market accounting. If the ABCDS derive their value from the expectation of the performance of the underlying collateral, financial institutions, accountants, and investors should have reasonable access to high quality relative performance information.

Appendix A: Distance-to-Delinquency Trigger Measure Details

In this appendix, we provide the details of the methodology used in constructing the distance-to-delinquency trigger measure.

The **distance-to-delinquency trigger** variable is calculated as the difference between a threshold value and the actual percent of delinquencies; this is represented by Equation (24). We examined each deal's prospectus, supplement, and pooling and servicing agreement (PSA) and collected the percentages and percent schedules for thresholds, depending on the type of threshold, documenting the definition for the credit enhancement percent if it applied to a deal's trigger definition.[61] We used these definitions to construct a threshold percent for each deal i and each month t to give us $Threshold_{i,t}$ and percent of delinquent loans for each deal i and each month t to give us $DQ\,Percent_{i,t}$

$$\text{Distance-to-}DQ\,Trigger_{i,t} = \left(Threshold_{i,t} - DQ\,Percent_{i,t}\right) \qquad (24)$$

We identified 8 different definitions on how a loan is classified as 60 plus day DQ based on the wording and grammatical usage in the pooling and servicing agreements (PSA). These are listed in Table XX and are all different combinations of loans that have payments which are late by 2 months or more, in foreclosure (FCL), in bankruptcy (BK), or real-estate owned (REO). Only definition 6 includes loan modifications.

Consistent across all deals was that the delinquency trigger is based on the balance of 60 plus day DQ loans, but one problem encountered when developing this measure is in how the remittance reports report delinquency data. While it is convenient to think of 30, 60, 90+ day delinquencies, REO, foreclosures, and bankrupt loans as 6 separate buckets, they are not actually classified this way. This is why in Table XX some definitions will have a type of loan in parenthesis to distinguish that these must also be 60 days or more delinquent. For example, in definition 3, bankrupt loans are in parenthesis, indicating that these types of loans will only be included in the delinquency percentage if they are also classified as 60 days or more delinquent. A loan that is in bankruptcy that is classified as 30 days delinquent would not be included.

Some remittance reports will stratify all of the loans into well-defined groups while others provide minimum information about the loans and their classification.[62] To overcome the data challenge with loan classification, we used loan level data available from ABSNet to calculate the 60+ day delinquency balances based on the definition of each deal. Two deals were not contained within ABSNet (CBASS 2006-CB6 and MABS 2005-NC2). Three deals (FFMER 2007-2, FFML 2007-FF1, and WMHE 2007-HE2), all of which are components of the fourth ABX vintage, had no account balances for loans during the sample period. For all of the deals with loan level omissions, we used deal level remittance report data to calculate the 60-day plus balances, which we choose as definition

[61] It may be important to note that some deals referred to this percent by various names, such as senior enhancement percent or required percent.
[62] For example, reports via CTSLink Wells Fargo are generally consistent in breaking down the groups into all possible subcategories.

5, regardless of method set forth in the prospectus because of the lack of granularity of the deal level data.[63]

For any deal that has data from ABSNet, but is missing observations for a few months, we replaced the missing observations with the deal level Distribution Report data, and used definition 5. The majority of these missing months come within the first year of a deal, so the chosen definition should not overestimate the balance of 60+ day delinquencies by a large magnitude because these are the months when foreclosures and real estate owned properties as a total of the overall deal will be the lowest.

The majority of deals follow the first three definitions. 37 deals use Definition 1; 10 deals use Definition 2; and 16 deals use Definition 16. Definition 1 is the total of loans that are just 60 days or more behind, which includes loans that are also either FCL, BK, or REO. This means loans that may be classified as FCL, BK, or REO, but not 60 days or more DQ, will not be included. Whereas, Definition 2 will include FCL, BK, and REO regardless of their DQ status. Comparatively speaking, deals using Definition 2 compared to Definition 1 will have a higher balance of 60 plus day DQ loans. Definition 3 consists of loans that are 60 plus day DQ, BK loans which are also classified as 60 plus day DQ, and all FCL and REO loans regardless of DQ status.

Of the remaining definitions: 3 deals use definition 4; 4 deals use definition 5; 2 deals use definition 6; 5 deals use definition 7; and 3 deals use definition 8. Definition 4 includes loans just classified as 60 plus day DQ as well as FCL and REO loans which are also classified as 60 plus day DQ, but excludes all BK loans.

Definition 5 includes 60 plus day DQ loans and all FCL and REO loans, regardless of DQ classification, but excludes all BK loans. Definition 5 includes loans which are solely classified as 60 plus day DQ as well as those that are classified as 60 plus day DQ and also in one of the following categories: REO, BK, FCL, and modifications that have occurred within the last 12 months. Definition 7 includes loans that are 60 plus day DQ only, those which are both 60 plus day DQ and in foreclosure, all loans in bankruptcy, and all REO loans. Definition 8 includes all loans which are classified as 60 plus day DQ, classified as both 60 plus day DQ and FCL, classified as both 60 plus day DQ and BK, and all REO loans.

We also found differences in the calculation of the ratio of delinquent loans to beginning pool balance across deals. There were 4 distinct methods, which are listed in Table XVIII. The first is the most straightforward and is used by 31 deals. It is simply the ratio of the DQ principal balance to beginning pool balance. The 2nd method takes the rolling three month average of the DQ principal balance and divides by the beginning pool balance and is used by 21 deals. The 3rd definition takes the rolling three month average of the simple ratio of DQ principal balance to beginning pool balance and is used by 27 deals. The 4th method is unique in that it is a combination of actual balances and average balance. It takes the rolling three month average of DQ principal and then adds the actual balances of FCL, REO, and BK balances. Only one deal uses this method (CARR 2006-NC1).

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[63] Definition 5 is the balance of 60+ day delinquencies, all foreclosure, and all real estate owned properties. This definition excludes bankruptcies.

The second part of the delinquency trigger is the threshold, which is typically calculated as the product of a specified percentage set forth in the deal documents and a credit enhancement percentage. Across deals, we found 4 enhancement percentage calculation methods. These are listed in Table XX in the last panel.

Method 1 takes the ratio of subordinate certificates[64] to the ending pool balance. 17 deals use this method. Method 2 takes the ratio of all certificates with a lower distribution priority to the certificate currently receiving payments to the ending pool balance. This is the least common method as only 5 deals use it. Method 3 looks at the difference between the ending pool balance and class A certificates and divides by the ending pool balance, and is used by 10 deals. Lastly, method 4 is a variation of method 1 and is the most commonly used method. More than half of the deals in the sample use it (48 out of 80). It looks at the ratio of subordinate certificates plus the overcollateralization amount to ending pool balance.

Figure 10 is a graph changes in the delinquency trigger measure across vintages. This variable may indicate changes in delinquency and foreclosure management. During the financial crisis, foreclosure moratoria in several large states postponed the reclassification of delinquencies into other categories such as foreclosure (Keys, et al., 2012). For the first vintage, distance-to-delinquency remains fairly flat and stable across all deals, suggesting predictable delinquency management. However, for the other vintages, there is a downward trend that gets steeper with each successive vintage, indicating that liquidation and foreclosure were being postponed, swelling the proportion of 60+ day delinquent loans.

Appendix B: Data Cleansing Description

No database exists that does not contain some errors, so the purpose of this appendix is not to highlight every inaccuracy in ABSNet. In fact, considering the complexities of asset-backed deals and the lack of uniform reporting across trustees and servicers, ABSNet does a remarkable job in constructing its database. But given the importance of collateral performance on the cash flow structure of a deal, it seems appropriate to look at the accuracy of the data. Therefore, we aim to shed light on common errors and inaccurate data that may induce bias and present systematic problems in the results of past and future studies, which utilize ABSNet or similar database.

Why should we care about the accuracy of this data? There are two main reasons. First, the performance of MBS is a function of the prioritization of cash flows, which can be altered by the performance of the underlying mortgages, so the results of any study utilizing inaccurate data may be biased and caution should be exercised in interpreting the results. Second, industry participants that use faulty data in models, such as a default probability model, would expose themselves, clients, and perhaps the market to undue and excessive risk.

Data

[64] We documented the definition of subordinated certificates for all deals that defined them to ensure accuracy and consistency. These certificates were generally defined as class M tranches in the deal documents. However, there were some deals that specified both class M and class B certificates as the subordinate tranches.

ABSNet Lewtan is a product of Moody's Analytics.[65] It provides data on more than 200,000 ABS/MBS traded securities and loan-level data for U.S. non-agency and European RMBS transactions and is one of the common MBS performance databases used by investors.[66] Initial deal and tranche characteristic data is obtained from the prospectus and supplemental prospectus for each deal and ongoing monthly performance data is collected from the monthly remittance reports from the trustee. The exact method (e.g. manually entered or textual analysis) that ABSNet uses to compile data is unknown.

Since the focus of this paper is on the performance of the underlying mortgages of MBS deals in the ABX index, we collected "total pool" level collateral performance data from ABSNet for the 80 deals in the ABX indexes using its Bloomberg Name from January 2006 to December 2010.[67] The Bloomberg Names are presented in Table XVII and are sorted by ABX vintage. The first ABX was launched on January 19, 2006, so it contained deals that were issued prior to that.

As a result, this vintage will be the only one to have a complete 60 months of history. In this Appendix, we will refer to the deals in the first ABX vintage as the oldest deals in the sample. The remaining three ABX vintages were issued on a rolling six month basis, and the history of the underlying deals of each reflects this rolling time frame. The number of months in the history of each deal can be found in Table XV. The deals in the fourth vintage have the shortest history, and we will commonly refer to these deals as the youngest.

For purposes of this study, we focus on a select number of variables, which include beginning and ending pool balance, scheduled principal, repurchases, delinquencies (30 day, 60 day, 90 day, and 90 plus day), real estate owned, foreclosed, and bankruptcy loan balances, liquidations, current gain and loss amounts, cumulative realized losses, and loss severities. To construct a dataset of correct data, we did the following steps. First, we downloaded total pool data for the selected fields listed above for each of the 80 ABX deals in excel format. Then, we manually checked each data entry field against the monthly remittance reports for accuracy from January 2006 to December 2010. These reports are available through ABSNet or Bloomberg in PDF format, or directly from the trustee's website and may be available in either a PDF or spreadsheet, depending on the trustee.[68]

ABSNet provides a glossary of data fields on their website, which we use as a guide.[69] For example, according to the ABSNet definition, their cumulative realized losses data field reports losses on a net basis. That is, gross cumulative losses are adjusted by any subsequent recoveries or losses. Following this definition, we recorded net cumulative realized losses. The information in the

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[65] It was previously owned by Standard and Poor's.

[66] Principia Partners 2012 Survey

[67] It is not uncommon for a deal to have multiple mortgage groups (or pools). Most of the time the investor report will identify performance statistics on the "Total Pool" and then breakout the numbers for each group. For these deals, ABSNet will retain a data on the "total pool" and for any subgroup, such as "Group 1" or "Group 2." For completeness, we also compared individually referenced pools for the AAA tranches in the ABX index since the performance of these tranches should be the most sensitive to changes in the cash flow waterfall, and found many of the same inconsistencies that are outlined in this paper.

[68] US Bank, BNY Mellon, and WellsFargo CTSLink websites have investor report information available in PDF and XLS formats, and loan level data in CSV, all of which require a login but access is free. Deutsche Bank has monthly statements in PDF format and loan level data in XLS. It also has monthly statement details in RST (rich structured text) format, which requires a special software to read and open. Deutsche Bank is the only one that does not require a login.

[69] URL: http://www.absnet.net/ABSNet/glossary/Index

remittance reports should be disclosed based on definitions set forth in the deal's pooling and servicing agreement (PSA), prospectus, and/or prospectus supplement. To strive for consistency, we recorded the line item definitions for each deal to ensure that the data was recorded correctly from the remittance reports to ABSNet.

There are two common data problems in the ABSNet database for the extended sample period: omitted and misreported variables. The easier of the two to recognize is omissions. A visual inspection should locate any omitted variables. If an entry field was omitted, we looked at the remittance reports to determine if data is a.) not available or b.) available, but just not recorded in ABSNet.

For most data fields, the information was available in the reports and just not retained by ABSNet, with the exception of 90 day delinquencies. The majority of the time this field was omitted because the information could not be located in the remittance report for either the entire sample period or part of it.

One common reason why 90 day delinquencies are omitted is that there is no definition for 90 day delinquent in the deal documents. However, for some deals, 90 day delinquencies would not be recorded at the beginning of the period, but then would be later on. As a result, these deals would have partial observations for the sample period.

It is important to note that while definitions do not change over the life of the deal, reporting formats would occasionally change for various reasons, which would introduce new items or split current items into a more detailed format. For example, a deal may report two categories of delinquencies: 30 day and 60+ day. Each group following the definition in the deal documents. Then after several months, the reports may add additional categories, such as 90 day, 150 day, or 180+ day. None of which would be defined in the deal documents.

Other deals report delinquencies in standard 30, 60 and 90 plus day delinquent buckets, while others will report more detail and break down the delinquencies even further by including 90, 120, 150, and 180 plus buckets. As a result, when the 90 day field is missing, it is typically because the trustee only reports 90 day plus.

Misreporting is more difficult to find without manually checking each field, but we have identified some potential diagnostic checks that will make locating some misreported fields easier. After we check each field, we compared the corrected data to the original ABSNet data. The difference between the correct data and the ABSNet data would be considered "misreporting." A positive number would indicate that ABSNet is underreporting the true balance, whereas a negative number would mean that ABSNet is over reporting the true balance. Misreporting is less of a widespread problem than omissions, but the misreporting that exists occurs often enough and is of large enough magnitude that it should be a concern to any users of this data.

In the following two sections, we further discuss the omitted variables and misreporting by giving a detailed description of the problems found in the 80 sample deals.

Omitted Data

Some of these errors can be easily rectified because the data is available in the monthly reports, but for whatever reason was not recorded in the database. The majority of the omissions are in the following data fields: repurchases, 90 day delinquency, both current and cumulative liquidations, current gain/loss amount, and cumulative realized losses. The problem is less pervasive for scheduled principal and 90 day plus delinquency. There are complete observations for four data fields: 30 and 60 Day delinquencies, foreclosed loans, and real estate owned mortgage balances.

While the remainder of this section will seem tedious and technical, there are two main conclusions. First, there seems to be a systematic pattern for omitted observations, which is directly related to trustee. For the sample group there are seven trustees: CTSLink Wells Fargo, Deutsche Bank, GMAC-RFC, LaSalle Bank/Bank of America,[70] JP Morgan, US Bank, and Citigroup. Second, there appear to be two specific dates for which ABSNet will begin recording data, despite the fact that the data is available in the trustee reports. For most of these deals, ABSNet data begins on either March 2008 or October 2008, which means that for 26 months (43.3% of the sample period) or 33 months (55% of the sample period) there is no data. The majority of these observations are for the current liquidations and current gain and loss fields. For the cumulative counterparts of these fields, cumulative liquidations and cumulative realized losses, most if not all dates will be missing.[71]

Figure XI graphically depicts these two conclusions. In the figure all 80 deals are separated first by trustee, which can be found in the top row of the figure, and then by vintage. This allows for comparison of deals within trustees across time and for comparison within trustees and issuers (i.e. same shelf name). In the figure, not all data fields are presented. Only the fields with the most omitted variables are represented. Some deals have more than one field, so there are a few shelf names with multiple fields listed. For example, under the GMAC-RFC trustee, in the third vintage the RASC shelf name has both current gain and loss and cumulative realized losses listed because both have a significant amount of months missing. Further, by looking at the RASC shelf name in the fourth vintage (located directly to the left), the pattern of omitted variables between RASC deals becomes apparent. Both are missing the same months, with the exception of an extra month in late 2009 for the younger of the two RASC deals.

Between Citigroup and BNY Mellon, there are 6 deals. These deals can be found in the last six columns of Figure XI. Only one of the six has missing data, and that deal is missing 60 months of the scheduled principal data field. None of other data fields for that deal or the other 5 deals are omitted, which makes the deals in the ABX with Citigroup and BNY Mellon as trustees the most reliable, as far as omission bias goes.

ABSNet's omissions for deals with CTSLink Wells Fargo (hereafter referred to as simply CTS) as trustee are limited to current and cumulative liquidations. Of the 80 deals in the sample group, 30 deals have CTS as trustee. And of these 30 deals, 7 of these deals have complete records, and are also

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[70] Bank of America acquired LaSalle Bank in 2007, which is in the middle of the sample period.

[71] One may be inclined to sum up current liquidations and gain and loss amounts to find the cumulative values, and while that may be an appropriate strategy for liquidations, it is not for cumulative realized losses. The main reason for this is that ABSNet records the current principal portion of losses for the current gain and loss amounts, but the cumulative realized losses is the total loss on loans, which includes the interest portion. If the current gain and losses were taken in aggregate it would underestimate the actual cumulative realized loss, so this is not a strategy that should be pursued.

the only deals in the entire sample to be accurate.[72] The omissions have consistencies across deals. For example, for 14 of the deals, current liquidations are not recorded until February 2008, after which ABSNet begins retaining the data. This translates to omitted observations for 26 months (43.3% of the sample period).

For deals that ABSNet does not start recording in March 2008, they typically will remain omitted until September 2008, after which ABSNet will start recording the current liquidations, which means for these deals there is missing data for 55% or 33 months of the sample period. In short, approximately 16.7%, 46.7% and 36.6% of the CTS deals have complete data, data that begin in March 2008, and data that begin in October 2008, respectively.

Twenty deals have Deutsche Bank (DB) listed as a trustee, and the problem data fields for these are 90 day delinquent, current gain/loss amount, and cumulative realized loss. The 90 day delinquent field is easily explainable for the 7 oldest deals in the sample group, which are those included in the first ABX vintage. For these deals, the monthly investor reports only breakdown delinquencies into three categories: 30, 60, and 90 plus day delinquent. There is no way to determine the outstanding balance of the 90 day delinquent loans. For the rest of the deals, DB changes the way it reports in late 2007 early 2008 to include a further breakdown of delinquencies, so that investors could see categories of late payments ranging from 1 month to 20 months. Even after the reporting change (i.e. when the data becomes available), ABSNet fails to record the 90 day delinquent category for 7 deals, but does record it for 3 deals.

For current gain and loss and cumulative realized losses, the 20 DB deals have discernable patterns in ABSNet omissions. For most of the deals, cumulative realized losses are missing for the entire sample period, but current gain and loss amounts are only missing until 2008, with the exception of three deals: AMSI 2005-R11, which is completely missing and ARSI 2005-W2 and NHEL 2007-2, both of which have no missing data. Of the 17 remaining deals, 14 are missing current gain and loss amounts until February 2008. ABSNet begins consistently recording for two deals in November 2008 (FFML 2006-FF4 and FFML 2006-FF13). The older of the two FFML deals has current gain and loss amount from the beginning of the deal history until August 2008. Then two months are missing, and data is reported again. For the other FFML deal, the patterns are consistent with all the other deals missing data. That is, data is missing from inception or beginning of sample period, until ABSNet begins recording. And lastly, for one deal (GSAMP 2005-HE4) data retention is nonexistent until June 2008. Then it is sporadic from July 2008 until October 2008, after which data is consistently recorded.

The patterns in omitted observations are less apparent for the rest of the trustees. For GMAC-RFC trusteed deals, there are missing observations for 90 day plus delinquencies, cumulative liquidations, and current gain and loss. Ninety day plus and cumulative liquidations are limited to the two oldest deals, which are those in the first ABX vintage. The delinquency category varies for these two deals. For one, data is only missing for the first two months, and for the other it is missing until February 2008. For both of these older deals, all of the cumulative liquidations are missing.

