THE SUBPRIME CREDIT CRISIS AND CONTAGION IN FINANCIAL MARKETS

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Abstract. We conduct an empirical investigation into the pricing of subprime asset-backed CDOs and the resulting contagion effects on other markets. Using data for the ABX indexes of subprime CDO prices, we find strong evidence of contagion effects. In particular, we find that contagion effects spread first from lower-rated ABX indexes to higher-rated ABX indexes, and then from the subprime markets to the Treasury bond and stock markets. ABX index returns forecast stock and Treasury bond returns as much as three weeks ahead during the crisis. Furthermore, ABX index shocks are significantly related to contractions in the size of the short-term credit markets and increases in the trading activity of financial stocks over the next several weeks. These results provide support for the hypothesis that financial contagion was spread through liquidity and risk-premium channels.

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1. INTRODUCTION

During the past year, financial markets have suffered catastrophic losses from the ongoing credit crisis. This crisis was initially triggered by the growing threat of extensive defaults by subprime borrowers in the mortgage markets. This rapidly led to massive declines in the market values of large portfolios of highly-rated asset-backed securities held by many financial institutions. The crisis has brought about an almost complete halt to the fledgling structured-credit market, a serious “credit crunch” for both individuals and financial institutions, and a major decline in the liquidity of debt securities in virtually every market.

Even at the early stages, the markets feared that the subprime crisis might spill over into other sectors of the economy.[1] As the crisis has unfolded, a number of these fears have been realized as large negative shocks have occurred in the housing, auction-rate, municipal-bond, and corporate-debt markets. The recent failures, or near failures, of Bear Stearns, Countrywide, and IndyMac Bank have many financial institutions scrambling for additional capital to bolster their balance sheets. Concerns about the viability of Fannie Mae and Freddie Mac have spread throughout the financial markets. These concerns, in turn, have resulted in credit default swaps on the U.S. Government being traded at spreads as high as 25 basis points. Recent intervention by the Federal Reserve in these markets has been motivated largely by the objective of avoiding broader credit contagion stemming from the crisis.

The issue of contagion in financial markets is of fundamental importance and there is an extensive literature addressing its causes and effects. Important recent papers focusing on contagion include Allen and Gale (2000), Kyle and Xiong (2001), Kodres and Pritsker (2002), Kiyotaki and Moore (2002), Kaminsky, Reinhart, and Vegh (2003), Allen and Gale (2004), Brunnermeier and Pedersen (2005, 2007), and many others. From a research perspective, the current crisis in the subprime asset-backed market provides a near-ideal “laboratory” for studying the role that contagion may play in financial markets when an asset class becomes severely distressed.[2]

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[1]For example, see Federal Reserve Governor Frederic S. Mishkin’s September 10, 2007 speech “Outlooks and Risk for the U.S. Economy” and Federal Reserve Chairman Ben S. Bernanke’s October 15, 2007 speech “The Recent Financial Turmoil and its Economic Consequences.”

[2]Important papers focusing on the valuation of distressed assets include Shleifer and Vishny (1992), Asquith, Gertner, and Scharfstein (1994), Opler and Titman (1994), Clark and Ofek (1994), John and Ofek (1995), Andrade and Kaplan (1998), Pulvino (1998), Kahl (2002), Longstaff (2004), Vayanos (2004), Acharya and Pedersen (2005), Brunnermeier and Pedersen (2005), and Carlin, Lobo, and Viswanathan (2007).

The contagion literature identifies at least three possible mechanisms by which shocks in one market may spill over into other markets. First, Kiyotaki and Moore (2002), Kaminsky, Reinhart, and Vegh (2003), and others describe mechanisms in which negative shocks in one market represent the arrival of economic news that directly effects the collateral values or cash flows associated with securities in other markets. In this mechanism, contagion can be viewed as the transmission of information from more-liquid markets or markets with more-rapid price discovery to other markets. Second, Allen and Gale, (2000), Brunnermeier and Pedersen (2005), and others show how investors who suffer losses in one market may find their ability to obtain funding impaired, potentially leading to a downward spiral in overall market liquidity and other asset prices via a "flight to quality." In this mechanism, contagion occurs through a liquidity shock across all markets. Third, Vayanos (2004), Acharya and Pedersen (2005), Longstaff (2008), and others imply that a severe negative shock in one market may be associated with an increase in the risk premium in other markets. In this mechanism, contagion occurs as negative returns in the distressed market affect subsequent returns in other markets via the time-varying risk premium.