Current gain and loss is the most widespread problem that occurs for all GMAC-RFC trusteed deals across all four ABX vintages. Five of the six deals are recorded beginning March 2008. The other

[72] Three of these seven deals are ACE Security Corporation deals. There is a fourth ACE deal in the fourth vintage, but it has 10 months of missing liquidation data.

deal begins two months earlier on January 2008. Cumulative realized loss omissions are limited to the youngest deals, those in the third and fourth ABX vintages, and occur later in the life of the deal. More specifically, data for November 2008 through May 2009 are missing. Cumulative realized losses get larger throughout the life of a deal, so this "back loading" of missing data points could potentially bias any results in studies that use this data field.

GMAC-RFC trusteed deals have rampant misreporting, which will be described in more detail later, but for now, we will note that although current gain and loss and cumulative realized returns seem to be the only ones omitted, current and cumulative liquidations are misreported, so one may be better off considering them missing.

For the 8 deals with LaSalle/Bank of America, the omission patterns are almost nonexistent, but there appear to be consistencies within certain shelves. Of the First Franklin Mortgage Loan Trust (FFML) deals, the oldest one has no missing data and the youngest one has only one date missing. There are four Bear Stearns shelf deals (BSABS). The oldest two, one from the first ABX vintage and the other from the second vintage, have scheduled principal, current and cumulative liquidation missing for one date (albeit, they are different dates: April 2008 and November 2008, respectively) out of the whole sample period. But for the two youngest BSABS deals, the same dates are missing for the same variables. This pattern is easily identified in Figure XI. As evident in the table, for the two BSABS deals in Vintages 3 and 4, the figure has three variables for each deal, and the same observations are missing across the deals.

There are 7 deals with US Bank as trustee. Only the three oldest deals, which are in the first ABX vintage, have omitted variables. Of these only one deal, SAIL 2005-HE3, has omitted observations for current liquidations, which are missing until February 2008, or 26 months.

Three of the JP Morgan Acquisition Corporation (JPMAC) deals have JP Morgan as the trustee. There is no pattern for missing data. The oldest deal, JMPAC 2005-OPT1 has no missing data, except for 90 day delinquencies, but the remittance report only reports 30, 60 and 90 plus day categories. The deal in the second vintage has missing observations for liquidations, but the dates are sporadic and are "back loaded" toward the end of the sample. While the youngest of the deals has missing observations for current gain and loss amounts and is missing at the front end of the sample.

Misreporting

The monthly remittance reports are intended to provide investors with information on the performance of the collateral of the MBS, so that they can gauge the performance of the underlying mortgages and determine whether that performance is in line with their expectations. Unfortunately, there is no standard or uniform format for remittance reports across deals like there is with corporate filings, such as 10Ks and 8Ks, with the Securities and Exchange Commission (SEC)

Many reports are ad hoc attempts at providing details about the performance of underlying mortgage collateral in the RMBS deal, and vary from trustee to trustee. This is a consequence of the lack of consistent or standardized definitions for many of the performance data. For example, some trustees report current gain or loss as the loss on the principal portion of liquidated loans, while others report it as the principal of liquidated and modified loans. Given the increase in modifications throughout the financial crisis, those deals which include modified loan losses, current gain and loss amounts may be substantially more than that reported for deals only reporting liquidated loan losses. In the absence of a uniform reporting method, trustees should provide information on the line items in the reports on how each is measured, but not all do. Instead, an investor will have to refer back to the deal documents for the precise definition for each line-item and then research whether the trustee is reporting it consistent with that definition across time. The high degree of heterogeneity within deals in regard to their structure, credit enhancements, pool characteristics, and deal definitions in conjunction with the lack of standardized reporting for collateral performance increases the probability that information will not flow to investors.

Given the complexities of MBS and the difficulties in discerning trustee reports, ABSNet does a remarkable job of constructing the database. ABSNet attempts to clean and standardized some of the performance data. For many of the fields, such as single month mortality (SMM) and constant prepayment rate (CPR), ABSNet has a "Reported" version to denote which came from the investor reports and a "Current" version to denote the version that has been calculated by ABSNet using a formula. ABSNet provides a glossary on their website, so that users can find the definition of each variable and how some of the variables were calculated.

In constructing a database on the collateral performance of the underlying mortgages of MBS from trustee reports, it is important to accurately record the information. For researchers and investors using ABSNet, the asymmetric information problem is further exacerbated by the fact that ABSNet misreports some of the data fields. Investors and researchers use the data to make inferences, so any inaccuracies may lead to inconsistent results.

In this section, we will describe some of the major misreporting problems by data field. Again, the following sections may appear tedious and technical, but there are three important results. First, most of these misreporting problems seem to be related to specific servicers, namely GMAC-RFC and JP Morgan. Second, there are enough inaccuracies that are considerable in size that it should be of concern to any researcher utilizing the data, especially if their sample includes deals with the aforementioned trustees. Third, given the nature of some of the misreporting, we provide guidance in identifying some of the inaccuracies that does not involve doing a month-to-month comparison with trustee reports.

A. Beginning and Ending Pool Balances

There are numerous instances where ABSNet erroneously records the wrong pool balance amounts. This is a serious problem since the majority of the collateral performance measures used are as a percent of ending pool balance.[73] Many of these errors can be found by looking at the single month mortality rate, calculated as

$$SMM = \frac{(BegBal - EndBal - Sched.Principal)}{(BegBal - Sched.Principal)}$$

[73] For example, 30 day delinquent percent is the ratio of outstanding principal of loans which are 30 days delinquent to ending pool balance.

A negative number is generally a red flag that pool balances are misreported. For example, the SMM rate on March 2009 for BSABS 2006-HE10 using the ABSNet data is -114.28%. Upon further investigation, one would see that both the beginning and ending pool balances are misreported. Once corrected, SMM rate becomes 2.39%. A less extreme example is JPMAC 2006-CH2. For November 2010, the SMM rate is -0.10%, which occurs because ABSNet records the beginning pool balance as the ending pool balance, so the two are equal.

This method will also help detect the beginning of misreporting. For example, for MABS 2005-NC2, a deal with US Bank investor reporting services as trustee, ABSNet begins the sample period by recording the ending pool balance correctly. Then after October 2009, ABSNet adds REO properties to the mortgage balance, which results in an increase of approximately $40 million. The SMM was only negative for one month, but it provides a starting point for further examination of the data.

While this is a simple method of detection, it should be noted that a negative number will not always indicate misreporting. For deals with prefunding accounts, the ending balance for a period may become larger than the beginning if loans are added to the trust during the prefunding period.

Another form of ending pool balance misreporting can be found in all of the 30 deals with CTSLink investor reporting services. ABSNet records the *scheduled* pool balances as the beginning and ending balances instead of the *actual* pool balances. Generally, this underreports the balance. The three oldest ACE deals were the only ones that were partially recorded correctly in ABSNet. Both ACE 2005-HE7 and ACE 2006-NC3 were correct until May 2007 and ACE 2006-NC1 was correct until July 2009. For all other deals, the balances were wrong for the entire sample period.

B. Liquidations

Misreporting for liquidations appears to be limited to GMAC-RFC remittance reports. For the six deals included in the ABX indexes for which GMAC-RFC was the servicer and U.S. Bank was the Trustee, liquidation numbers were wrong for most of the sample period. Misreporting occurred for all of 2006, 2007, and for part, if not for most, of 2008. One deal's liquidation data was corrected in January 2008 (RAMP 2006 NC2), and the remaining five were corrected later that same year in November 2008.

For most deals in ABSNet, liquidation amount is the outstanding principal balance of the loans liquidated in the current period. During the misreported months for the GMAC-RFC deals, this number appears, more often than not, to be calculated as the total net realized loss of principal and future interest from liquidated loans. This type of calculation grossly underreports the balance of liquidations because liquidations should be the principal amount of the loans in question, not just the net loss portion.

For example, in the December 26, 2007 report for RASC 2006-KS9, the balance of liquidated loans is $4,503,387, but the liquidation amount reported in ABSNet is $1,720,999, which is the amount of total net realized loss for the month, which includes the principal and interest portion of loss.

Recording liquidations this way underreports the true balance of liquidations by $2,782,388, which is a sizeable amount.

The average monthly underreporting for current and cumulative liquidations over the sample period for the six GMAC-RFC deals are presented in panels two and three of Table XVIII, respectively. Misreporting is defined as the true balance less the reported amount. A positive number would indicate that the true balance is larger than the reported value or in other words, ABSNet underreported the observation. Likewise, a negative number would mean that the true balance is less than the reported value, so ABSNet over reported.

Misreporting is worse for RASC shelf deals, with the exception of the youngest deal, RASC 2007 KS-2. This is to be expected because ABSNet corrected the misreporting in for this deal after October 2008, so there was misreported data for only 20 of the deal's 46 month history in the sample period whereas the older deals had considerable more. RAMP 2005 EFC-4 and RASC 2005 KS-11 had 34 of 60 months of misreported data; RAMP 2006 NC2 was the deal which was corrected the earliest, so it only had 23 of 58 months of misreported data; RASC 2006 KS-3 was misreported for 31 of 57 months; and RASC 2006 KS-9 was misreported for 24 of 50 months. In short, for deals with the highest average monthly misreporting, misreporting occurred in 48% or more of the deals history within the sample. For the two deals with the lowest average misreporting, misreporting was only experienced 43% or less of the time.

Since liquidations were misreported, cumulative liquidations were as well, which can be seen in the third panel of Table XVIII. Notice that the two oldest deals, RAMP 2005 EFC-4 and RASC 2005 KS-11, appear to not be misreported. This is not the case, per se. Instead of ABSNet misreporting this data field, these observations are completely omitted as mentioned in the previous section. The rest of the deals show the same pattern as the liquidation data field.

The negative values in the minimum field come from the months where there are none or minimal subsequent recoveries on liquidated loans, so that total net realized loss includes most, if not all of the principal amount. In which case the majority of the misreporting comes from the future interest loss portion of those loans. To illustrate this, Figure XII is an excerpt from the Loss and Recovery Statement in the August 2006 report for RAMP 2006 NC2. This is the first month for which this deal recorded a liquidation. The only liquidation is a charged-off of 9 loans of which all of the principal balances were classified as losses plus future interest. For this month ABSNet recorded the cumulative liquidation amount as the total realized loss of $669,964.46, which includes the principal and interest portion of the loss. The actual liquidation amount should only be the principal balance of the charged-off loan, which is $631,957.15. The difference between the actual and the misreported cumulative liquidation is $38,007.31 (i.e. the interest portion of loss), which is the minimum amount found in Table XVIII.

A red flag for this type of misreporting can be found in the loss severities. Current loss severity is calculated as the ratio of current gain or loss to current liquidation, while the cumulative loss severity is cumulative realized losses to cumulative liquidations.[74] Severities indicate how much loss is recorded

[74] $Current\ loss\ severity = \frac{Current\ gain/loss}{current\ liquidation}$ and $Cumulative\ loss\ severity = \frac{Cumulative\ net\ realized\ loss}{Cumulative\ liquidations}$

per liquidated dollar. When the liquidation field is reporting the realized losses, the severities will be in the 80-100% range.

Figure XIII graphs the misreported and corrected loss severities for the RASC 2006 KS-9 deal, which is in the third ABX vintage. If there is misreporting, depicted as the blue line, then current loss severities will be within the 80-95% range. When liquidations are recorded correctly, the current loss severity, represented by the red line, drops to the 40-70% range after the first few months. Current gain or loss amounts are omitted until March 2008 for the data taken directly from ABSNet, which is why the misreported loss severity does not exist until midway through the graph. Despite this omission, it is easy to see that the misreported loss severity is well above its corrected counterpart.

C. Cumulative Realized Losses

According to the glossary, ABSNet reports the cumulative realized loss amount per month as the net loss, which adjusts for any subsequent losses or recoveries. MBS investors are concerned with net losses, rather than gross losses, because any additional recoveries or losses will affect the cash flow waterfall, which may adversely impact junior tranche holders more than senior.

Even though ABSNet states it reports the net loss, there are many instances where does not. This, again, seems to be dependent the trustee investor reporting service. For the deals in this sample, there are two ways losses are reported in the remittance reports. They can be reported either as simply net realized losses, or in two line items: gross realized losses and subsequent recoveries/losses. In the latter case, one can take the difference of the two line items to calculated net realized losses.

Misreporting in ABSNet typically occurs when the net realized loss is not a single line item in the remittance report, but instead split into two parts: gross losses and subsequent recoveries/losses. For example, all Deutsche Bank investor reports have separate line items for "cumulative realized losses" and cumulative subsequent recoveries.[75] ABSNet reports the cumulative realized loss, which are from the reports and are gross, without adjusting for the subsequent recoveries and losses.

The simple adjustment for this would be to take the cumulative realized loss reported in ABSNet and subtract cumulative recoveries, which is also a data field in ABSNet. The main problem with this is that ABSNet does not consistently report the recoveries, making this an unreliable approach. The only remaining option is to manually record the current and cumulative recoveries, however, another problem arises.

For many of the older deals that use Deutsche Bank trustee reporting services, subsequent recoveries cannot be found in the remittance report until 2007, typically some time during the second half.[76] In the month they first appear, there are two line items, current and cumulative recoveries.

[75] The subsequent recoveries are on a net basis. That is, subsequent recoveries less any subsequent additional losses.
[76] For example, for DB deals in the first ABX vintage, recoveries show up for ARSI 2005-W2, GSAMP 2005-HE4, and LBMLT 2005-WL2 in the November 2007 report, and for NCHET 2005-4 and SVHE 2005-4 in the July 2007 and June 2008 reports.

These are never the equal, indicating that there were prior recoveries that were not reported in the previous months. Then there are instances when recoveries are never reported.[77]

For deals with LaSalle Bank/ Bank of America reports, cumulative realized losses are reported as gross in ABSNet, but the remittance reports consistently report all subsequent recoveries, so calculating net losses is possible, although the process may be time consuming. Deals with CTSlink, Citigroup, BNY Mellon and US Bank reporting services are reported on a net basis consistently.

ABSNet is inconsistent in how the JP Morgan deals are recorded. Instead of constantly reporting on a gross or net basis, ABSNet switches back and forth between the two. For example, in July 2008 for the JPMAC 2006 CH-2 deal, ABSNet reports cumulative loss as the gross loss, and the very next month reports it as the net loss. Compared to the opposite method, July is over reported by $35,225, and August is underreported by $45,781. The randomly occurs throughout the history of these deals.

For the GMAC-RFC deals, there is not a single methodology that ABSNet appears to use. Instead it seems to be an ad hoc calculation of different items. GMAC-RFC investor reports break down realized losses by types: liquidations, charge-offs, servicing modifications and bankruptcies. For at least part of the sample period, it appears that for some of the GMAC-RFC deals, losses may be calculated as simply liquidations and charge-offs, while for other deals, modifications are included. There is no systematic approach for deciphering how ABSNet records cumulative realized losses or when they change to the appropriate method without comparing the ABSNet data directly with the investor reports on a month by month basis.

The fourth panel in Table XVI presents the summary statistics for the misreporting in cumulative realized loss amount. As is evident by this table, there is no discernable pattern for how ABSNet reports this line item. For example, RAMP 2005 EFC-4 shows that there is an average underreporting of $173,329, whereas RASC 2006 KS-3 shows an average over reporting of $253,737. It should be noted that for the youngest two GMAC-RFC deals, RASC 2006 KS-9 and RASC 2007 KS-2, there are 8 and 7 months of cumulative realized loss data missing, respectively.

Data Comparison

We examine seven collateral performance measures: SMM, percentages of 30 day, 60 day, and 90 plus day delinquencies, foreclosed, real estate owned (REO) loans, and loss rates. SMM is measured as described above in the misreporting section. The delinquencies, foreclosures, and REO measures are calculated as a ratio to ending pool balance, and loss rate is the ratio of net cumulative realized loss to the original pool balance.

Here we measure the collateral performance variables as changes. For example, 30 day delinquent rate is calculated as the ratio of the balance of loans that are classified as 30 days delinquent to the ending pool balance of the deal. As a result, the 30 day delinquent variable in our analysis will be the change in that ratio or rate. Table XIX reports the summary statistics of the collateral

[77] JPMAC 2007-CH3 and MLMI 2007 MLN1, both of which are in the fourth ABX vintage

performance measures in levels (or rates) associated with the 20 deals in each of the ABX vintages. The first set of statistics are for the corrected data and the next set is the data directly from ABSNet.

The differences in the number of observations between datasets is a direct result of the omitted observations found in the ABSNet database. The majority of omissions are related to the cumulative realized losses. For the first vintage, there are 364 missing months or approximately 30% of the observations across the 20 deals over the 5 year sample period.[78] For the second, third, and fourth vintages, the number is considerably less at 191, 292, and 133 months, respectively.

The impact of incorrect beginning and ending pool balances shows up in the SMM summary statistics. The second vintage (ABX 2006-2) is the only one that did not have significant problems with pool balances. For this vintage, the sample variances are equal and there are no differences in means. Further, the samples have similar kurtosis and skewness. The other three vintages tell a dramatically different story. The large negative numbers in the minimum column for the ABSNet change the shape of the distribution in that it is skewed negatively and has a large kurtosis. Although, both dataset have kurtosis greater than 3, which means higher peaks and thinner tails than a normal distribution, the ABSNet data has significantly larger kurtosis. Higher peaks and thinner tails means that most of the observations are clustered around the mean and there is not a lot of variation between observations.

The last three columns in Table XIX present the results from a differences-in-means test between the datasets. None of the variances of the SMM are equal at the 5% significance level for the three vintages with rampant misreporting in the pool balances, which should have been expected based on how the misreported balances changed the shape of the distribution based on kurtosis and skewness measures. But despite this, the means between databases are insignificantly different.

The third vintage, ABX 2007-1, has the most differences between datasets. The sample means for the 30, 60, and 90 plus day delinquency, foreclosure and loss rates are all statistically different at the 10% level. Further, the magnitude of the difference is quite substantial. For the delinquencies and foreclosure rates, the means are lower for the corrected data, with the largest decrease coming from the 90 day plus bucket and the foreclosures. However, the loss rate is 78 basis points larger for the corrected sample.

The only other variable that is statistically different across sets is the loss rate for the second vintage, ABX 2006-2. It is 56 basis points larger in the corrected data than in the ABSNet data. These increases in loss rates can be attributed to two reasons. First, this variable is the one with the most omitted observations. When ABSNet reports fails to report current gain or loss at any time then as a byproduct the cumulative realized losses are missing for any period following. By looking at Figure XI, it obvious that for many of the CTSLink, DB, and GMAC deals, the front end of the sample period has numerous missing observations until February 2008. This means, that cumulative realized losses will be missing for the entire sample period. For the two BSABS deals with LaSalle/Bank of America reporting in the second and third vintages, current gain or loss is missing at the back end of the sample period.

[78] There are 1,200 months of observations, which is 60 months for each of the 20 deals.

The second reason the loss rate is higher in the corrected data may have to do with the fact that ABSNet reports some cumulative losses on a net basis and other on a gross basis. When losses are on a net basis, subsequent recoveries and subsequent losses are taken into account. If a loan experiences a subsequent recovery, then the realized loss will decrease for the period. If any additional losses are incurred, then realized losses will decrease. Deals with mortgages that were originated in late 2006 and early 2007 experienced more subsequent losses than recoveries, contributing to cumulative realized losses.

REFERENCES

Allen, Franklin, and Elena Carletti, 2008, Mark-to-market accounting and liquidity pricing. *Journal of Accounting and Economics,* 45, 358–378.

Bai, Jennie and Pierre Collin-Dufresne, 2013, The CDS-Bond Basis. AFA 2013 San Diego Meetings Paper. Available at SSRN: https://ssrn.com/abstract=2024531

Baltagi, Badi H., and Ping X. Wu, 1999, Unequally spaced panel data regressions with AR (1) disturbances. *Econometric Theory,* 15.06, 814-823.

Barry, Christopher B., and Stephen J. Brown, 1985, Differential information and security market equilibrium. *Journal of Financial and Quantitative Analysis,* 20, 407–422.

Bikhchandani, Sushil, David Hirshleifer, and Ivo Welch, 1992. A theory of fads, fashion, custom, and cultural change as informational cascades. *Journal of Political Economy*, 100(5), 992-1026.

Bikhchandani, Sushil, David Hirshleifer, and Ivo Welch, 1998. Learning from the behavior of others: Conformity, fads, and informational cascades. *The Journal of Economic Perspectives*, 12(3), 151-170.

Black, Fischer, 1986, Noise. *The Journal of Finance*, 41(3), 528-543.

Blanco, Roberto, Simon Brennan, and Ian W. Marsh, 2005, An empirical analysis of the dynamic relation between investment-grade bonds and credit default swaps. *The Journal of Finance*, 60(5), 2255-2281.

Callen, Jeffrey L., Joshua Livnat, and Dan Segal, 2009. The impact of earnings on the pricing of credit default swaps. *The Accounting Review*, 84(5), 1363-1394.

Collin-Dufresne, Pierre, Robert S. Goldstein, and Fan Yang, 2012. On the Relative Pricing of Long-Maturity Index Options and Collateralized Debt Obligations. *The Journal of Finance*, 67(6), 1983-2014.

Collin-Dufresne, Pierre, Robert S. Goldstein, and J. Spencer Martin, 2001, The determinants of credit spread changes. *The Journal of Finance*, 56(6), 2177-2207.

Coval, Joshua D., Jakub W. Jurek, and Erik Stafford, 2009. Economic catastrophe bonds. *The American Economic Review*, 99(3), 628-666.

Dechow, Patricia M., Richard G. Sloan, and Amy P. Sweeney, 1995, Detecting earnings management. *Accounting Review,* 193–225.

Demiroglu, Cem, and Christopher James, 2012, How important is having skin in the game? Originator-sponsor affiliation and losses on mortgage-backed securities. *The Review of Financial Studies,* 25, 11, 3217-3258.

Diether, Karl B., Christopher J. Malloy, and Anna Scherbina, 2002, Differences of opinion and the cross section of stock returns. *The Journal of Finance,* 57, 2113–2141.

Dow, James and Gary B. Gorton, 1994, Arbitrage chains. *The Journal of Finance*, 49(3), 819-849.

Du, Wenxin, Salil Gadgil, Michael B. Gordy, Clara Vega, 2016, Counterparty Risk and Counterparty Choice in the Credit Default Swap Market. *Working Paper.*

Duffie, Darrell, 1996. Special repo rates. *The Journal of Finance*, 51(2), 493-526.

Duffie, Darrell, and David Lando, 2001. Term structures of credit spreads with incomplete accounting information. *Econometrica*, 69(3), 633-664.

Duffie, Darrell, Nicolae Gârleanu, and Lasse Heje Pedersen, 2002. Securities lending, shorting, and pricing. *Journal of Financial Economics*, 66(2), 307-339.

Duffie, Darrell, Nicolae Gârleanu, and Lasse Heje Pedersen, 2005. Over-the-Counter Markets. *Econometrica*, 73(6), 1815-1847.

Dungey, Mardi, Gerald P. Dwyer, and Thomas Flavin, 2013, Systematic and liquidity risk in subprime-mortgage backed securities. *Open Economies Review,* 24, 5–32.

Fender, Ingo, and Martin Scheicher, 2009, The pricing of subprime mortgage risk in good times and bad: evidence from the ABX.HE indices. *Applied Financial Economics,* 19, 1925–1945.

Finger, C. C., 2000, Toward a Better Estimation of Wrong-Way Credit Exposure. *The Journal of Risk Finance,* 1(3), 43-51.

Fremault, Anne, 1991, Stock index futures and index arbitrage in a rational expectations model. *Journal of Business*, 64(4), 523-547.

Gonzalo, Jesus, and Clive Granger, 1995, Estimation of common long-memory components incointegrated systems. *Journal of Business & Economic Statistics*, 13(1), 27-35.

Goodman, Laurie S., Shumin Li, Douglas J. Lucas, Thomas A. Zimmerman, and Frank J. Fabozzi, 2008, *Subprime mortgage credit derivatives*, volume 159 (John Wiley & Sons).

Gorton, Gary B. and George G. Pennacchi, 1993. Security Baskets and Index-Linked Securities. *Journal of Business*, 66(1), 1-27.

Gorton, Gary, 2009, Information, liquidity, and the (ongoing) panic of 2007. *American Economic Review,* 99, 567–72.

Grossman, Sanford J., and Joseph E. Stiglitz, 1980, On the impossibility of informationally efficient markets. *The American Economic Review*, 70(3), 393-408.

Hasbrouck, Joel, 1995, One security, many markets: Determining the contributions to price discovery. *The Journal of Finance*, 50 (4), 1175-1199

Jarrow, Robert, and Philip Protter, 2004. Structural versus reduced form models: a new information based perspective. *Journal of Investment Management*, 2(2), 1-10.

Johansen, Søren, Rocco Mosconi, and Bent Nielsen, 2000, Cointegration analysis in the presence of structural breaks in the deterministic trend. *The Econometrics Journal,* 3.2: 216-249.

Jones, Jennifer J., 1991, Earnings management during import relief investigations. *Journal of Accounting Research,* 193–228.

Keys, Benjamin J., Amit Seru, and Vikrant Vig, 2012, Lender screening and the role of securitization: evidence from prime and subprime mortgage markets. *Review of Financial Studies,* 25, 2071–2108.

Kothari, Sagar P., Andrew J. Leone, and Charles E. Wasley, 2005, Performance matched discretionary accrual measures. *Journal of Accounting and Economics,* 39, 163–197.

Kumar, Praveen, and Duane J. Seppi, 1994, Information and index arbitrage. *Journal of Business*, 67(4), 481-509.

Kyle, Albert S., 1985. Continuous auctions and insider trading. *Econometrica*, 53(6), 1315-1335.

Longstaff, Francis A., 2010, The subprime credit crisis and contagion in financial markets. *Journal of Financial Economics,* 97, 436–450.

Longstaff, Francis A., and Brett W. Myers, 2014, How does the market value toxic assets? *Journal of Financial and Quantitative Analysis*, 49(2), 297-319.

Longstaff, Francis A., Sanjay Mithal, and Eric Neis, 2005, Corporate yield spreads: Default risk or liquidity? New evidence from the credit default swap market. *The Journal of Finance* 60(5), 2213-2253.

Merton, Robert C., 1974. On the pricing of corporate debt: The risk structure of interest rates. *The Journal of Finance*, 29(2), 449-470.

Merton, Robert C., 1987, A simple model of capital market equilibrium with incomplete information, *The Journal of Finance,* 42, 483–510.

Miller, Edward M., 1977, Risk, uncertainty, and divergence of opinion. *The Journal of Finance,* 32, 1151–1168.

Mitchell, Mark, Todd Pulvino, and Erik Stafford, 2002. Limited arbitrage in equity markets. *The Journal of Finance*, 57(2), 551-584.

Morkoetter, Stefan, Johanna Pleus, and Simone Westerfeld, 2012, The impact of counterparty risk on credit default swap pricing dynamics. *The Journal of Credit Risk,* 8, 63.

Purnanandam, Amiyatosh, 2011, Originate-to-distribute model and the subprime mortgage crisis. *Review of Financial Studies,* 24, 1881–1915.

Shiller, Robert, 1984. Stock prices and social dynamics. *Brookings Papers on Economic Activity*, 2, 457-510.

Shleifer, Andrei and Rober W. Vishny, 1997. The limits of arbitrage. *The Journal of Finance*, 52(1), 35-55.

Stanton, Richard, and Nancy Wallace, 2011, The bear's lair: Index credit default swaps and the subprime mortgage crisis. *Review of Financial Studies,* 24, 3250–3280.

Subrahmanyam, Avanidhar, 1991, A theory of trading in stock index futures. *The Review of Financial Studies*, 4(1), 17-51.

Tuckman, Bruce, and Jean-Luc Vila, 1992, Arbitrage with Holding Costs: A Utility-Based Approach. *The Journal of Finance*, 47(4), 1283-1302.

Vayanos, Dimitri, and Pierre-Olivier Weill, 2008. A Search-Based Theory of the On-the-Run Phenomenon. *The Journal of Finance*, 63(3), 1361-1398.

Table I
Summary Statistics for Conventional Deal-Level Collateral Performance Measures for All ABX Vintages

	Mean	Stand. Dev.	Minimum	Maximum
ABX 2006-1				
30 Day DQ Pct	4.433	1.565	0.000	9.941
60 Day DQ Pct	2.467	1.196	0.000	7.335
90+ Day DQ Pct	6.854	7.126	0.000	37.802
REO Pct	5.126	4.609	0.000	27.325
Foreclosure Pct	11.898	7.833	0.000	42.649
Bankruptcy Pct	2.700	1.632	0.000	8.810
ABX 2006-2				
30 Day DQ Pct	4.598	1.462	0.000	11.587
60 Day DQ Pct	2.672	1.144	0.000	8.522
90+ Day DQ Pct	7.352	7.505	0.000	38.144
REO Pct	5.864	4.891	0.000	24.545
Foreclosure Pct	13.784	8.407	0.000	37.140
Bankruptcy Pct	2.344	1.371	0.000	6.037
ABX 2007-1				
30 Day DQ Pct	4.900	1.447	0.000	12.776
60 Day DQ Pct	3.031	1.230	0.000	8.786
90+ Day DQ Pct	10.216	10.026	0.000	50.063
REO Pct	5.169	4.067	0.000	22.369
Foreclosure Pct	13.745	7.573	0.000	32.825
Bankruptcy Pct	2.194	1.447	0.000	19.500
ABX 2007-2				
30 Day DQ Pct	5.261	1.534	0.008	10.737
60 Day DQ Pct	3.196	1.196	0.000	7.258
90+ Day DQ Pct	10.068	9.127	0.000	44.204
REO Pct	4.736	3.885	0.000	22.741
Foreclosure Pct	14.640	7.834	0.000	34.220
Bankruptcy Pct	2.120	1.435	0.000	9.600

This table reports the summary statistics for select conventionally used collateral performance measures from vintage inception through December 2010. Each is calculated as the percentage of the outstanding principal amount in each category of the current ending total pool balance for each deal.

Table II

Summary Statistics for Deals within Each Vintage

ABX 2006-1		Dist.-to-Loss		Info Quality	
Deal Name	**N**	**Mean**	**Std**	**Mean**	**Std**
ACE 2005-HE7	42	-0.0757	0.0495	0.6708	0.2346
AMSI 2005-R11	42	-0.0043	0.0133	0.5676	0.1069
ARSI 2005-W2	42	-0.0436	0.0382	0.5192	0.1528
BSABS 2005-HE11	42	-0.0326	0.0280	0.5984	0.1346
CWL 2005-BC5	42	-0.0047	0.0074	0.6381	0.1205
FFML 2005-FF12	42	-0.0428	0.0501	0.5399	0.2057
GSAMP 2005-HE4	42	-0.0218	0.0165	0.7309	0.1532
HEAT 2005-8	42	-0.0620	0.0518	0.5725	0.2090
JPMAC 2005-OPT1	42	0.0068	0.0030	0.8970	0.1306
LBMLT 2005-WL2	42	-0.0296	0.0236	0.6808	0.2605
MABS 2005-NC2	42	-0.0625	0.0601	0.0000	0.0000
MLMI 2005-AR1	42	-0.0215	0.0236	0.7702	0.1320
MSAC 2005-HE5	42	-0.0282	0.0210	0.7946	0.1794
NCHET 2005-4	42	-0.0059	0.0120	0.6665	0.1149
RAMP 2005-EFC4	42	-0.0224	0.0243	0.6528	0.1885
RASC 2005-KS11	42	-0.0429	0.0325	0.5860	0.1763
SABR 2005-HE1	42	-0.0587	0.0439	0.7506	0.2317
SAIL 2005-HE3	42	-0.0365	0.0249	0.6291	0.2946
SASC 2005-WF4	42	0.0011	0.0052	0.7205	0.1091
SVHE 2005-4	42	-0.0826	0.0488	0.3626	0.1620
Range		0.0894	0.0571	0.8970	0.2946

ABX 2006-2		Dist.-to-Loss		Info Quality	
Deal Name	**N**	**Mean**	**Std**	**Mean**	**Std**
ACE 2006-NC1	42	-0.0530	0.0469	0.5597	0.1820
ARSI 2006-W1	42	-0.0687	0.0616	0.5473	0.2501
BSABS 2006-HE3	42	-0.0476	0.0542	0.5749	0.1874
CARR 2006-NC1	42	0.0070	0.0144	0.3911	0.0785
CWL 2006-8	42	-0.0337	0.0267	0.3106	0.1006
FFML 2006-FF4	42	-0.0407	0.0516	0.5086	0.2359
GSAMP 2006-HE3	42	-0.0839	0.0563	0.4926	0.1889
HEAT 2006-4	42	-0.0747	0.0545	0.4141	0.1807
JPMAC 2006-FRE1	42	-0.0616	0.0352	0.5819	0.1728
LBMLT 2006-1	42	-0.0931	0.0625	0.5699	0.1883
MABS 2006-NC1	42	-0.0546	0.0443	0.5427	0.1738
MLMI 2006-HE1	42	-0.0724	0.0455	0.5590	0.1935
MSAC 2006-HE2	42	-0.0903	0.0645	0.5408	0.2222
MSAC 2006-WMC2	42	-0.1260	0.0920	0.6307	0.1570
RAMP 2006-NC2	42	0.0437	0.1212	0.4850	0.1594
RASC 2006-KS3	42	-0.0681	0.0478	0.5170	0.1912
SABR 2006-OP1	42	-0.0119	0.0131	0.7033	0.1377
SAIL 2006-4	42	-0.0814	0.0615	0.4420	0.1844
SASC 2006-WF2	42	-0.0318	0.0302	0.5109	0.1137
SVHE 2006-OPT5	42	-0.0638	0.1036	0.4497	0.1586
Range		0.1697	0.1082	0.3927	0.1716

Table III

Summary Statistics for Deals within Each Vintage

ABX 2007-1		Dist.-to-Loss		Info Quality	
Deal Name	**N**	**Mean**	**Std**	**Mean**	**Std**
ABFC 2006-OPT2	42	-0.0495	0.0479	0.3568	0.1259
ACE 2006-NC3	42	-0.0572	0.0487	0.2498	0.0978
BSABS 2006-HE10	42	-0.0516	0.0662	0.2415	0.0749
CARR 2006-NC4	42	0.0070	0.0184	0.2303	0.0621
CBASS 2006-CB6	42	-0.0696	0.0557	0.0000	0.0000
CMLTI 2006-WFH3	42	-0.0414	0.0415	0.3420	0.1645
CWL 2006-18	42	-0.0266	0.0278	0.2540	0.0990
FFML 2006-FF13	42	-0.0662	0.0611	0.3237	0.1690
FHLT 2006-3	42	-0.1486	0.1123	0.1735	0.1221
GSAMP 2006-HE5	42	-0.0738	0.0604	0.4004	0.2397
HEAT 2006-7	42	-0.1317	0.1060	0.1986	0.1532
JPMAC 2006-CH2	42	-0.0320	0.0352	0.3374	0.0831
LBMLT 2006-6	42	-0.1181	0.0809	0.3899	0.1995
MABS 2006-NC3	42	-0.0950	0.0827	0.3004	0.1743
MLMI 2006-HE5	42	-0.0930	0.0713	0.3212	0.1577
MSAC 2006-HE6	42	-0.0753	0.0553	0.3158	0.1349
RASC 2006-KS9	42	-0.0847	0.0700	0.2715	0.1489
SABR 2006-HE2	42	-0.0932	0.0766	0.3934	0.1844
SASC 2006-BC4	42	-0.0701	0.0636	0.3530	0.1737
SVHE 2006-EQ1	42	-0.0499	0.0512	0.3554	0.1557
Range		0.1557	0.0938	0.4004	0.2397

ABX 2007-2		Dist.-to-Loss		Info Quality	
Deal Name	**N**	**Mean**	**Std**	**Mean**	**Std**
ACE 2007-HE4	42	-0.1413	0.1250	0.2516	0.2092
BSABS 2007-HE3	42	-0.0471	0.0672	0.1872	0.1106
CMLTI 2007-AMC2	42	-0.0782	0.0763	0.1820	0.1029
CWL 2007-1	42	-0.0193	0.0258	0.1870	0.1866
FFMER 2007-2	42	-0.0581	0.0636	0.1824	0.1169
FFML 2007-FF1	42	-0.0616	0.0623	0.7306	0.2448
GSAMP 2007-NC1	42	-0.1034	0.0908	0.2395	0.1510
HASC 2007-NC1	42	-0.0622	0.0666	0.1764	0.1143
HEAT 2007-2	42	-0.1102	0.1033	0.1913	0.1420
JPMAC 2007-CH3	42	-0.0266	0.0362	0.1873	0.0945
MLMI 2007-MLN1	42	-0.0816	0.0716	0.1945	0.1228
MSAC 2007-NC3	42	-0.0644	0.0755	0.1812	0.1180
NHEL 2007-2	42	-0.0437	0.0575	0.0782	0.0508
NHELI 2007-2	42	-0.0871	0.0872	0.2511	0.1563
OOMLT 2007-5	42	-0.0579	0.0612	0.1916	0.1112
RASC 2007-KS2	42	-0.0870	0.0793	0.2169	0.1289
SABR 2007-BR4	42	-0.0848	0.0852	0.2155	0.1556
SASC 2007-BC1	42	-0.0558	0.0536	0.2884	0.1819
SVHE 2007-OPT1	42	-0.0508	0.0540	0.1654	0.0924
WMHE 2007-HE2	42	-0.0844	0.0734	0.1803	0.1124
Range		0.1221	0.0992	0.6524	0.1940

Table IV: Predicted Relationships for Credit, Contractual, and Market Variables

Type	Variable	Bond	ABCDS	ABX
Credit	ΔSubordination Pct	-	-	-
Credit	Current Loss Tranche	+	+	n/a
Credit	Acceleration Feature	+	+	+
Credit	Distance-to-DQ Trigger	-	-	-
Credit	Distance-to-Loss Trigger	-	-	-
Credit	Poor Information Quality	+	+	+
Contractual	Funding Costs	-	n/a	n/a
Contractual	Counterparty Risk	n/a	-	-
Market	Short Interest Ratio	n/a	+	+
Market	S&P 500	-	-	-

This table summarizes the predicted relationships between spread changes for each of the securities in our study - cash RMBS bond, ABCDS, and the ABX - and each variable in our credit risk model. The explanatory variables are categorized by type depending on whether they are consider credit measures, contractual difference controls, or market variables.