Our objective in this paper is to shed some light on these issues by studying the subprime asset-backed collateralized debt obligation (CDO) market during the 2006-2007 period and exploring how negative shocks affected other markets as the subprime crisis unfolded. The study is based on an extensive data set of prices for the ABX indexes of subprime mortgage-related asset-backed CDOs. Using a vector autoregression (VAR) framework, we examine the extent to which ABX returns are related to returns in other financial markets as well as to market leverage and trading activity measures.

Two major empirical results emerge from this analysis. First, we find that shocks tended to flow from the lower-rated to higher-rated ABX indexes as the crisis developed. Specifically, we find that the returns for the BBB and BBB− ABX indexes have reliable incremental forecast power for the AAA, AA, and A indexes several weeks ahead. Returns for the higher-rated ABX indexes tend to be much more predictable than is the case for the lower-rated ABX index returns.

Second, despite the lower liquidity of the ABS CDO market, we find that ABX index returns developed significant predictive power for subsequent Treasury bond and stock market returns as the crisis unfolded. The ABX returns have significant forecast ability for stock and bond market returns as far as three weeks ahead. Treasury bond prices increase in response to negative shocks to ABS CDO values, consistent with a flight-to-quality pattern. This effect, however, is much stronger for short-term Treasury rates than for longer-term Treasury rates. Furthermore, negative shocks to the ABX indexes map into significant subsequent negative returns for both the S&P 500 Index and the financial subcomponent of the Index. We also find that downward shocks in the ABX indexes translate into significant declines in the size of the roughly $2 trillion commercial paper market over the next several weeks along with large increases in the trading activity of financial stocks.

These results provide some insights into the nature of mechanisms driving the spillovers across markets in the present credit crisis. For example, finding that shocks tend to be transmitted with a lag from the less-liquid ABX index market to the highly-liquid Treasury-bond and stock markets argues against the price-discovery view of financial contagion. In contrast, the effects on the size of the credit market and the trading activity in the stock market are consistent with the Allen and Gale (2000), Kodres and Pritsker (2002), and Brunnermeier and Pedersen (2005) liquidity-induced contagion mechanism. Furthermore, the predictability of returns based on ABX returns is also consistent with the time-varying risk premium contagion mechanism implied by Vayanos (2004), Acharya and Pedersen (2005), and others.

On the other hand, these results leave open the door for other possibly behavioral explanations. It is puzzling that returns for the lower-credit-quality ABX indexes are able to forecast returns for the higher-credit-quality ABX indexes. It is even more puzzling that ABX returns have so much forecast power for stock and bond market returns several weeks ahead. It may be that extremely bad news is incorporated more rapidly into the prices of the distressed assets than into the prices of nondistressed assets; that the stock and Treasury bond markets experienced something akin to a "deer-in-headlights" phenomenon. Thus, the nature of the price-discovery process in financial markets could be state dependent.

The remainder of this paper is organized as follows. Section 2 briefly reviews the literature on contagion in financial markets. Section 3 provides an introduction to the asset-backed CDO market. Section 4 describes the ABX indexes and the other data used in the study. Section 5 presents the empirical results. Section 6 summarizes the results and presents concluding remarks.

2. CONTAGION IN FINANCIAL MARKETS

The literature on contagion in financial markets is far too extensive for us to review fully here. Kindleberger (1978), Dornbusch, Park, and Claessens (2000), and Kaminsky, Reinhart, and Vegh (2003), however, provide excellent surveys. Generally, this literature has focused on contagion effects across countries. Contagion, however, is possible in virtually any set of financial markets. In this section, we will simply summarize some of the key implications of the contagion literature for the behavior of security prices during periods of extreme market distress.