Table V: Summary Statistics for Variables for Basis and Tracking Error Regressions

Variable	Mean	St. Dev.	Min.	Max.	N
Basis (%)	-103.02	684.42	-9,839.61	1,419.46	11,924
ABCDS Spread (%)	70.50	77.70	0.25	2,497.20	12,328
Bond Spread (%)	165.84	676.92	-560.24	9,960.67	12,837
Δ Sub Pct.	-0.03	0.73	-27.60	28.05	12,816
Acc. Feature	0.85	0.36	0.00	1.00	13,215
Δ Dist-to-Loss	0.00	0.02	-0.63	0.62	12,816
Sq. Δ Dist-to-Loss	0.00	0.01	0.00	0.39	12,816
Poor Info. Quality	0.38	0.26	0.00	1.56	13,045
Loss Dummy	0.09	0.29	0.00	1.00	13,197
ABX Tracking Error (%)	2.02	72.11	-170.82	671.14	837
ABX Δ Sub Pct.	0.00	0.00	-0.01	0.02	820
ABX Δ Dist-to-Loss	0.00	0.01	-0.10	0.10	820
ABX Sq. Δ Dist-to-Loss	0.00	0.00	0.00	0.01	820
ABX Poor Info. Quality	0.40	0.22	0.03	0.89	840
Short Interest Ratio	18.98	12.15	3.46	49.07	41
Counterparty Risk	136.00	55.83	42.61	297.65	41
Funding Cost	0.40	0.64	-0.55	2.74	41
S&P500 Return	-0.34	6.05	-16.94	9.39	40
Δ Spot	-0.11	0.30	-1.23	0.37	40
Δ Slope	0.07	0.29	-0.64	0.86	40

This table presents the summary statistics used in the analysis of basis from July 2007-December 2010 grouped by initial bond credit rating. Basis is calculated as the difference between the ABCDS spread and the bond spread (yield to maturity (YTM) over 1 month LIBOR) on a MBS bond. ΔSubordination Pct is the month to month change in the subordination percent for each bond. Acceleration feature is an indicator variable, defined as 1 if the current OC amount is less than the target and 0 otherwise. Dist.-to-Loss Trigger is the difference between a threshold percent and the percent of aggregate losses. Poor Info Quality is the coefficient of variation of aggregate loss data from three MBS deal level data sources. ABX Tracking Error is the difference between the ABX index and its corresponding portfolio of single-name ABCDS contracts. All ABX level credit explanatory variables are calculated on the ABCDS portfolio level by taking a bond weighted average of the referenced bonds of the corresponding ABX subindex for each variable. Short Interest Ratio serves as a proxy for insurance demand imbalances and is the change in the market ratio of the market value of shares sold short to the average daily trading volume over the month for the financial services ETF (Ticker: XLF). Counterparty Risk is a proxy for risk associated with the seller of an ABDS contract failing to uphold its contractual obligations. Funding Cost is the difference between 3 month LIBOR and the general collateral repo rate. S&P 500 Return is calculated as the percent change in the price of the S&P 500 index over the month. ΔSpot Rate is the month to month change in the 1-year CMT rate. ΔSlope is the change in the slope, which is defined as the difference between the 10-year CMT rate and the 1-year CMT rate.

Table VI

Cross-Correlation Table for Variables included in the Monthly Basis Regressions

	Basis	Lagged Basis	Δ Sub Pct.	Acc. Feature	Δ Dist-to-Loss	Sq. Δ Dist-to-Loss	Poor Info. Quality	Loss Dummy	Short Interest Ratio	Counter-party Risk	Funding Cost	S&P500 Return	Δ Spot	Δ Slope
Basis	1													
Lagged Basis	0.96	1												
Δ Sub Pct.	0.07	0.07	1											
Acc. Feature	-0.06	-0.05	-0.11	1										
Δ Dist-to-Loss	-0.04	-0.04	0.17	-0.18	1									
Sq. Δ Dist-to-Loss	0.00	0.00	-0.02	0.02	-0.67	1								
Poor Info. Quality	-0.23	-0.24	-0.02	0.28	0.17	0.02	1							
Loss Dummy	-0.18	-0.16	-0.04	0.07	-0.04	0.02	0.06	1						
Short Interest Ratio	0.06	0.06	0.26	-0.36	0.22	-0.01	-0.21	-0.06	1					
Counterparty Risk	-0.03	-0.02	-0.16	0.28	-0.20	0.01	0.09	0.03	-0.75	1				
Funding Cost	0.01	0.02	-0.09	0.16	-0.19	0.01	-0.05	-0.01	-0.54	0.59	1			
S&P500 Return	-0.05	-0.05	-0.08	0.00	0.04	0.02	0.13	0.02	0.26	-0.25	-0.44	1		
Δ Spot	-0.04	-0.05	-0.09	0.19	-0.05	0.01	0.17	0.04	0.12	0.02	-0.2	0.28	1	
Δ Slope	0.02	0.02	0.04	-0.13	0.01	0.01	-0.13	-0.05	-0.01	-0.07	0.09	-0.09	-0.42	1

This table presents the correlation table for the variables included in the regression analysis of monthly basis from July 2007 to December 2010. Basis is calculated as the difference between the ABCDS and bond spreads (YTM over 1 month LIBOR). Acceleration feature is an indicator variable, which is defined as 1 if the current OC amount is less than the target amount, and zero otherwise. ΔSub Pct. is the month to month change in the subordination percent for each RMBS. ΔDist.-to-Loss is the change in the Dist.-to-Loss measure, which is the difference between a threshold percent and the percent of aggregate losses. This variable controls for changes in trigger distance while Sq. ΔDist.-to-Loss accounts for the acceleration of changes in trigger distance. Poor Info. Quality is the coefficient of variation of aggregate loss data from three MBS deal-level data sources. Short Interest Ratio is the ratio of the market value of shares sold short to the average daily trading volume over the month for the financial services ETF (Ticker: XLF). Counterparty risk is the average CDS spread for market makers in the ABX index. Funding Cost is the difference between 3 month LIBOR and the general collateral repo rate. S&P 500 Return is the percent change in the price of the S&P 500 index over the month. ΔSpot is the month to month change in the 1-year CMT rate. ΔSlope is the change in slope, which is defined as the difference between the 10-year CMT and the 1-year CMT rates.

Table VII

Cross-Correlation Table for Variables included in the Monthly Tracking Error Regressions

	Tracking Error	Lagged Tracking Error	ABX Δ Sub Pct.	ABX Δ Dist-to-Loss	ABX Sq. Δ Dist-to-Loss	ABX Poor Info. Quality	Short Interest Ratio	Counter-party Risk	Funding Cost	S&P500 Return	Δ Spot	Δ Slope
ABX Tracking Error	1											
Lagged ABX Tracking Error	0.90	1										
ABX Δ Sub Pct.	-0.10	-0.14	1									
ABX Δ Dist-to-Loss	-0.11	-0.11	0.15	1								
ABX Sq. Δ Dist-to-Loss	0.03	0.03	-0.14	-0.08	1							
ABX Poor Info. Quality	-0.03	-0.01	-0.10	0.09	0.04	1						
Short Interest Ratio	0.02	-0.06	0.42	0.08	-0.13	-0.26	1					
Counterparty Risk	0.18	0.22	-0.25	-0.07	0.14	0.12	-0.73	1				
Funding Cost	0.26	0.36	-0.13	-0.12	0.09	-0.06	-0.48	0.56	1			
S&P500 Return	0.16	0.19	0.08	-0.03	-0.13	-0.14	-0.02	0.21	0.39	1		
Δ Spot	-0.09	-0.12	-0.16	0.00	0.09	0.21	0.04	0.06	-0.17	-0.45	1	
Δ Slope	0.07	0.12	0.02	-0.12	0.05	-0.14	-0.04	-0.02	0.28	0.26	-0.46	1

This table presents the correlation table for the variables included in the regression analysis of monthly ABX tracking error from July 2007 to December 2010. Tracking error is calculated as the difference between the ABX spread and the spread of a portfolio constructed of equally weighted ABCDS contracts adjusted by bond factor of the RMBS bonds referenced in the ABX subindex, (ABX Subindex Spread_t - ABCDS Portfolio Spread_t). All credit explanatory variables are calculated on the ABCDS portfolio level by taking an equally weighted average after adjusting for bond factor of the referenced bonds of the corresponding ABX subindex for each variable. ABX ΔSub Pct is the month to month change in the subordination percent for each ABCDS portfolio. Dist.-to-Loss trigger is the difference between a threshold percent and the percent of aggregate losses. ΔDist.-to-loss controls for changes in trigger distance while Sq. ΔDist-to-loss is the squared change in trigger distance and controls for the acceleration of changes in trigger distance. Info quality is the coefficient of variation of aggregate loss data from three MBS deal-level data sources for each ABCDS portfolio. Short interest ratio is the ratio of the market value of shares sold short to the average daily trading volume over the month for the financial services ETF (Ticker: XLF). Counterparty risk is the average of the CDS spread for the ABX market makers. Funding Cost is the difference between 3 month LIBOR and the general collateral repo rate. S&P 500 return is the percent change in the price of the S&P 500 over the month. ΔSpot rate is the month to month change in the 1-year CMT rate. ΔSlope is the change in the slope, which is defined as the difference between the 10-year CMT and the 1-year CMT rates.

Table VIII

Vector Error Correction Model for Price Discovery

Panel A: Mean and Median Error Correction Coefficients by Subindex

2006-1	Available	Coint	Mean λ1	Median λ1	Mean λ2	Median λ2
AAA	18	18	-0.0012	-0.0005	-3.93E-05	-3.80E-05
AA	17	17	-0.0096	-0.0034	-0.0002	-0.0002
A	19	18	-0.0345	-0.0219	-0.0096	-0.0008
BBB	19	13	-0.0380	-0.0373	-0.0402	-0.0011
BBB-	19	10	-0.0385	-0.0215	0.0185	0.0108

2006-2	Available	Coint	Mean λ1	Median λ1	Mean λ2	Median λ2
AAA	18	18	-0.0013	-0.0010	-0.0001	-0.0001
AA	20	19	-0.0165	-0.0126	0.0004	-0.0005
A	19	16	-0.0200	-0.0230	0.0039	0.0006
BBB	19	6	0.1502	-0.0304	0.0350	0.0239
BBB-	18	3	-0.0435	-0.0286	0.0094	0.0222

2007-1	Available	Coint	Mean λ1	Median λ1	Mean λ2	Median λ2
AAA	20	20	-0.0008	-0.0006	-0.0001	-0.0001
AA	20	20	-0.0076	-0.0056	0.0004	-0.0003
A	19	15	-0.0971	-0.0256	0.0005	-0.0010
BBB	18	4	-0.0354	-0.0267	-0.0008	-0.0003
BBB-	20	5	-0.0525	-0.0544	0.0295	0.0060

2007-2	Available	Coint	Mean λ1	Median λ1	Mean λ2	Median λ2
AAA	20	20	-0.0020	-0.0014	1.51E-06	-0.0001
AA	20	19	-0.0044	-0.0010	-0.0011	-0.0011
A	20	16	-0.0299	-0.0275	0.0008	-0.0007
BBB	20	5	-0.0108	-0.0073	-0.0042	-0.0057
BBB-	18	5	-0.0149	-0.0182	0.0016	0.0027

Panel A reports the number of ABCDS-bond relationships that are cointegrated using the Johansen et al. (2000) testing procedure out of the number available in the data, the mean and median speed of adjustment coefficients from the unmodified VECM based on Blanco, Brennan and Marsh (2005) for only the cointegrated relationships.

Table VIII Cont.

Panel B: Market Contributions to Price Discovery

2006-1	Only Bond Market ($\lambda 1<0$)	Only CDS Market ($\lambda 2>0$)	Both Markets ($\lambda 1<0$ and $\lambda 2>0$)	Ambiguous ($\lambda 1>0$ or $\lambda 2<0$)	Neither
AAA	3	0	0	1	14
AA	6	0	0	3	8
A	11	0	1	4	2
BBB	9	0	2	2	0
BBB-	8	0	0	1	1

2006-2	Only Bond Market ($\lambda 1<0$)	Only CDS Market ($\lambda 2>0$)	Both Markets ($\lambda 1<0$ and $\lambda 2>0$)	Ambiguous ($\lambda 1>0$ or $\lambda 2<0$)	Neither
AAA	0	0	0	4	14
AA	17	0	0	0	2
A	12	0	0	1	3
BBB	2	1	1	1	1
BBB-	2	1	0	0	0

2007-1	Only Bond Market ($\lambda 1<0$)	Only CDS Market ($\lambda 2>0$)	Both Markets ($\lambda 1<0$ and $\lambda 2>0$)	Ambiguous ($\lambda 1>0$ or $\lambda 2<0$)	Neither
AAA	0	0	0	4	16
AA	13	0	0	0	7
A	11	1	0	2	1
BBB	3	0	0	0	1
BBB-	2	0	2	0	1

2007-2	Only Bond Market ($\lambda 1<0$)	Only CDS Market ($\lambda 2>0$)	Both Markets ($\lambda 1<0$ and $\lambda 2>0$)	Ambiguous ($\lambda 1>0$ or $\lambda 2<0$)	Neither
AAA	1	0	0	4	15
AA	5	0	0	1	13
A	14	1	0	0	1
BBB	4	0	0	0	1
BBB-	3	1	0	0	1

Panel B shows a count of the speed of adjustment coefficients from the VECM model that are significant at the 10% level. Column 2 is a count of all of the relationships where only $\lambda 1$ is significant and negative, indicating price discovery occurs in the bond market. Column 3 is a count of all of the relationships where only $\lambda 2$ is signficant and positive, indicating price discovery occurs in the CDS market. Column 4 is a count of all the relationships where both $\lambda 1$ and $\lambda 2$ are significant, which suggests that both markets share in price discovery. Column 5 is a count of all of the relationships where either coefficient is significant, but has the wrong sign. Lastly, column 6 is a count of all relationships where neither sign is significant.

Table VIII Cont.

Panel C: Hasbrouck and Granger-Gonzalo Measures for Relationships with Both Markets Playing Significant Role

2006-1	**Both Markets (λ1<0 and λ2>0)**	**Dominant CDS Market Discovery (Lower Bound >0.5 & GG>0.5)**	**Conflicting Results**
AAA	0	0	0
AA	0	0	0
A	1	0	1
BBB	2	0	2
BBB-	0	0	0

2006-2	**Both Markets (λ1<0 and λ2>0)**	**Dominant CDS Market Discovery (Lower Bound >0.5 & GG>0.5)**	**Conflicting Results**
AAA	0	0	0
AA	0	0	0
A	0	0	0
BBB	1	0	1
BBB-	0	0	0

2007-1	**Both Markets (λ1<0 and λ2>0)**	**Dominant CDS Market Discovery (Lower Bound >0.5 & GG>0.5)**	**Conflicting Results**
AAA	0	0	0
AA	0	0	0
A	0	0	0
BBB	0	0	0
BBB-	2	0	1

2007-2	**Both Markets (λ1<0 and λ2>0)**	**Dominant CDS Market Discovery (Lower Bound >0.5 & GG>0.5)**	**Conflicting Results**
AAA	0	0	0
AA	0	0	0
A	0	0	0
BBB	0	0	0
BBB-	0	0	0

Panel C represents the Hasbrouck and Granger-Gonzalo measures to see which market dominants price discovery. The ABCDS market would be considered the dominant market if either variable is over 0.5.

Table IX

Vector Error Correction Model for Price Discovery and Information Flow from Remittance Reports

Panel A: Mean and Median Error Correction & Remittance Report Coefficients by Subindex

2006-1	**Available**	**Coint**	**Mean λ1**	**Median λ1**	**Mean λ2**	**Median λ2**	**Mean β1**	**Median β1**	**Mean β2**	**Median β2**
AAA	18	18	-0.0016	-0.0006	0.0000	-0.0001	-0.3880	-0.1536	0.0013	0.0009
AA	17	17	-0.0104	-0.0041	0.0000	-0.0001	-2.1490	-0.4521	0.3198	-0.0028
A	19	18	-0.0354	-0.0219	-0.0111	-0.0009	58.5754	-0.7461	-1.0699	-0.0065
BBB	19	13	-0.0394	-0.0360	-0.0272	-0.0012	1.5333	1.2389	-7.0439	0.0616
BBB-	19	10	-0.0421	-0.0246	0.0138	0.0000	2.0326	2.8339	2.7633	-1.9156

2006-2	**Available**	**Coint**	**Mean λ1**	**Median λ1**	**Mean λ2**	**Median λ2**	**Mean β1**	**Median β1**	**Mean β2**	**Median β2**
AAA	18	18	-0.0014	-0.0012	-0.0001	-0.0001	-0.1223	-0.1210	-0.0043	-0.0043
AA	20	19	-0.0172	-0.0115	0.0003	-0.0008	0.2377	0.0074	0.3608	0.1601
A	19	17	-0.0207	-0.0224	-0.0011	-0.0029	0.4500	0.2327	2.7763	1.9448
BBB	19	6	0.1491	-0.0295	0.0369	0.0206	-483.6628	-0.4867	0.6825	0.2503
BBB-	18	3	-0.0505	-0.0367	0.0094	0.0150	2.5738	2.2694	1.5180	0.0959

2007-1	**Available**	**Coint**	**Mean λ1**	**Median λ1**	**Mean λ2**	**Median λ2**	**Mean β1**	**Median β1**	**Mean β2**	**Median β2**
AAA	20	20	-0.0009	-0.0007	-0.0001	-0.0001	-0.0665	-0.0741	0.0167	-0.0062
AA	20	20	-0.0077	-0.0056	0.0001	-0.0005	-0.2203	-0.2705	0.3186	0.3020
A	19	15	-0.0971	-0.0256	0.0006	-0.0004	-30.8940	0.1336	0.2528	0.1069
BBB	18	4	-0.0389	-0.0269	-0.0014	-0.0008	0.4888	-0.5284	0.5072	0.5896
BBB-	20	5	-0.0562	-0.0567	0.0291	0.0049	1.4514	1.7137	-0.9047	0.8237

2007-2	**Available**	**Coint**	**Mean λ1**	**Median λ1**	**Mean λ2**	**Median λ2**	**Mean β1**	**Median β1**	**Mean β2**	**Median β2**
AAA	20	20	-0.0022	-0.0013	0.0000	-0.0001	-0.0351	-0.0174	0.0349	0.0112
AA	20	19	-0.0045	-0.0010	-0.0005	-0.0004	-0.0560	-0.0430	0.5043	0.7116
A	20	16	-0.0320	-0.0302	-0.0001	-0.0021	0.9725	0.3269	0.8702	0.8912
BBB	20	5	-0.0110	-0.0074	-0.0037	-0.0052	0.3400	0.0171	1.2147	1.2507
BBB-	18	6	-0.0161	-0.0192	0.0015	0.0015	-0.2513	-0.4282	0.3045	0.1851

Panel A reports the number of ABCDS-bond relationships that are cointegrated using the Johansen et al. (2000) testing procedure out of the number available in the data, the mean and median speed of adjustment coefficients from the modified VECM, which includes an indicator variable for report date, which is equal to 1 for the days before, on, and after the report is released for only the cointegrated relationships. β1 shows the response to the report in the ABCDS market, and β2 shows the response in the bond market. A positive (negative) coefficient indicates a negative (positive) response because the dependent variable is the change in spreads, not prices

Table IX Cont.