Following Dornbusch, Park, and Claessens (2000), Kaminsky, Reinhart, and Vegh

(2003), Bae, Karolyi, and Stulz (2003), and many others, we adopt a working definition of financial contagion as an episode in which there is a significant increase in cross-market linkages after a shock occurs in one market. The literature identifies at least three major channels by which contagion effects can be propagated through different financial markets.

The first can be termed the correlated-information channel. In this mechanism, a shock to one financial market signals economic news that is directly or indirectly relevant for security prices in other markets. For example, Dornbusch, Park, and Claessens (2000) describe direct effects occuring through fundamentals such as trade links. Kiyotaki and Moore (2002) describe a balance-sheet channel in which losses in one market translate into declines in the equity of other firms holding the distressed assets. King and Wadhwani (1990) present a model in which contagion occurs as rational agents attempt to infer information from price changes in other markets. A common implication throughout the correlated information literature is that contagion occurs rapidly via the price-discovery process. Thus, this channel should result in immediate price effects in the markets affected by the distress event, particularly when these markets are more liquid that the market in which the original distress event occurs.

The second can be designated the liquidity channel. In this mechanism, a shock to one financial market results in decrease in the overall liquidity of all financial markets. In turn, this may affect investor behavior and asset prices. For example, Allen and Gale (2000) present a model in which banks have cross holdings of deposits across regions. In this model, financial shocks cause banks to liquidate these cross holdings, thereby denying liquidity to other regions. Kodres and Pritsker (2002) present a model in which contagion occurs as losses in one market force economic agents to either liquidate leveraged positions or to rebalance their portfolios in response. Brunnermeier and Pedersen (2007) argue that agents who experience losses in one market may find their ability to obtain funding impaired, which then would result in declines in the liquidity of the other financial assets in the markets. A key implication of this liquidity-related channel of contagion is that a distress event may be associated with subsequent declines in the availability of credit and increases in trading activity in other markets.

The third can be termed the risk-premium channel. In this mechanism, financial shocks in one market may affect the willingness of market participants to bear risk in any market. Thus, prices in all markets may be affected as equilibrium risk premia change in response. For example, Vayanos (2004) and Acharya and Pedersen (2005) present models in which shocks such as those that might result from a distress event translate into major changes in the equilibrium risk premia of assets in the economy. An important implication of this time variation in risk premia is that return shocks to the distressed security will be predictive for the subsequent returns of other assets.

Although similar in many ways, these three contagion channels each have different implications for the behavior of security prices across markets when a distress event occurs. We will explore these empirical implications later in the paper.

3. THE SUBPRIME ASSET-BACKED CDO MARKET

In the current credit crisis, tranches or CDOs based on the cash flows of portfolios of subprime home-equity loans have been the major source of credit losses to many financial institutions. Accordingly, we will focus primarily on these securities throughout this study. This section provides a brief introduction to the asset-backed securities (ABS) market.

Subprime CDOs were aggressively sold to investors during the past several years and were widely viewed as one of the most important financial innovations of the past decade. According to the Securities Industry and Financial Markets Association, the total U.S. issuance of asset-backed securities during the 2005-2007 period was $3.289 trillion, and the total U.S. issuance of CDOs during the same period was $965 billion.

Asset-backed tranches or CDOs share many features in common with CDOs for corporate bonds. As described in Longstaff and Rajan (2008), a CDO is created by an issuer first forming a portfolio of loans, either by lending money directly, or by buying debt securities in the marketplace.[3] In the ABS market, these loans could consist of first mortgages, second mortgages, loans on manufactured homes, credit card receivables, auto loans, student loans, and even account receivables.[4] Once the portfolio is formed, the CDO issuer sells tranches based on the cash flows scheduled to be generated by the underlying loans. Typically, the tranches vary in terms of their subordination. For example, the equity or residual tranche receives a high coupon on its principal amount, but is first in line to absorb any credit losses suffered by the underlying portfolio. On the other hand, a supersenior tranche might only receive a coupon of Libor plus 20 basis points, but would not suffer any credit losses until after the total credit losses for the portfolio exceeded 15 percent.

In effect, a ABS CDO structure could be viewed as a synthetic lender where the assets consist of, say, subprime home equity loans and where the capital structure consists of equity, subordinated debt, and senior debt (all often in the form of floating-rate notes). From a CDO issuer's perspective, the advantages of issuing CDOs is that it allows the issuer to make loans, repackage them, and then sell them to third parties, thereby allowing the issuer to earn fees from originating and then servicing the

[3]Alternatively, a synthetic CDO could be constructed through the use of credit default swaps.

[4]For an excellent review of the ABS market, see Rajan, McDermott, and Roy (2007).

loans without having to commit their capital permanently. Of course, this mechanism creates a number of moral hazard risks since the issuer is aware that he may not suffer any credit losses on the loans he makes since they will be sold as repackaged CDOs.

To provide an illustration of a typical subprime ABS CDO, Table 1 gives the details of a $900 million CDO sponsored by Countrywide Home Loans, Inc. and issued through Lehman Brothers in February 2006. The issuing entity is designed as CWABS Asset-Backed Certificates Trust 2006-1. Of the total notional amount underlying the CDO, about $500 million is based on subprime fixed-rate mortgages, while $400 million is based on subprime floating-rate mortgages. On the fixed-rate side, the CDO consists of 12 separate tranches. The first six are equal in seniority but differ in terms of their coupon rates and collateral. The other six tranches are subordinated sequentially, with the MF-6 tranche absorbing the first $5.525 million in losses, the MF-5 tranche absorbing the next $6.188 million in losses, etc. A similar structure applies on the floating-rate side of the portfolio with the MV-7 tranche absorbing the first $5.549 million of losses, the MV-6 tranche absorbing the next $5.907 million of losses, etc. The average FICO score for the fixed-rate and floating-rate loans is 611 and 618, respectively, placing these loans squarely in the subprime category. Interestingly, while some of the underlying mortgages bear low "teaser" rates, many carry very high mortgage rates; the mortgage rates for the loans in the underlying portfolio vary from 4.95 to 12.00 percent. Given the different positions of the tranches in the capital structure "pecking order," it is not surprising that the tranches can have different credit ratings. Table 1 shows that the initial credit ratings for the tranches offered range from Aaa/AAA to Baa1/A.

Since each of these CDO tranches can be viewed as either a fixed-rate bond or a floating-rate note, the prices of these securities are generally quoted per $100 notional. To illustrate, the MF-1 tranche in the CWABS 2006-1 example has a Bloomberg quoted price of 65.00 on December 4, 2007. Thus, an investor who acquired this tranche at the issue price of 99.99814 on February 8, 2006 would have mark-to-market loss of nearly 35 percent. Given that this tranche initially had a credit rating of AA1/AA+, the subsequent large decline in the value of the tranche argues that the initial credit rating may have been overly optimistic.

From the perspective of the ABS CDO markets, there are several key events or threads that underlie the current distressed state of the market. First, the unexpected wave of subprime defaults and declines in housing values has created severe uncertainty about what the ultimate magnitude of credit losses will be. Second, given the inherent complexity of the underlying loan portfolios on which asset-backed CDOs are based (as evidenced from the Countrywide example in Table 1), many participants in the financial markets appear to have placed a high degree of reliance on the credit ratings provided by the ratings agencies in making investment and pricing decisions. When the rating agencies began to backtrack from their previous optimistic ratings in mid-

2007 and the liquidity in secondary CDO markets dried up, many investors were left completely in the dark as to what their asset-backed CDO positions were actually worth.

4. THE ABX INDEXES

To measure the returns on subprime CDOs, we use market quotations for the widely-known ABX indexes maintained by Markit Group Ltd. These indexes consist of daily closing values obtained from market dealers for subprime home-equity-related CDOs of various credit ratings.[5] In particular, the ABX indexes consist of five separate indexes, where each of these indexes is based on the market quotations of a specific basket of distinct subprime CDOs.