Panel B: Market Contributions to Price Discovery

2006-1	Only Bond Market ($\lambda1<0$)	Only CDS Market ($\lambda2>0$)	Both Markets ($\lambda1<0$ and $\lambda2>0$)	Ambiguous ($\lambda1>0$ or $\lambda2<0$)	Neither
AAA	5	0	0	1	12
AA	6	0	0	4	7
A	11	0	1	4	2
BBB	8	0	2	3	0
BBB-	9	0	0	1	0
2006-2	**Only Bond Market ($\lambda1<0$)**	**Only CDS Market ($\lambda2>0$)**	**Both Markets ($\lambda1<0$ and $\lambda2>0$)**	**Ambiguous ($\lambda1>0$ or $\lambda2<0$)**	**Neither**
AAA	0	0	0	6	12
AA	15	0	0	1	3
A	12	0	0	1	3
BBB	2	1	1	1	1
BBB-	2	0	0	0	1
2007-1	**Only Bond Market ($\lambda1<0$)**	**Only CDS Market ($\lambda2>0$)**	**Both Markets ($\lambda1<0$ and $\lambda2>0$)**	**Ambiguous ($\lambda1>0$ or $\lambda2<0$)**	**Neither**
AAA	0	0	0	7	13
AA	12	0	0	1	7
A	11	1	0	2	1
BBB	3	0	0	0	1
BBB-	2	0	2	0	1
2007-2	**Only Bond Market ($\lambda1<0$)**	**Only CDS Market ($\lambda2>0$)**	**Both Markets ($\lambda1<0$ and $\lambda2>0$)**	**Ambiguous ($\lambda1>0$ or $\lambda2<0$)**	**Neither**
AAA	1	0	0	3	16
AA	4	0	0	1	14
A	14	0	0	0	2
BBB	4	0	0	0	1
BBB-	3	1	0	0	1

Panel B shows a count of the speed of adjustment coefficients from the VECM model that are significant at the 10% level. Column 2 is a count of all of the relationships where only $\lambda1$ is significant and negative, indicating price discovery occurs in the bond market. Column 3 is a count of all of the relationships where only $\lambda2$ is signficant and positive, indicating price discovery occurs in the CDS market. Column 4 is a count of all the relationships where both $\lambda1$ and $\lambda2$ are significant, which suggests that both markets share in price discovery. Column 5 is a count of all of the relationships where either coefficient is significant, but has the wrong sign. Lastly, column 6 is a count of all relationships where neither sign is significant.

Table IX Cont.

Panel C: Hasbrouck and Granger-Gonzalo Measures for Relationships with Both Markets Playing

2006-1	**Both Markets (λ1<0 and λ2>0)**	**Dominant CDS Market Discovery (Lower Bound >0.5 & GG>0.5)**	**Conflicting Results**
AAA	0	0	0
AA	0	0	0
A	1	0	1
BBB	2	1	1
BBB-	0	0	0

2006-2	**Both Markets (λ1<0 and λ2>0)**	**Dominant CDS Market Discovery (Lower Bound >0.5 & GG>0.5)**	**Conflicting Results**
AAA	0	0	0
AA	0	0	0
A	0	0	0
BBB	1	0	1
BBB-	0	0	0

2007-1	**Both Markets (λ1<0 and λ2>0)**	**Dominant CDS Market Discovery (Lower Bound >0.5 & GG>0.5)**	**Conflicting Results**
AAA	0	0	0
AA	0	0	0
A	0	0	0
BBB	0	0	0
BBB-	2	0	2

2007-2	**Both Markets (λ1<0 and λ2>0)**	**Dominant CDS Market Discovery (Lower Bound >0.5 & GG>0.5)**	**Conflicting Results**
AAA	0	0	0
AA	0	0	0
A	0	0	0
BBB	0	0	0
BBB-	0	0	0

Panel C represents the Hasbrouck and Granger-Gonzalo results to see which market dominants price discovery. The ABCDS market would be considered the dominant market if either variable is over 0.5. If both measures how the CDS market as dominant, then it is counted in column 3. If the measures provide conflicting results, it is show in column 4.

Table IX Cont.

Panel D: Report Date Modification

2006-1	CDS Market Response Only Positive: (β1<0)	CDS Market Response Only Negative: (β1>0)	Bond Market Response Only Positive: (β2<0)	Bond Market Response Only Negative: (β2>0)	Both	Respond Same Pos.	Respond Same Neg.	Respond Differently Pos/Neg	Respond Differently Neg/Pos
AAA	8	0	0	1	0				
AA	6	0	0	1	0				
A	3	0	3	2	0				
BBB	0	1	3	3	1		1		
BBB-	1	1	1	0	2		1		1

2006-2	CDS Market Response Only Positive: (β1<0)	CDS Market Response Only Negative: (β1>0)	Bond Market Response Only Positive: (β2<0)	Bond Market Response Only Negative: (β2>0)	Both	Respond Same Pos.	Respond Same Neg.	Respond Differently Pos/Neg	Respond Differently Neg/Pos
AAA	1	1	1	2	0				
AA	1	1	0	3	1		1		
A	0	2	0	6	1		1		
BBB	0	2	0	3	0				
BBB-	0	3	0	3	1				1

2007-1	CDS Market Response Only Positive: (β1<0)	CDS Market Response Only Negative: (β1>0)	Bond Market Response Only Positive: (β2<0)	Bond Market Response Only Negative: (β2>0)	Both	Respond Same Pos.	Respond Same Neg.	Respond Differently Pos/Neg	Respond Differently Neg/Pos
AAA	0	0	0	2	0				
AA	4	0	0	7	0				
A	0	0	1	2	1			1	
BBB	0	1	0	10	1		1		
BBB-	0	2	0	4	2		2		

2007-2	CDS Market Response Only Positive: (β1<0)	CDS Market Response Only Negative: (β1>0)	Bond Market Response Only Positive: (β2<0)	Bond Market Response Only Negative: (β2>0)	Both	Respond Same Pos.	Respond Same Neg.	Respond Differently Pos/Neg	Respond Differently Neg/Pos
AAA	1	0	0	6	0				
AA	0	0	0	11	1			1	
A	0	1	0	8	2		2		
BBB	0	0	0	9	1		1		
BBB-	1	1	0	5	1		1		

Panel D presents a summary of each market's response to the information contained in the remittance reports. Columns 2 and 3 show the results if the ABCDS market is the only one to respond, which means only β1 is significant. Column 2 shows a count of positive responses, and Column 3 shows negative responses. Columns 4 and 5 show the results if the bond market is the only one to respond, which means only β2 is significant. If the response is positive, then it is recorded in Column 4 and if the response is negative, then it is recorded in Column 5. If both markets respond, meaning both β1 and β2 are significant, then Columns 7 and 8 show the results if they are the same, both positive or both negative, respectively. Lastly, Columns 9 and 10 show if the markets respond differently to the informtion release. Column 9 (10) shows a count when the ABCDS market responds positively (negatively), but the bond market responds negatively (positively).

Table X: VECM Analysis: Market Contributions to Price Discovery for the ABCDS and ABX Markets

Index	λ1	t-stat	λ2	t-stat	lower	mid	upper	GG	ABX Dom? HAS	ABX Dom? GG
ABX.HE.AAA.06-1	0.000	-0.648	0.000	0.070	0.011	0.031	0.051	0.356	0	0
ABX.HE.AA.06-1	-0.002	-1.098	0.025*	1.849	0.733	0.737	0.742	0.924	1	1
ABX.HE.A.06-1	-0.011**	-2.098	0.079***	3.886	0.767	0.772	0.776	0.874	1	1
ABX.HE.BBB.06-1	-0.032***	-3.707	0.004	1.067	0.076	0.078	0.079	0.119	0	0
ABX.HE.BBB-.06-1	-0.028***	-3.548	0.010*	1.722	0.188	0.194	0.200	0.266	0	0

Index	λ1	t-stat	λ2	t-stat	lower	mid	upper	GG	ABX Dom? HAS	ABX Dom? GG
ABX.HE.AAA.06-2	-0.001	-1.094	0.001	0.237	0.044	0.058	0.073	0.628	0	1
ABX.HE.AA.06-2	-0.008*	-1.869	0.063***	2.605	0.644	0.656	0.669	0.885	1	1
ABX.HE.A.06-2	-0.004	-0.985	0.028**	2.051	0.806	0.810	0.814	0.885	1	1
ABX.HE.BBB.06-2	-0.001	-0.276	0.365***	5.771	0.995	0.997	0.998	0.999	1	1
ABX.HE.BBB-.06-2	-0.001	-0.343	0.028**	2.136	0.974	0.974	0.975	0.969	1	1

Index	λ1	t-stat	λ2	t-stat	lower	mid	upper	GG	ABX Dom? HAS	ABX Dom? GG
ABX.HE.AAA.07-1	-0.001	-1.447	0.001	0.275	0.035	0.039	0.043	0.625	0	1
ABX.HE.AA.07-1	-0.006**	-2.086	0.033	1.663	0.385	0.389	0.394	0.854	0	1
ABX.HE.A.07-1	0.000	0.150	0.348***	7.446	1.000	1.000	1.000	1.001	1	1
ABX.HE.BBB.07-1	0.001	0.792	0.036**	2.213	0.882	0.884	0.887	1.035	1	1
ABX.HE.BBB-.07-1	0.002	0.996	0.052***	2.724	0.881	0.885	0.890	1.033	1	1

Index	λ1	t-stat	λ2	t-stat	lower	mid	upper	GG	ABX Dom? HAS	ABX Dom? GG
ABX.HE.AAA.07-2	-0.001	-1.451	0.004	0.534	0.117	0.127	0.138	0.863	0	1
ABX.HE.AA.07-2	-0.003	-1.529	0.024	1.485	0.484	0.486	0.487	0.888	0	1
ABX.HE.A.07-2	0.001	0.753	0.049**	2.519	0.918	0.919	0.920	1.021	1	1
ABX.HE.BBB.07-2	0.000	0.109	0.028*	1.92	0.997	0.998	0.998	1.007	1	1
ABX.HE.BBB-.07-2	0.002	1.196	0.063***	3.137	0.872	0.875	0.877	1.035	1	1

This table presents the speed of adjustment coefficients from the unmodified VECM between the ABX and its coresponding ABCDS portfolio. If price discovery occurs in the ABCDS portfolio (ABX), then λ1 (λ2) should be negative (positive) and significant. We also present the lower, middle, and upper measures for the Hasbrouck measures, following Blanco, Brennan, and Marsh (2005). The last two columns show whether price discovery is dominant in the ABX based on the Hasbrouck measures (Column 10) and the Granger-Gonzalo measure (Column 11). For the ABX to be considered dominant either measure must be greater than 0.50.

Table XI: Modified VECM Analysis: Market Contributions to Price Discovery for the ABCDS and ABX Markets

Index	λ1	t-stat	λ2	t-stat	β1	t-stat	β2	t-stat	lower	mid	upper	GG	ABX Dom? HAS	ABX Dom? GG
ABX.HE.AAA.06-1	-0.001	-1.527	0.000	-0.042	-12.217**	-2.395	-7.207	-0.277	0.00	0.01	0.01	-0.17	0	0
ABX.HE.AA.06-1	-0.005**	-2.413	0.021	1.535	-72.796***	-4.721	-93.868	-0.832	0.29	0.29	0.29	0.82	0	1
ABX.HE.A.06-1	-0.007	-1.349	0.081***	3.963	-450.827***	-4.921	-282.235	-0.813	0.89	0.89	0.90	0.92	1	1
ABX.HE.BBB.06-1	-0.023***	-2.581	0.003	0.776	-2,960.03***	-4.359	343.724	1.072	0.08	0.09	0.09	0.12	0	0
ABX.HE.BBB-.06-1	-0.018**	-2.288	0.009	1.410	-3,154.09***	-5.614	523.047	1.227	0.27	0.28	0.29	0.32	0	0

Index	λ1	t-stat	λ2	t-stat	β1	t-stat	β2	t-stat	lower	mid	upper	GG	ABX Dom? HAS	ABX Dom? GG
ABX.HE.AAA.06-2	-0.001	-1.502	0.002	0.422	-8.716	-1.325	28.279	0.552	0.07	0.09	0.11	0.69	0	1
ABX.HE.AA.06-2	-0.012***	-2.744	0.069***	2.799	-128.038***	-4.546	195.923	1.244	0.49	0.51	0.53	0.85	0	1
ABX.HE.A.06-2	-0.003	-0.772	0.028**	2.037	-282.601***	-5.188	47.485	0.233	0.87	0.87	0.88	0.91	1	1
ABX.HE.BBB.06-2	-0.001	-0.660	0.356***	5.635	-389.955***	-6.757	-5,018***	-2.666	0.99	0.99	0.99	1.00	1	1
ABX.HE.BBB-.06-2	0.000	-0.077	0.027**	2.109	-445.740***	-8.352	209.930	0.749	1.00	1.00	1.00	0.99	1	1

Index	λ1	t-stat	λ2	t-stat	β1	t-stat	β2	t-stat	lower	mid	upper	GG	ABX Dom? HAS	ABX Dom? GG
ABX.HE.AAA.07-1	-0.001	-1.593	0.002	0.399	-3.573	-0.675	17.887	0.385	0.06	0.06	0.07	0.69	0	1
ABX.HE.AA.07-1	-0.006**	-2.232	0.033*	1.673	-67.71***	-4.363	48.777	0.424	0.36	0.36	0.37	0.85	0	1
ABX.HE.A.07-1	0.000	-0.328	0.342***	7.307	-129.505***	-5.832	-999.093	-1.436	1.00	1.00	1.00	1.00	1	1
ABX.HE.BBB.07-1	0.000	-0.048	0.039**	2.325	-172.137***	-6.739	286.980	1.029	1.00	1.00	1.00	1.00	1	1
ABX.HE.BBB-.07-1	0.000	0.018	0.055***	2.858	-202.359***	-7.019	380.941	1.133	1.00	1.00	1.00	1.00	1	1

Index	λ1	t-stat	λ2	t-stat	β1	t-stat	β2	t-stat	lower	mid	upper	GG	ABX Dom? HAS	ABX Dom? GG
ABX.HE.AAA.07-2	-0.001	-1.509	0.007	0.846	-2.140	-0.439	77.343	0.930	0.23	0.25	0.26	0.91	0	1
ABX.HE.AA.07-2	-0.002	-1.184	0.023	1.438	-54.36***	-4.341	52.381	0.505	0.59	0.60	0.60	0.91	1	1
ABX.HE.A.07-2	0.000	0.246	0.051***	2.581	-99.017***	-5.726	207.578	0.806	0.99	0.99	0.99	1.01	1	1
ABX.HE.BBB.07-2	0.000	0.125	0.028*	1.918	-136.757***	-5.616	45.762	0.222	1.00	1.00	1.00	1.01	1	1
ABX.HE.BBB-.07-2	0.001	0.745	0.064***	3.155	-120.615***	-4.772	102.895	0.353	0.95	0.95	0.95	1.02	1	1

This table presents the speed of adjustment coefficients from the modified VECM between the ABX and its coresponding ABCDS portfolio.If price discovery occurs in the ABCDS portfolio (ABX), then λ1 (λ2) should be negative (positive) and significant. If information from the remittance report flows to the ABX or the ABCDS portfolio, it is captured by β1 and β2, respectively. A positive (negative) response would have a negative (positive) coefficient because the dependent is change in spreads in the respective markets. We also present the lower, middle, and upper measures for the Hasbrouck measures, following Blanco, Brennan, and Marsh (2005). The last two columns show whether price discovery is dominant in the ABX based on the Hasbrouck measures (Column 10) and the Granger-Gonzalo measure (Column 11).

Table XII: Regression of Weekly Spread Changes in the Bond and ABCDS Markets by Credit Rating

Panel A: Bond Spreads

	AAA	AA	A	BBB	BBB-
Lag ΔBond Spread	0.499***	0.529***	0.477***	0.564***	0.507***
Δ Sub	-0.005	0.075	-5.323*	-4.605	-3.600
Acc. Feature	-0.114**	-0.660	-3.170	3.788	4.736
Δ Loss	0.726	2.971	-10.960	-580.900	84.130
Δ Loss Squared	2.765	-10.700	20.900	-897.800	187.100
Poor Info Quality	-0.227**	0.192	-47.780***	-6.159	-42.79**
Loss Tranche	0.027	1.765**	0.080	17.650***	11.080*
Short Interest Ratio	0.000	0.0343*	-0.297*	-0.079	-0.155
Counter party risk	0.001***	0.0169***	-0.003	0.013	0.061*
Funding Cost	-0.026	1.019***	-1.584	-1.252	3.868
S&P 500	0.416**	1.387	11.680	25.660	32.720
Δ Spot	0.003	-2.372***	0.830	2.178	-5.977
Δ Slope	0.102***	-1.150***	1.220	-9.002*	-10.940***
Constant	0.049	-2.629***	29.77***	3.051	7.385*
Observations	13,174	13,100	11,080	7,958	7,299
Number of bonds	79	80	80	80	80
Adjusted R-squared	0.697	0.771	0.68	0.756	0.745

Panel B: ABCDS Spreads

	AAA	AA	A	BBB	BBB-
Lag ΔABCDS Spread	-0.143***	-0.144***	-0.609***	2.991***	-0.196***
Δ Sub	0.037	0.487	-4.454	415.600	3.543
Acc. Feature	0.003	-0.497	13.420	-521.700	-1.900
Δ Loss	5.912	25.060	106.300	16,181.00	-967.4***
Δ Loss Squared	10.750	-51.090	36.400	22,299.00	3443.000
Poor Info Quality	-0.753	-2.788	-31.830	3,879.00	-8.036
Loss Tranche	0.330	-1.581	6.074	1,999.00*	12.950***
Short Interest Ratio	0.016*	-0.032	-1.295	-4.869	0.056
Counter party risk	0.006***	0.005	-0.560	-1.000	0.028*
Funding Cost	-0.145	-0.845	6.404	-259.000	-2.980***
S&P 500	-11.630***	-7.626	187.400	8,457.00	-5.414
Δ Spot	0.338	2.877	-37.820	-716.500	1.293
Δ Slope	0.363	3.621*	-50.440	-297.800	-5.756
Constant	-0.567	2.269	54.270	-212.200	-1.694
Observations	11,862	12,091	10,519	7,781	6,998
Number of bonds	75	77	77	76	75
Adjusted R-squared	0.019	0.014	0.366	0.493	0.031

This table reports results for the fixed-effects panel regression of weekly changes (Wed-to-Wed) in spreads of the bond and ABCDS from July 2007-December 2010. All t-statistics are corrected for AR(1) errors, following Baltagi and Wu (1999). Bond spread is the difference between yield to maturity and 1 month LIBOR. ABCDS is the spread on the ABCDS contract. Δ Sub Pct is the month to month change in the subordination percent for each bond. Acceleration feature is an indicator variable defined as 1 if the current overcollateralization amount is less than the target amount and 0 otherwise. Dist.-to-Loss Trigger is the difference between a threshold percent and the percent of aggregate losses. Change controls for changes in trigger distance while the Squared ΔDist.-to-Loss accounts for the acceleration of changes in trigger distance. Info Quality is the coefficient of variation of aggregate loss data from three MBS deal level data sources. Short Interest Ratio serves as a proxy for insurance demand imbalances and is the change in the market ratio of the market value of shares sold short to the average daily trading volume over the month for the financial services ETF (Ticker: XLF). Counterparty Risk is a proxy for risk associated with the seller of an ABDS contract failing to uphold its contractual obligations. Funding Cost is the difference between 3 month LIBOR and the general collateral repo rate. S&P 500 Return is calculated as the percent change in the price of the S&P 500 index over the month. ΔSpot Rate is the month to month change in the 1-year CMT rate. ΔSlope is the change in the slope, which is defined as the difference between the 10-year CMT rate and the 1-year CMT rate. *p<0.10, **p<0.05, ***p<0.01.