The AAA index is based on a portfolio of 20 subprime home-equity CDOs with initial credit ratings of AAA. The AA index is based on a portfolio of 20 subprime home-equity CDOs with initial credit ratings of AA. Similarly, the other three indexes are based on portfolios of subprime home-equity CDOs with credit ratings of A, BBB, and BBB−, respectively. Each index is a simple average of the prices for the 20 CDOs or tranches in the basket, where prices are quoted relative to a $100 notional position.

The 20 subprime deals that appear in each basket are chosen from among the qualifying deals of the largest subprime home equity asset-backed security shelf programs during the six-month period preceeding the formation of the indexes. The algorithm for choosing the 20 subprime CDOs to be included in each index limits the same loan originator to four deals and the same master servicer to six deals. The minimum deal size is $500 million. Each CDO (tranche) must have a weighted average life between four to six years as of the issuance date (except the AAA tranche which must be greater than five years). The tranches must be rated by Moody's and Standard and Poors; the lesser of the ratings applies. At least 90 percent of a deal's assets must be first lien mortgages, and the weighted average FICO credit score for loans underlying the tranche must be less than 620. Deals must pay on the 25th of each month and referenced tranches must bear interest at a floating-rate benchmark of one-month Libor. The five ABX indexes are reconstituted every six months. The first series of ABX indexes were formed in January 2006 and are designated the ABX.HE 1 AAA, AA, A, BBB, and BBB− indexes. The second series of ABX indexes were formed in July 2006 and are designated the ABX.HE 2 AAA, AA, A, BBB, and BBB− indexes.

[5] Market makers for the ABX indexes during our sample period include Bank of America, BNP Paribas, Deutsche Bank, Lehman Brothers, Morgan Stanley, Barclays Capital, Citigroup, Goldman Sachs, RBS Greenwich Capital, UBS, Bear Stearns, Credit Suisse, JP Morgan, Merrill Lynch, and Wachovia.

Similarly for the ABX.HE 3 and ABX.HE 4 indexes which were formed in January 2007 and July 2007, respectively.

Market quotations for the ABX indexes can be difficult to obtain. Fortunately, we were given access to a proprietary data set by a major fixed income asset management firm that includes daily closing values for all of the ABX.HE 1, 2, 3, and 4 indexes for the two-year period from the inception of the ABX index in January 19, 2006 to December 26, 2007. Table 2 presents summary statistics for the ABX indexes. Figure 1 plots the time series of ABX.HE 1 AAA, AA, A, BBB, and BBB− indexes during the sample period.

Table 2 and Figure 1 illustrate the wide variation in the market valuations of subprime ABS tranches during the sample period. Table 3 provides a chronology of the major crisis events during 2007. This chronology is taken from an extensive timeline reported by Reuters.

As shown in Table 2, the market values of the tranches ranged from 99.18 to 100.28 at the beginning of 2006. There is only minor variation in these prices until the beginning of 2007. By the end of February 2007, the BBB− index had declined to about 80. This coincides with the February 2007 evidence of subprime losses and profit warnings by subprime lenders. After February, the indexes recovered partially. By mid 2007, however, the indexes began to decline precipitously. Similar patterns are observed for the ABX.HE 2, 3, and 4 indexes.

5. THE EMPIRICAL ANALYSIS

Although the subprime mortgage crisis is far from over, it merits attention as an almost "perfect storm" example of a financial contagion event. As the crisis began to unfold at the beginning of 2007, market participants gradually realized that the actual cash flows from their holdings of ABS CDOs might ultimately be far less than they had anticipated given the high credit ratings these securities initially carried. As the mark-to-market values of these securities plummeted, fears about the viability of the financial institutions holding these securities grew. Some of these fears are currently beginning to be realized with large institutions such as Bear Stearns, Countrywide, and IndyMac Bank either failing, or being forced to merge. At this date, even the solvency of government sponsored agencies such as Fannie Mae and Freddie Mac is in doubt, and credit default swaps on the sovereign debt of the U.S. Government are traded with the cost of credit protection being as high as 25 basis points.