Table XIII: Regression of Weekly Spread Changes in the ABCDS Portfolios and the ABX Index by Credit Rating

Panel A: ABCDS Portfolio Spreads

	AAA	AA	A	BBB	BBB-
Lag ΔPort ABCDS Spread	-0.064	-0.154***	-0.600***	-0.473***	-0.230***
ΔSub	0.423	0.854	-8.140	103.300	-6.069
ΔLoss	21.480	136.300*	-121.600	-283.300	-144.800
ΔLoss Squared	343.500	1,529.0	-1,178.0	6,551.0	-2,959.0
Poor Info Quality	0.207	-5.315	-18.720	-22.660	-13.840
Short Interest Ratio	0.007	-0.057	0.127	-0.537	0.095
Counter party risk	0.004	0.002	0.034	-0.055	0.036
Funding Cost	-0.238	-0.831	-2.104	9.423	-1.395
S&P 500	-11.880***	-3.433	99.950	215.200	14.380
ΔSpot	0.442	2.713	5.404	-35.070	4.264
ΔSlope	0.389	4.313	8.183	-13.550	-2.873
Constant	-0.485	4.065	0.925	13.870	-0.165
Observations	650	659	660	660	660
R-squared	0.014	0.013	0.348	0.212	0.041

Panel B: ABX Spreads

	AAA	AA	A	BBB	BBB-
Lag ΔABX Spread	-0.194***	-0.050	-0.150***	-0.368***	-0.367***
ΔSub	0.429	1.629**	3.007	14.160	-13.960
ΔLoss	62.170***	61.090*	-42.220	-62.440	85.500
ΔLoss Squared	1,186***	3,280***	2,004*	366.400	-8,717.00
Poor Info Quality	0.237	-3.795*	-18.230***	-54.290	-67.620**
Short Interest Ratio	0.0200*	-0.009	-0.001	0.031	-0.070
Counter party risk	0.008***	0.002	0.016	0.070	0.047
Funding Cost	0.078	-0.861**	-4.454***	-15.18**	-17.50***
S&P 500	-15.160***	-35.750***	-110.90***	-440.50***	-421.00***
ΔSpot	-0.647	1.019	7.904*	65.70**	67.00***
ΔSlope	-1.388***	-1.502	-6.213**	-61.27***	-33.65**
Constant	-1.480***	2.100	7.252*	15.500	23.610
Observations	651	651	651	651	648
R-squared	0.263	0.093	0.122	0.184	0.189

This table reports results for the fixed-effects panel regression of weekly changes (Wed-to-Wed) in spreads of the bond and ABCDS from July 2007-December 2010 grouped by initial bond credit rating. All t-statistics are corrected for AR(1) errors, following Baltagi and Wu (1999). All ABX level explanatory variables are the outstanding factor-adjusted equally weighted averages for the referenced cash bonds in the ABX index. ΔSub. Pct is the month to month change in the subordination percent. Distance-to-loss trigger is the difference between a threshold percent and the percent of aggregate losses. ΔDist-to-Loss controls for changes in trigger distance while the squared ΔDist.-to-Loss accounts for the acceleration of changes in trigger distance. Info quality is the coefficient of variation of aggregate loss data from three MBS deal-level data sources. Short Interest Ratio serves as a proxy for insurance demand imbalances and is the ratio of the market value of shares sold short to the average daily trading volume over the month for the financial services ETF (Ticker: XLF). Counterpary risk is the average of the CDS spreads for the ABX market makers. Funding cost is the difference between 3 month LIBOR and the general collateral repo rate. S&P 500 return is the percent change in the price of the S&P 500 index over the month. ΔSpot is the month to month change in the 1-year CMT rate. ΔSlope is the change in the slope, which is defined as the difference between the 10-year CMT rate and the 1-year CMT rate. *p<0.10, **p<0.05, and ***p<0.01.

Table XIV: Principal Component Analysis on Model Residuals

Bonds	**First**	**Second**	**Adjusted R2**	**Unexplained Portion**	**Potential Impact**
AAA	0.282	0.265	0.697	0.303	0.086
AA	0.306	0.207	0.771	0.229	0.070
A	0.507	0.300	0.680	0.320	0.162
BBB	0.517	0.263	0.756	0.244	0.126
BBB-	0.691	0.139	0.745	0.255	0.176

ABCDS	**First**	**Second**	**Adjusted R2**	**Unexplained Portion**	**Potential Impact**
AAA	0.394	0.139	0.019	0.981	0.386
AA	0.427	0.119	0.014	0.986	0.421
A	0.681	0.098	0.366	0.634	0.432
BBB	0.483	0.306	0.493	0.507	0.245
BBB-	0.270	0.213	0.031	0.969	0.262

Port ABCDS	**First**	**Second**	**Adjusted R2**	**Unexplained Portion**	**Potential Impact**
AAA	0.556	0.293	0.014	0.986	0.548
AA	0.744	0.225	0.013	0.987	0.735
A	0.579	0.398	0.348	0.652	0.378
BBB	0.993	0.004	0.212	0.788	0.782
BBB-	0.388	0.323	0.041	0.959	0.372

ABX	**First**	**Second**	**Adjusted R2**	**Unexplained Portion**	**Potential Impact**
AAA	0.877	0.063	0.263	0.737	0.646
AA	0.740	0.145	0.093	0.907	0.672
A	0.828	0.111	0.122	0.878	0.727
BBB	0.947	0.049	0.184	0.816	0.773
BBB-	0.942	0.054	0.189	0.811	0.764

This table presents the results from principal component analysis on the covariances of the residuals from the credit risk models in Tables XII and XIII. We use the combined residuals, which is the sum of the fixed-effects error component and the overall error. First and Second show how much of the variance in residuals is explained by the first and second principal components, respectively. Adjusted R2's are from the credit risk models in Tables XII and XIII. The unexplained portion is 1 minus R2, which approximately represents how much of the variation in the credit spreads lies outside of the credit risk model. Potential impact is the unexplained portion of variation multiplied by the first principal component. This is a simplified measurement of how much of the unexplained portion may be explained by the systematic factor, which is represented by the first principal component. Using our interpretation that the systematic factor is noise trading supply and demand shocks, this is the potential impact of noise traders on credit risk pricing.

Table XV: Regression Analysis of Month End Basis

	AAA	AA	A	BBB	BBB-
Lagged Basis	0.729***	0.910***	0.997***	0.926***	0.609***
Δ Sub Pct.	0.112	-1.83	-8.269**	-5.271	-52.94
Acc. Feature	-0.192	0.831	2.861	12.56	60.02
Δ Dist-to-Loss	-143.300***	11.81	-213.60	411.40	224.90
Sq. Δ Dist-to-Loss	-373.700*	751	-1,197	30,906	242,380
Poor Info. Quality	1.198	-9.371	50.120***	-27.79	-1,057***
Loss Dummy	-1.74	-8.563**	-42.050***	-49.44***	-165.600***
Short Interest Ratio	-0.074**	-0.180	0.940***	1.893***	3.774**
Counterparty Risk	0.016***	-0.049***	0.0497	0.380***	0.248
Funding Cost	-1.267***	-5.548***	0.0536	-14.24***	-15.080
S&P500 Return	-0.156***	-0.425***	-0.105	-0.455	-4.891**
Δ Spot	3.299***	8.406***	-4.074	-24.970***	-63.640
Δ Slope	0.562	2.30	-13.30**	2.450	-32.240
Constant	2.453	12.630**	-45.57***	-100.300***	89.640
Observations	2,511	2,585	2,239	1,626	1,507
Number of bonds	75	77	77	76	74
Adjusted R-squared	0.556	0.791	0.987	0.892	0.457

This table reports results for the fixed-effects panel regression of month-end basis from July 2007-December 2010 grouped by initial bond credit rating. Initial credit rating is used because the bonds included in the ABX subindexes were chosen based on the initial credit rating of the bond. If any bond was subsequently downgraded, the ABX subindex was not altered to reflect the change. All t-statistics are corrected for AR(1) errors, following Baltagi and Wu (1999). Basis approximates the mispricing between the cash and credit derivative markets and is calculated as the difference between the ABCDS spread and the bond spread (yield to maturity (YTM) over 1 month LIBOR) on a MBS bond. Δ Sub Pct. is the month to month change in the subordination percent for each bond. Acceleration feature is an indicator variable, which is defined as 1 if the current overcollateralization amount is less than the target amount and 0 otherwise. Dist.-to-Loss Trigger is the difference between a threshold percent and the percent of aggregate losses. Change controls for changes in trigger distance while the Squared ΔDist.-to-Loss accounts for the acceleration of changes in trigger distance. Info Quality is the coefficient of variation of aggregate loss data from three MBS deal level data sources. Short Interest Ratio serves as a proxy for insurance demand imbalances and is the change in the market ratio of the market value of shares sold short to the average daily trading volume over the month for the financial services ETF (Ticker: XLF). Counterparty Risk is a proxy for risk associated with the seller of an ABDS contract failing to uphold its contractual obligations. Funding Cost is the difference between 3 month LIBOR and the general collateral repo rate. S&P 500 Return is calculated as the percent change in the price of the S&P 500 index over the month. ΔSpot Rate is the month to month change in the 1-year CMT rate. ΔSlope is the change in the slope, which is defined as the difference between the 10-year CMT rate and the 1-year CMT rate. *p<0.10, **p<0.05, ***p<0.01.

Table XVI: Regression Analysis of Month End in Tracking Error

	AAA	AA	A	BBB	BBB-
Lagged ABX Tracking Error	0.794***	0.348***	0.620***	0.611***	0.703***
ABX Δ Sub Pct.	-554.770***	-1,233***	-210.80	367.50	-441.00
ABX Δ Dist-to-Loss	28.800	-150.900	-40.450	-258.900	97.850
ABX Sq. Δ Dist-to-Loss	1,134	1,333	1,582	1,875	-32,452
ABX Poor Info. Quality	-9.484*	-47.100***	-97.410***	-185.800**	-174.800**
Short Interest Ratio	0.058	-0.135	0.252	0.872	0.74
Counterparty Risk	0.0109	0.0417	0.165***	0.419***	0.205*
Funding Cost	0.456	0.78	-4.21	-12	-15.390*
S&P500 Return	-0.0449	0.311	-0.733	1.673	0.389
Δ Spot	-1.844	1.345	-2.405	-3.358	-1.792
Δ Slope	-1.368	-9.390***	-7.316	-4.947	-0.105
Constant	1.494	24.51***	14.610	2.364	25.620
Observations	153	155	156	156	156
Adjusted R-squared	0.696	0.435	0.597	0.517	0.58

This table reports the results for the fixed-effects panel regressions of monthly ABX tracking error from July 2007 to December 2010 based on credit rated subindexes. All t-statistics are corrected for AR(1) errors, following Baltagi and Wu (1999). All ABX level explanatory variables are the outstanding factor-adjusted equally weighted averages for the referenced cash bonds in the ABX index. ΔSub. Pct is the month to month change in the supordination percent. Distance-to-loss trigger is the difference between a threshold percent and the percent of affregate losses. ΔDist-to-Loss controls for changes in trigger distance while the squared ΔDist.-to-Loss accounts for the acceleration of changes in trigger distance. Info quality is the coefficient of variation of aggregate loss data from three MBS deal-level data sources. Short Interest Ratio serves as a proxy for insurance demand imbalances and is the ratio of the market value of shares sold short to the average daily trading volume over the month for the financial services ETF (Ticker: XLF). Counterpary risk is the average of the CDS spreads for the ABX market makers. Funding costs is the difference between 3 month LIBOR and the general colateral repo rate. S&P 500 return is the percent change in the price of the S&P 500 index over the month. ΔSpot is the month to month change in the 1-year CMT rate. ΔSlope is the change in the slope, which is defined as the difference between the 10-year CMT rate and the 1-year CMT rate. *p<0.10, **p<0.05, and ***p<0.01.

Table XVII: List of BloombergNames and Shelf Registrations for ABX deals by vintage

Vintage 1			*Vintage 2*			*Vintage 3*			*Vintage 4*		
BloombergName	**Shelf**	**Months**	**BloombergName**	**Shelf**	**Months**	**BloombergName**	**Shelf**	**Months**	**BloombergName**	**Shelf**	**Months**
ACE 2005-HE7	ACE	60	ACE 2006-NC1	ACE	59	ABFC 2006-OPT2	ABFC	51	ACE 2007-HE4	ACE	44
AMSI 2005-R11	AMSI	60	ARSI 2006-W1	ARSI	59	ACE 2006-NC3	ACE	49	BSABS 2007-HE3	BSABS	45
ARSI 2005-W2	ARSI	60	BSABS 2006-HE3	BSABS	57	BSABS 2006-HE10	BSABS	48	CMLTI 2007-AMC2	CMLTI	45
BSABS 2005-HE11	BSABS	60	CARR 2006-NC1	CARR	58	CARR 2006-NC4	CARR	51	CWL 2007-1	CWL	47
CWL 2005-BC5	CWL	60	CWL 2006-8	CWL	54	CBASS 2006-CB6	CBASS	53	FFMER 2007-2	FFMER	44
FFML 2005-FF12	FFML	60	FFML 2006-FF4	FFML	57	CMLTI 2006-WFH3	CMLTI	50	FFML 2007-FF1	FFML	47
GSAMP 2005-HE4	GSAMP	60	GSAMP 2006-HE3	GSAMP	55	CWL 2006-18	CWL	51	GSAMP 2007-NC1	GSAMP	46
HEAT 2005-8	HEAT	60	HEAT 2006-4	HEAT	56	FFML 2006-FF13	FFML	51	HASC 2007-NC1	HASC	43
JPMAC 2005-OPT1	JPMAC	60	JPMAC 2006-FRE1	JPMAC	59	FHLT 2006-3	FHLT	51	HEAT 2007-2	HEAT	45
LBMLT 2005-WL2	LBMLT	60	LBMLT 2006-1	LBMLT	58	GSAMP 2006-HE5	GSAMP	52	JPMAC 2007-CH3	JPMAC	44
MABS 2005-NC2	MABS	60	MABS 2006-NC1	MABS	58	HEAT 2006-7	HEAT	51	MLMI 2007-MLN1	MLMI	44
MLMI 2005-AR1	MLMI	60	MLMI 2006-HE1	MLMI	59	JPMAC 2006-CH2	JPMAC	49	MSAC 2007-NC3	MSAC	43
MSAC 2005-HE5	MSAC	60	MSAC 2006-HE2	MSAC1	55	LBMLT 2006-6	LBMLT	53	NHEL 2007-2	NHEL	43
NCHET 2005-4	NCHET	60	MSAC 2006-WMC2	MSAC2	54	MABS 2006-NC3	MABS	48	NHELI 2007-2	NHELI	47
RAMP 2005-EFC4	RAMP	60	RAMP 2006-NC2	RAMP	58	MLMI 2006-HE5	MLMI	51	OOMLT 2007-5	OOMLT	44
RASC 2005-KS11	RASC	60	RASC 2006-KS3	RASC	57	MSAC 2006-HE6	MSAC	51	RASC 2007-KS2	RASC	46
SABR 2005-HE1	SABR	60	SABR 2006-OP1	SABR	59	RASC 2006-KS9	RASC	50	SABR 2007-BR4	SABR	43
SAIL 2005-HE3	SAIL	60	SAIL 2006-4	SAIL	54	SABR 2006-HE2	SABR	51	SASC 2007-BC1	SASC	47
SASC 2005-WF4	SASC	60	SASC 2006-WF2	SASC	54	SASC 2006-BC4	SASC	49	SVHE 2007-OPT1	SVHE	44
SVHE 2005-4	SVHE	60	SVHE 2006-OPT5	SVHE	54	SVHE 2006-EQ1	SVHE	51	WMHE 2007-HE2	WMHE	44

This table is a list of the BloombergNames and Shelf registration of the 80 ABX deals by vintage. Month refers to the number of months of data available during the sample period from January 2006-December 2010. The first vintage was launch in January 2006, so it will be the only one which contains deals which have data for the entire sample period. With each index roll, the history of the underlying deals will become shorter.

Table XVIII: Summary Statistics for GMAC-RFC Deal Misreporting

90 Day DQ

Deal Name	Vintage	N	Mean	STD	Min	Max
RAMP 2005 EFC-4	1	60	698,037.45	1,404,760.49	0.00	5,202,978.18
RASC 2005 KS-11	1	0	0.00	0.00	0.00	0.00
RAMP 2006 NC2	2	0	0.00	0.00	0.00	0.00
RASC 2006 KS-3	2	0	0.00	0.00	0.00	0.00
RASC 2006 KS-9	3	0	0.00	0.00	0.00	0.00
RASC 2007 KS-2	4	0	0.00	0.00	0.00	0.00

Liquidations

Deal Name	Vintage	N	Mean	STD	Min	Max
RAMP 2005 EFC-4	1	58	905,556.50	2,346,426.38	-102,673.42	16,893,890.83
RASC 2005 KS-11	1	58	1,125,675.43	1,599,398.98	-8,915.57	5,792,120.18
RAMP 2006 NC2	2	58	260,266.29	640,444.83	-155,101.12	3,253,870.29
RASC 2006 KS-3	2	57	1,047,964.63	1,582,847.95	-113,042.03	5,447,329.61
RASC 2006 KS-9	3	50	1,196,980.64	2,130,549.90	-27,769.13	8,027,414.93
RASC 2007 KS-2	4	46	643,420.31	1,276,847.11	0.00	4,647,168.28

Cumulative Liquidations

Deal Name	Vintage	N	Mean	STD	Min	Max
RAMP 2005 EFC-4*	1	0	0.00	0.00	0.00	0.00
RASC 2005 KS-11*	1	0	0.00	0.00	0.00	0.00
RAMP 2006 NC2	2	58	11,023,834.34	6,267,915.25	-38,007.31	15,250,546.03
RASC 2006 KS-3	2	57	36,588,341.21	25,467,690.95	0.00	59,733,983.88
RASC 2006 KS-9	3	50	38,825,727.50	25,907,124.07	-20,765.02	59,849,031.91
RASC 2007 KS-2	4	46	19,972,185.33	12,573,258.25	0.00	29,597,334.57

Cumulative Realized Loss

Deal Name	Vintage	N	Mean	STD	Min	Max
RAMP 2005 EFC-4	1	58	173,329.19	255,592.50	-267,300.46	1,068,083.20
RASC 2005 KS-11	1	58	8,397.75	63,984.61	-218.92	487,288.35
RAMP 2006 NC2	2	58	0.00	0.00	0.00	0.00
RASC 2006 KS-3	2	57	-253,737.20	414,034.35	-1,103,169.63	264.42
RASC 2006 KS-9	3	42	43,168.05	279,760.97	0.00	1,813,058.31
RASC 2007 KS-2	4	39	0.00	0.00	0.00	0.00

This table presents the summary statistics for the misreporting found in the GMAC-RFC deals by data field. The deals in the first vintage have the largest number of observations. Then with each vintage roll, the number of potential observations decreases as the newer deals included in each subsequent vintage are issued and reporting begins. Misreporting is calculated as the number in the remittance report less the amount recorded in ABSNet. A positive number would indicate that ABSNet is underreporting the true balance, whereas a negative number would mean that ABSNet is overreporting. *Indicates that there is no misreporting for the deal because the field contains omitted variables for the sample period.

Table XIX: Summary Statistics and Difference-in-Means Test Results

ABX 2006-1	*Remittance Report Data*					*ABSNet Data*					*DIM Results*		
	N	**Mean**	**Std**	**Min.**	**Max**	**N**	**Mean**	**Std**	**Min.**	**Max**	**DIM**	**p_value**	**EOV**
SMM	1200	2.34	1.41	-10.87	11.93	1134	2.31	2.06	-45.09	11.93	0.03	0.73	No
30 Day DQ (%)	1200	4.43	1.57	0.00	9.94	1200	4.43	1.56	0.00	9.94	0.01	0.93	Yes
60 Day DQ (%)	1200	2.47	1.20	0.00	7.33	1200	2.47	1.20	0.00	7.33	0.00	0.96	Yes
90 Plus Day DQ (%)	1200	6.85	7.13	0.00	37.80	1146	7.10	7.18	0.00	37.80	-0.25	0.41	Yes
Foreclosed (%)	1200	11.90	7.83	0.00	42.65	1200	11.88	7.83	0.00	43.06	0.02	0.99	Yes
Loss Rate	1200	5.07	5.44	0.00	21.01	836	5.22	5.58	0.00	20.05	-0.16	0.53	Yes
REO (%)	1200	5.13	4.61	0.00	27.33	1200	5.11	4.58	0.00	27.33	0.01	0.83	Yes

ABX 2006-2	*Remittance Report Data*					*ABSNet Data*					*DIM Results*		
	N	**Mean**	**Std**	**Min.**	**Max**	**N**	**Mean**	**Std**	**Min.**	**Max**	**DIM**	**p_value**	**EOV**
SMM	1080	2.09	0.96	-2.49	9.39	1079	2.09	0.94	0.00	9.39	0.00	1.00	Yes
30 Day DQ (%)	1080	4.74	1.32	0.02	11.59	1080	4.76	1.33	0.02	11.59	-0.01	0.82	Yes
60 Day DQ (%)	1080	2.77	1.07	0.00	8.52	1080	2.78	1.07	0.00	8.52	0.00	0.96	Yes
90 Plus Day DQ (%)	1080	7.71	7.52	0.00	38.14	1080	7.65	7.50	0.00	38.14	0.05	0.87	Yes
Foreclosed (%)	1080	14.46	8.04	0.00	37.14	1080	14.42	8.05	0.00	37.14	0.04	0.92	Yes
Loss Rate	1080	7.32	7.47	0.00	69.16	889	6.76	6.82	0.00	23.08	0.56	0.08	No
REO (%)	1080	6.16	4.83	0.00	24.55	1080	6.07	4.71	0.00	24.21	0.09	0.67	Yes

ABX 2007-1	*Remittance Report Data*					*ABSNet Data*					*DIM Results*		
	N	**Mean**	**Std**	**Min.**	**Max**	**N**	**Mean**	**Std**	**Min.**	**Max**	**DIM**	**p_value**	**EOV**
SMM	960	1.71	0.81	-2.49	7.32	956	1.53	4.21	-114.28	54.91	0.17	0.21	No
30 Day DQ (%)	960	4.82	1.65	0.02	12.78	959	5.09	1.39	0.71	18.69	-0.28	<0.01	No
60 Day DQ (%)	960	3.04	1.28	0.00	8.79	959	3.20	1.21	0.00	14.47	-0.16	<0.01	No
90 Plus Day DQ (%)	960	10.50	10.15	0.00	50.06	959	11.38	10.66	0.00	50.06	-0.88	0.07	Yes
Foreclosed (%)	960	13.75	7.48	0.00	32.82	959	14.64	7.06	0.00	32.82	-0.88	<0.01	No
Loss Rate	912	8.73	8.59	0.00	36.38	668	7.73	8.07	0.00	34.97	1.00	0.02	No
REO (%)	960	5.36	4.07	0.00	22.37	959	5.41	4.02	0.00	22.46	-0.05	0.80	Yes

ABX 2007-2	*Remittance Report Data*					*ABSNet Data*					*DIM Results*		
	N	**Mean**	**Std**	**Min.**	**Max**	**N**	**Mean**	**Std**	**Min.**	**Max**	**DIM**	**p_value**	**EOV**
SMM	840	1.45	0.74	-0.01	6.86	838	1.43	0.99	-18.21	4.51	0.02	0.61	No
30 Day DQ (%)	840	5.47	1.30	1.41	10.74	840	5.47	1.30	1.41	10.56	0.00	0.94	Yes
60 Day DQ (%)	840	3.36	1.03	0.23	7.26	840	3.36	1.03	0.23	7.26	0.00	0.95	Yes
90 Plus Day DQ (%)	840	10.72	9.05	0.01	44.20	840	10.73	9.06	0.01	44.20	0.00	0.98	Yes
Foreclosed (%)	840	15.58	7.13	0.00	34.22	840	15.60	7.15	0.00	34.31	-0.02	0.96	Yes
Loss Rate	840	9.54	8.71	0.00	38.67	707	9.58	8.79	0.00	38.67	-0.04	0.92	Yes
REO (%)	840	5.05	3.81	0.00	22.74	840	5.05	3.82	0.00	22.82	0.00	0.97	Yes

Each panel reports the summary statistics for the remittance report data and the data directly from ABSNet for each of the four ABX vintages. The last three columns present the results from a difference-in-means (DIM) test. The equality of variance (EOV) column reports whether the variances are statistically the same based on the results of a folded F-test. "Yes" indicates that the sample variances are not significantly different at the 5% level, while a "No" indicates that the sample variances are significantly different. For the DIM p-values, if the sample variances are statistically different, the p-values are from a pooled t-test; otherwise an unpooled t-test is used.

Table XX: Definitions Used in the Construction of Distance to Trigger Variables

60 Plus Day Delinquent Definition

Def. #	Definition
1	DQ 60+ (inc. REO, BK, FCL)
2	DQ 60+, + FCL + REO, + BK
3	DQ 60+ (inc. BK) + FCL + REO
4	DQ 60+ (inc. FCL, REO) (NO BK)
5	DQ 60+, + FCL + REO (NO BK)
6	DQ 60+ (inc. REO, BK, FCL, mods w/n 12 months)
7	DQ 60+ (inc. FCL), +BK, +REO
8	DQ 60+ (inc. FCL, BK), +REO

DQ Ratio Method

Def. #	Definition
1	Ratio
2	Rolling Balance
3	Rolling Rate
4	Average Bal of DQ, Actual Bal of FCL, REO, BK

DQ Credit Enhancement Percent Calculation Method

Def. #	Definition
1	Subcerts/Endpool Bal
2	lower distribution priority certs/end poolbal
3	(End Pool Bal-Class A)/End poolbal
4	(subcerts+oc)/endpoolbal

REO indicates Real Estate Owned. BK means loans in bankruptcy. FCL is for loans in foreclosure. For the DQ 60+ definitions, if in parenthesis, these loans must also be 60 days or more delinquent. If separated by a comma, these loans can just be classified as FCL, BK or REO without consideration of delinquency status.

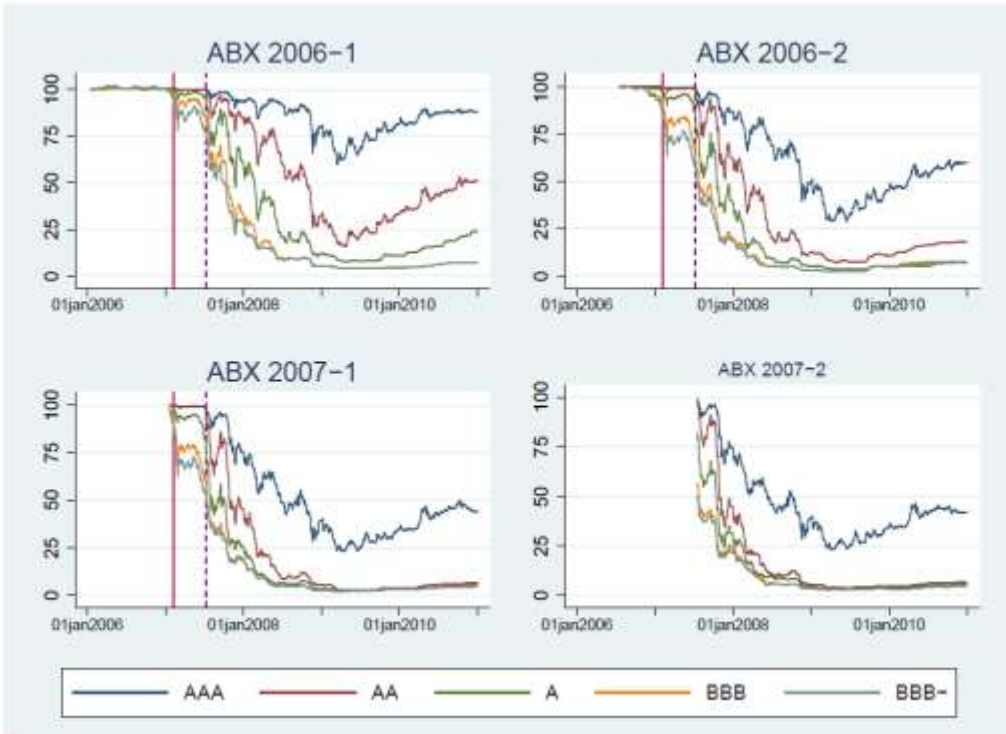

Figure 1. ABX Index by Vintage

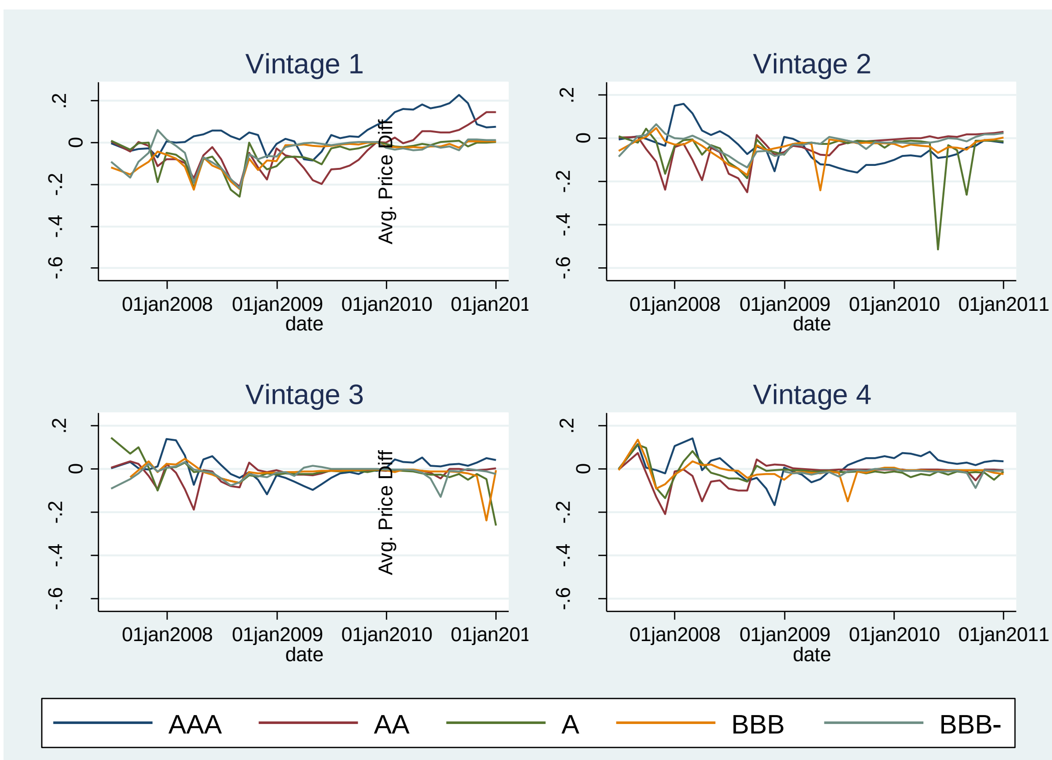

Figure 2. Average Monthly Price Difference for RMBS Bonds By Subindex Across Vintages