In exploring the empirical implications of the contagion literature for the subprime crisis, our approach will be to test whether there is an increase in cross-market linkages between the ABS CDO market and other markets during the crisis period. This approach is motivated by the standard definition in the literature of contagion as a change in the linkages between markets after a distress event. Specifically, we apply a vector autoregression (VAR) framework that allows us to estimate the relation between returns during the 2006 pre-crisis period separately from the relation between returns during the 2007 crisis period. The choice of 2007 as the crisis period is motivated by the timeline provided in Table 3. An important advantage of this VAR framework is its ability to identify empirical relations while avoiding endogeneity problems among variables.

5.1 The VAR Variables

To capture valuation effects in the distressed ABS CDO market, we use the returns on the ABX indexes (formed from the on-the-run series, e.g. rolling the series from ABX-HE 1 to ABX-HE 2 when the latter index is constructed, etc.). Specifically, we use the weekly (Wednesday to Wednesday) returns for the corresponding on-the-run ABX index. Altogether, we have five such on-the-run series of returns, each representing a different credit rating, which we designate ABX_{AAA}, ABX_{AA}, ABX_{A}, ABX_{BBB}, and ABX_{BBB-}.

As measures of the valuation effects in other markets, we focus primarily on the Treasury bond and stock markets. To capture changes in the Treasury bond market, we use weekly changes (over the same period as for the ABX returns) in the constant maturity one-year and ten-year Treasury yields (obtained from the Federal Reserve Board's website). Yields are measured in percentage terms. Thus, a one-basis point yield change from, say, 4.50 to 4.51 equals 0.01.

To capture changes in the stock market, we use two different measures. Specifically, we collect weekly return data for both the S&P 500 index and the S&P 500 subindex of financial firms (dividends omitted from both return series). This subindex currently consists of 92 commercial and investment banks, insurance companies, home lenders, government sponsored entities such as Fannie Mae and Freddie Mac, and monoline bond insurers such as AMBAC. The S&P 500 subindex of financial firms can be viewed as a broader measure of "moderately distressed" assets since many of these firms have exposure to the subprime market through their portfolio holdings. The data for the S&P 500 indexes are obtained from the Bloomberg system.

In addition to valuation effects, we also consider variables that proxy for changes in the availability of funding or funding liquidity in the financial markets. In general, measuring changes in the aggregate size of the credit sector over a short period such as a week is challenging. In the current subprime crisis, however, considerable attention has focused on the commercial paper market. Over the past decade, this market has grown to a notional size on the order of $2 trillion and has become a major source of short-term funding for financial institutions, investors, and corporations. Given that the median maturity of commercial paper is on the order of 30 days, percentage changes in the size of this market may provide a useful proxy for discretionary changes in the amount of short-term credit provided in the financial markets. We obtain weekly (Wednesday) data on the size of the commercial paper market from the Federal Reserve Board's website.

Finally, to explore whether the subprime crisis is associated with portfolio rebalancing or flight-to-quality behavior in the market, we compute the ratio of the aggregate weekly trading volume for the firms in the S&P 500 subindex of financial firms to the aggregate weekly trading volume for all firms in the S&P 500 index. In computing this ratio for week i, we use the volume data for the week immediately before and including the Wednesday of week i. The rationale for considering this variable is that if agents only trade the market (as standard portfolio theory suggests), then no segment of the market should be traded more than any other. Thus, this ratio should remain constant even during a crisis. On the other hand, finding that the stocks in the S&P 500 subindex of financial firms are traded more intensively than the remaining S&P 500 firms during the crisis would provide evidence consistent with a flight to quality or a major rebalancing of portfolios in the financial markets.

5.2 Was There Contagion Across ABX Indexes?

We begin by first examining whether the various ABX indexes of ABS CDO prices behaved similarly as the crisis unfolded. In doing this, however, it is important to be very clear about what conclusions can and cannot be drawn from this analysis. In particular, we chose this market and time period to study precisely because of the repeated negative shocks it has experienced. Thus, finding evidence of serial correlation in ABX returns may simply represent "look back" bias in the sample. Alternatively, evidence of serial correlation may also simply be due to the effect of stale or infrequently-updated prices in the illiquid ABS CDO market. An important advantage of the VAR approach we adopt is that we can test whether there are spillover effects from one ABX index to a second ABX index *after* controlling for the lagged returns of the second ABX index. Thus, inferences about spillovers should be free from this type of "look back" bias.