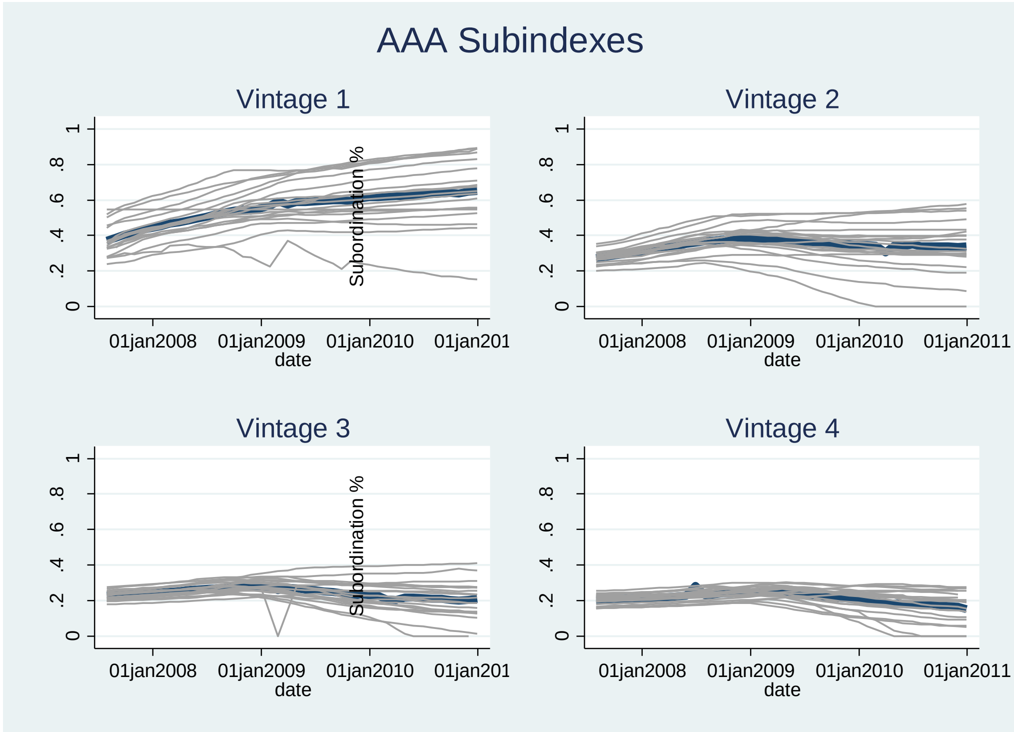

Figure 3. Subordination Levels for the AAA Subindexes

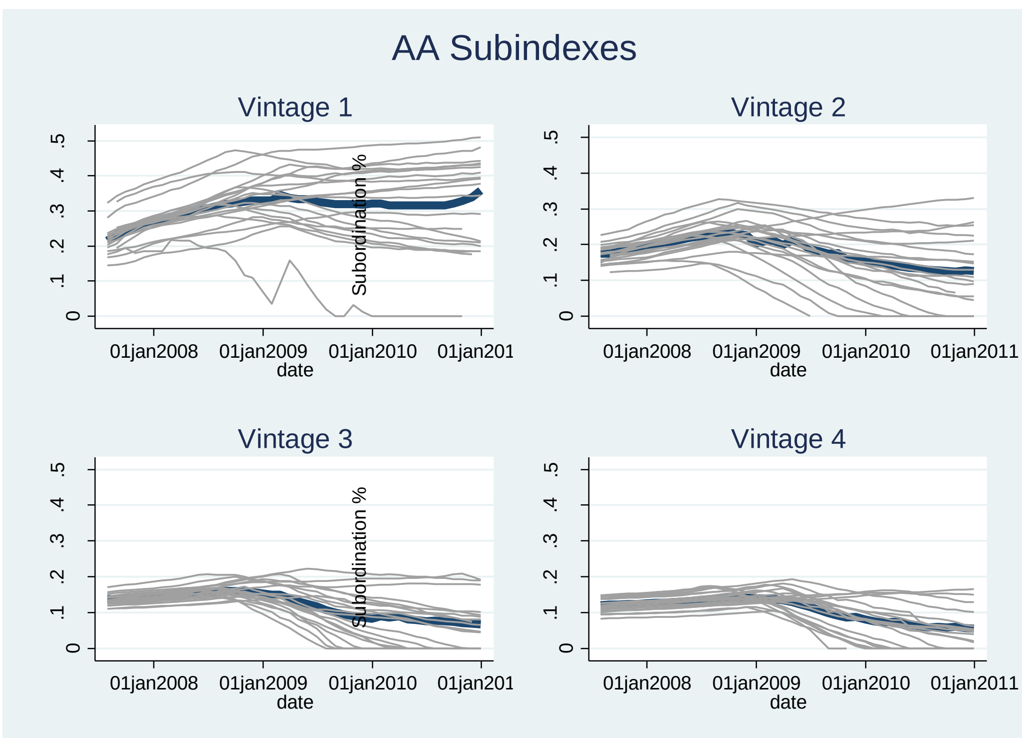

Figure 4. Subordination Levels for the AA Subindexes

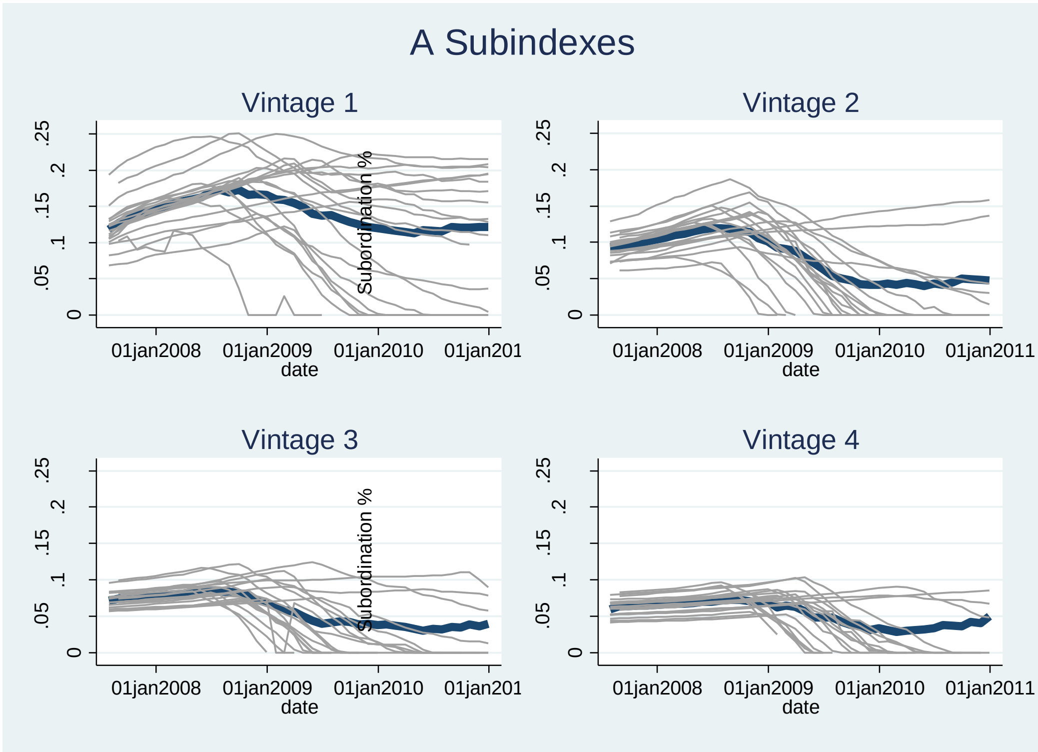

Figure 5. Subordination Levels for the A Subindexes

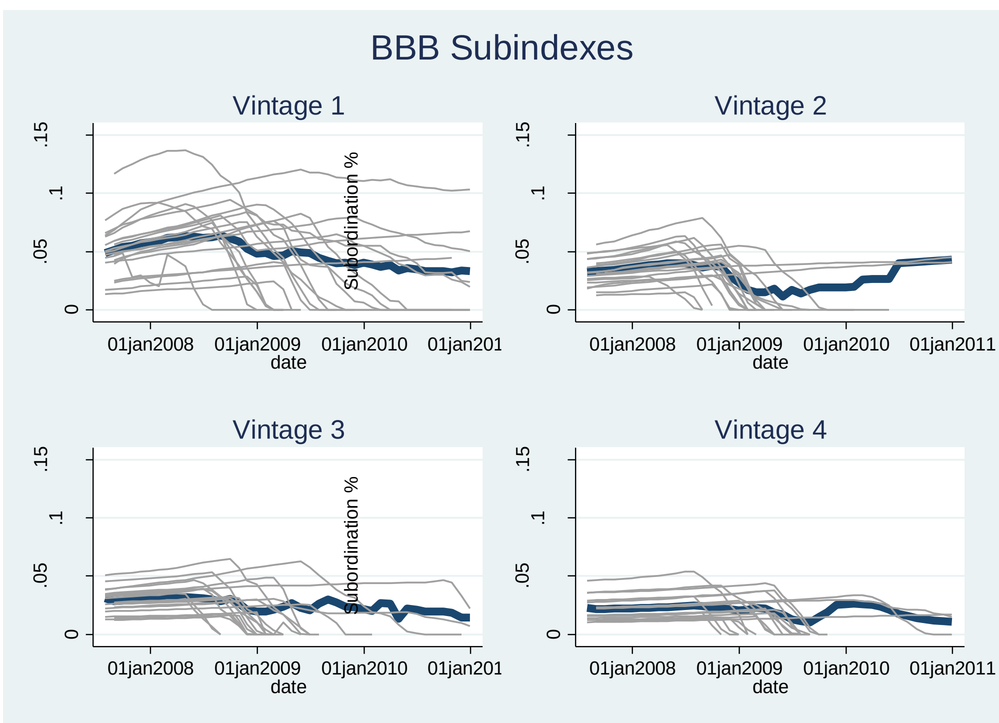

Figure 6. Subordination Levels for the BBB Subindexes

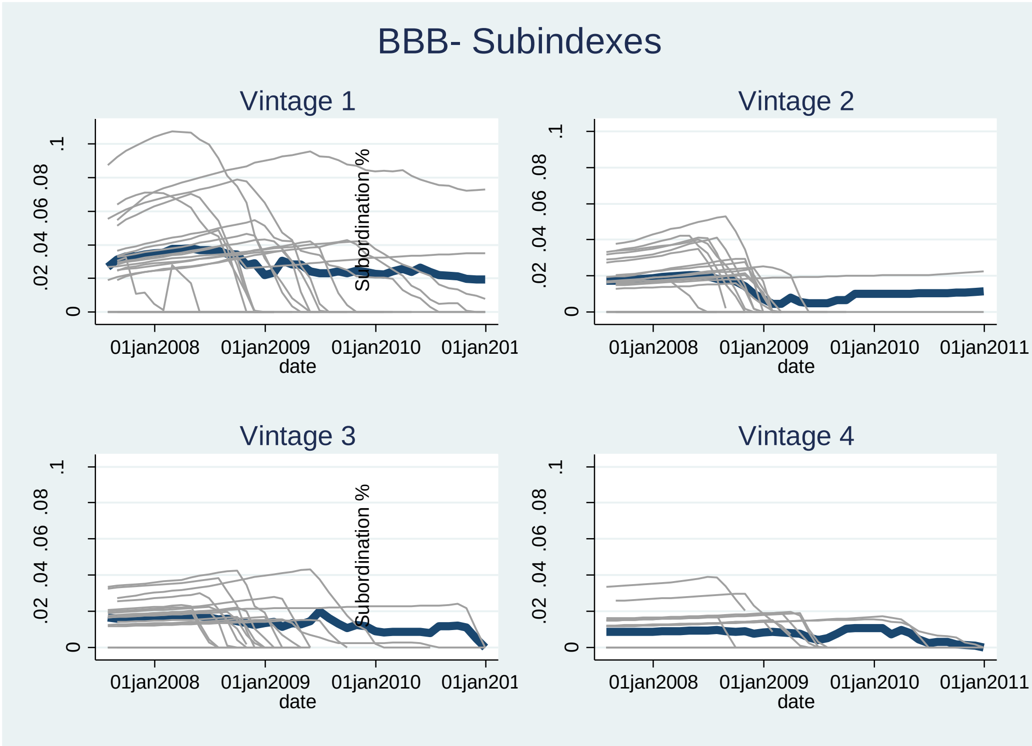

Figure 7. Subordination Levels for the BBB- Subindexes

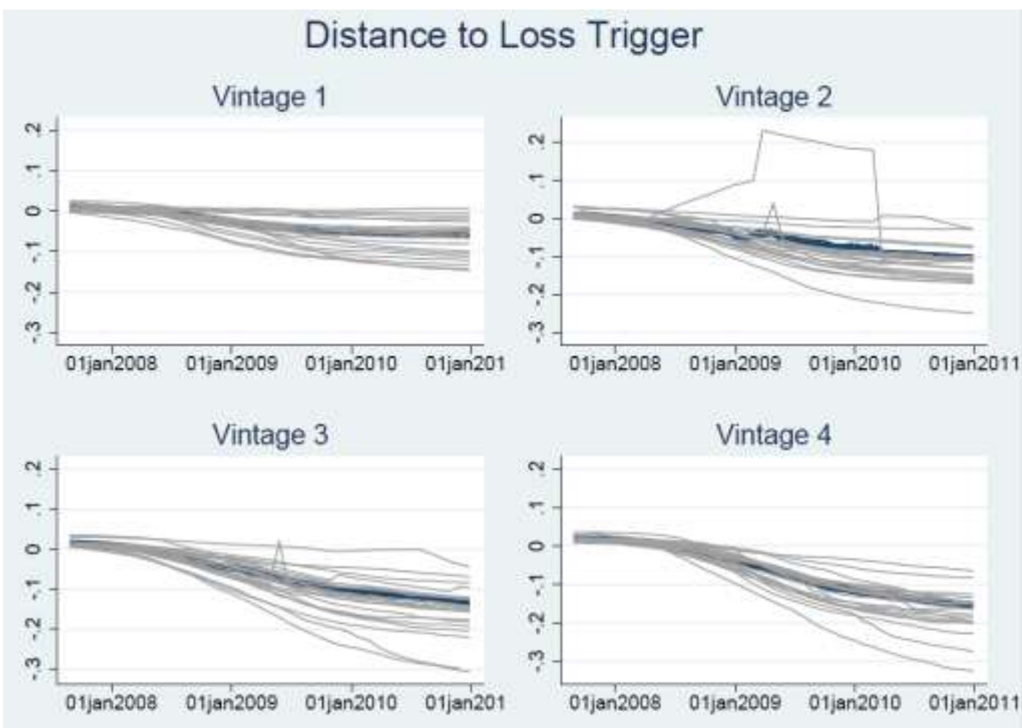

Figure 8. Distance to Loss Trigger by Vintage

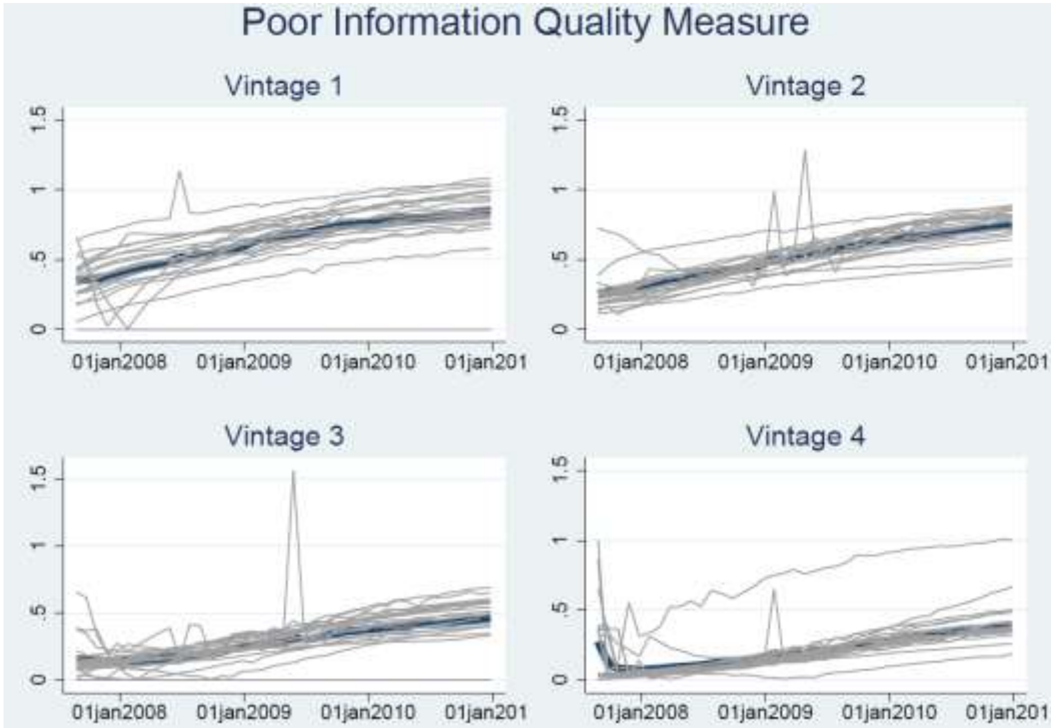

Figure 9. Poor Information Quality Measure by Vintage

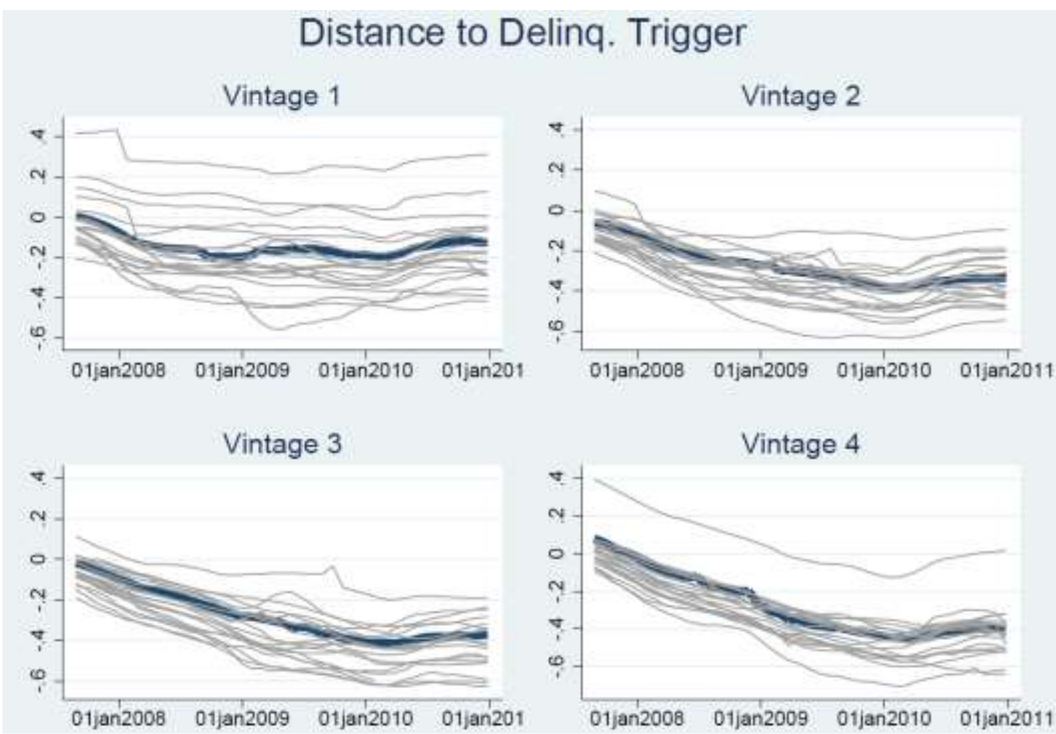

Figure 10. Distance to Delinquency Trigger by Vintage

Figure 11 Graphical depiction of omitted variables within ABSNet grouped by Trustee

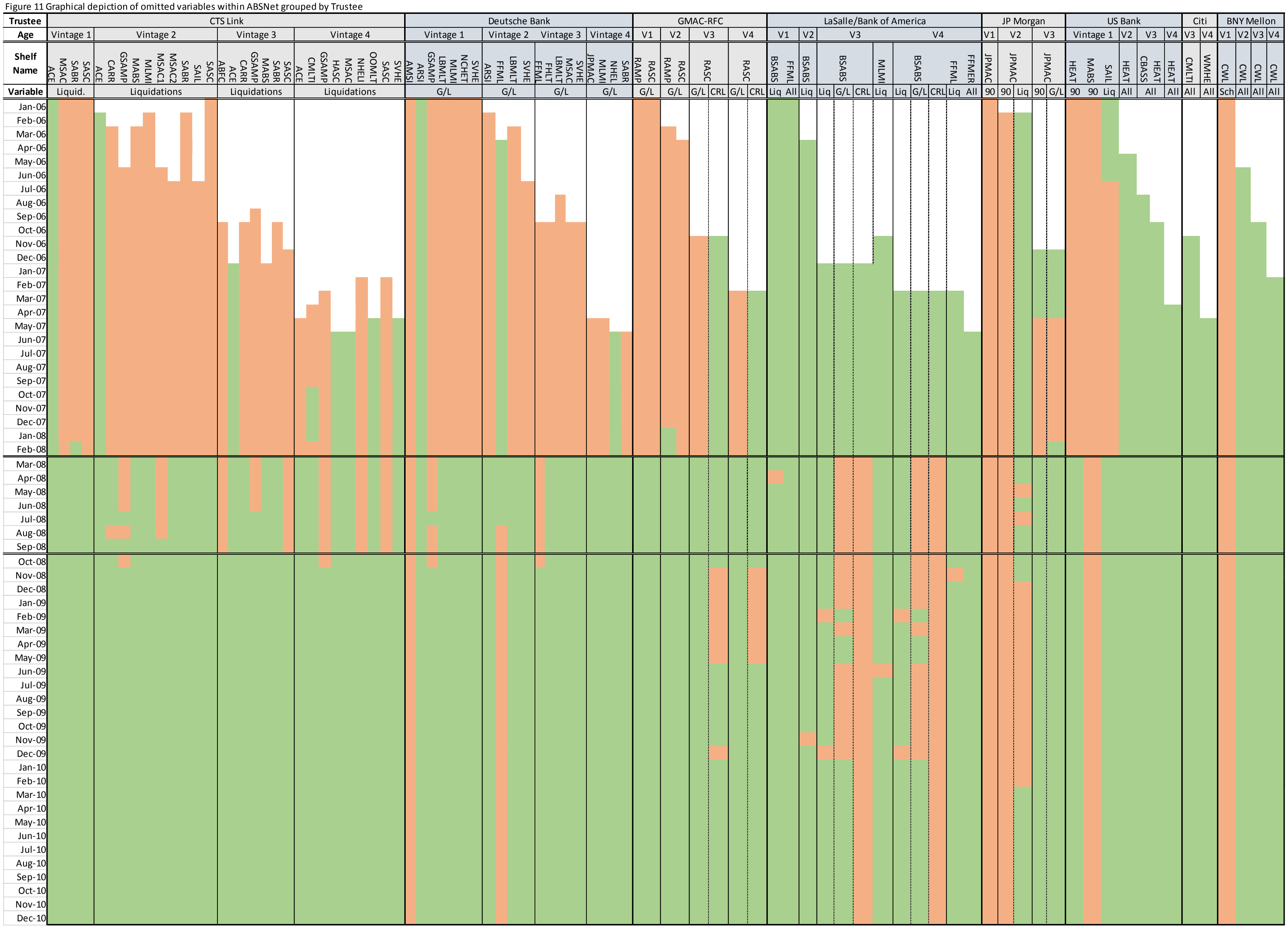

Figure 12. August 2006 Loss and Recovery Statement for RAMP 2006 NC2

GMAC RFC

Statement to Certificateholder

Residential Asset Mtge Products, 2006-NC2
August 25, 2006

Deal Totals	Loss Count	0	9	0	0	9
	Beginning Aggregate Scheduled Balance	0.00	631,957.15	0.00	0.00	631,957.15
	Principal Portion of Loss	0.00	631,957.15	0.00	0.00	631,957.15
	Interest Portion of Loss	0.00	38,007.31	0.00	0.00	38,007.31
	Total Realized Loss	0.00	669,964.46	0.00	0.00	669,964.46

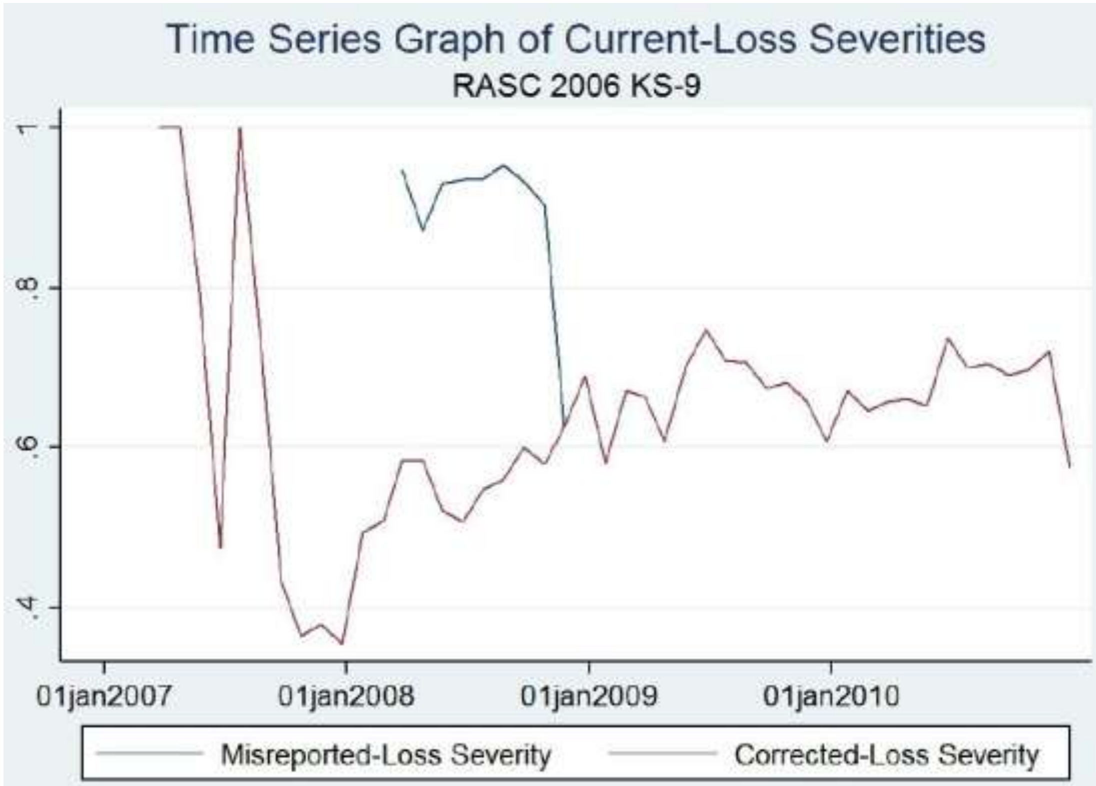

Figure 13. This figure shows how current loss severity as provided by ABSNet can serve as a potential gauge for whether there is misreporting in current liquidation amounts. Current loss severity is the ratio of current gain or loss amount to current liquidations. It indicates how much loss is recorded per liquidated dollar. If there is misreporting, as depicted by the blue line, then current loss severities will be within the 80-100% range. When liquidations are correct, current loss severity drops to the 40-70% range after the first few months.