To explore the relation between the various ABX index returns we estimate the following VAR specification,

$$ABX_{i,t} = \gamma_0 + \sum_{k=1}^{4} \gamma_{1k} ABX_{i,t-k} + \gamma_{2k} I_{2006} ABX_{j,t-k} + \gamma_{3k} I_{2007} ABX_{j,t-k} + \epsilon_{i,t}, \quad (1)$$

where $ABX_{i,t}$, $ABX_{j,t}$, $i \neq j$ represent returns on ABX indexes, and I_{2006} and I_{2007} are dummy variables that take value one when t is in the respective year, and zero otherwise. In this specification, the γ_{2k} capture the relation between ABX_j returns and subsequent ABX_i returns during 2006, while the γ_{3k} coefficients capture the relation during 2007. If there was contagion across the ABX indexes once the subprime crisis began, then we would expect the relation to be much stronger during 2007 than during 2006.

Table 4 reports the estimation results. Specifically, we report the t-statistics for the γ_{2k} and γ_{3K} coefficients. In addition, we report the p-value for the F-test that the γ_{2k} coefficients are jointly zero. Similarly, we report the p-value for the F-test that the γ_{3k} coefficients are jointly zero. These tests allow us to determine whether there is a significant difference in the relation between ABX returns across the pre-crisis and crisis periods.

Table 4 shows clearly that there is no significant lead-lag relation between the ABX indexes during 2006. After controlling for each ABX index's lagged values, none of the other ABX indexes have any forecast ability during 2006. Similarly, the hypothesis that the γ_{2k} coefficients are jointly zero is never rejected in the VARs.

The results, however, are dramatically different during the 2007 crisis period. Many of the γ_{3k} coefficients become highly significant once the crisis begins, providing clear evidence of a major increase in cross-market linkages. The joint tests indicate that most of the ABX indexes are significantly predictable on the basis of lagged values of the other ABX indexes. The primary exception is the BBB− index which is not significantly predictable on the basis of AAA index returns.

This latter result, along with the observation that many of the t-statistics and p-values for the higher-credit ABX indexes reject the null hypothesis much more soundly than for the lower-credit ABX indexes, suggests that the direction of financial contagion was from the lower-credit to higher-credit ABX indexes. This view is also strongly supported by the adjusted R^2's for the VARs. In particular, the AAA, AA, and A ABX indexes are much more predictable by the other lagged ABX indexes than is the case for the BBB and BBB− ABX indexes.[6]

In summary, there is strong evidence that linkages across the different ABX indexes increased dramatically after the onset of the subprime crisis. Furthermore, shocks to the highest-rated ABX indexes were much more predictable than those for the lowest-rated ABX indexes, consistent with the view that contagion spread slowly from the sectors whose cash flows were impacted first by subprime borrowers' defaults

[6]The nature of the time series properties of these ABX indexes is very relevant given the recently announced investigations by the Federal Bureau of Investigation, the Securities and Exchange Commission and the U.S. Attorney in New York. These agencies have opened criminal inquiries into whether a dozen or more major financial firms including UBS and Merrill Lynch deliberately failed to mark their CDOs to market as their prices continued to decline. See Scannell, Raghavan, and Efrati (2008).

to the other sectors. These slow-moving valuation effects are somewhat challenging to reconcile with the correlated-information view of contagion. In contrast, these effects appear more similar to those that would be anticipated from the risk-premium channel.

5.3 Was There Contagion Across Markets?

Turning now to the question of whether the subprime crisis resulted in increased cross-market linkages between the ABS CDO market and other major markets, we estimate the following VAR system,

$$Y_t = \gamma_0 + \sum_{k=1}^{4} \gamma_{1k} Y_{t-k} + \gamma_{2k} I_{2006} ABX_{t-k} + \gamma_{3k} I_{2007} ABX_{t-k} + \epsilon_{i,t}. \quad (2)$$

for six different specifications of the dependent variable Y_t. Specifically, as the dependent variable Y_t, we use the changes in the one-year and ten-year yield, the returns on the S&P 500 index, the returns on the subindex of S&P 500 financial firms, percentage changes in the amount of commercial paper outstanding, and the ratio of financial to market stock trading volume. As before, the γ_{2k} coefficients capture the relation between the ABX index and subsequent values of Y during 2006, while the γ_{3k} coefficients capture the corresponding relation during 2007. The four-week lag structure is suggested by the typical 30-day maturity of the commercial paper market and is also consistent with the Akaike AIC criterion. Note that for every specification of the dependent variable Y, we estimate the system five different times, each time using a different ABX index. Table 5 reports the VAR estimation results.

For the pre-crisis 2006 period, Table 5 shows a pattern very similar to that in Table 4. Specifically, there is no evidence of any significant linkage between the ABX markets and any of the six dependent variables. This is evident both from the individual t-statistics for the γ_{2k} coefficients and from the p-values for the F-test of joint significance for the γ_{2k} coefficients. These results for the 2006 period are intuitive since the ABS CDO market is much less liquid than the Treasury and stock markets. Thus, in ordinary circumstances, we would anticipate that there would be very little information in the ABX indexes that might be useful in forecasting Treasury and stock market returns.

Once the subprime crisis began in 2007, however, the relation between ABX returns and the other markets changed dramatically. Table 5 shows that in virtually every VAR specification, the lagged values of the ABX indexes have significant forecast ability for the other markets.

Focusing first on changes in the one-year Treasury yield, Table 5 shows that all five of the ABX indexes have strong forecast ability as far as three weeks ahead; the

t-statistics for the third lagged value of the five ABX indexes range from 3.50 to 6.47. Each of the significant coefficients is positive, indicating that a negative shock to the ABX index translates into a decline in the one-year Treasury yield, which, in turn, implies an increase in the value of the one-year Treasury bond. Thus, these results are consistent with a flight-to-quality in the Treasury bond market in response to shocks in the subprime market.

Similarly, the lagged ABX returns are highly significant in predicting changes in the ten-year Treasury yield. The second lagged ABX return is significant for the AAA index, and the third lagged ABX return is significant for the other four indexes. Again, the sign of the significant coefficients are all positive which is consistent with a flight-to-quality. Interestingly, the magnitude of the coefficients for the ten-year Treasury bonds is roughly the same as that for the one-year Treasury bonds. Recall, however, that the duration and, therefore, the price effect on the value of a ten-year bond is many times that for the one-year bonds. Thus, these results imply large increases in the value of ten-year Treasury bonds stemming from declines in the value of ABS CDOs.

Turning to the stock market results, Table 5 shows that the lagged ABX returns have significant forecasting ability for the S&P 500 financial subindex. In particular, the third lag of the ABX index return is significant at the five-percent level for the AA, A, BBB, and BBB− indexes. In contrast, the first lag for the AAA index is significant. This latter result is consistent with the earlier finding that contagion effects arrive in the higher-rated ABX indexes more slowly and, therefore, the forecast ability of the AAA index is limited to the first lag. The sign of the coefficients for most of the significant lagged ABX returns are positive as would be expected. In particular, negative returns for the ABX index forecast negative returns for financial firms.

The results for the S&P 500 index show that the ABX index returns are also able to predict broader stock market returns. The first lag of the AAA ABX index is significant, while the third lags of the AA, A, and BBB indexes are significant. The second lag of the BBB− index is also significant. Again, the signs for the significant coefficients are all positive, implying that downward shocks in the value of the ABS CDOs translate into subsequent declines in the value of the S&P 500.

Recall that time variation in risk premium may be one source of predictability in asset returns. Consistent with this, Table 5 shows that both the Treasury bond and stock market regressions display a high level of predictability. The adjusted R^2s for the one-year Treasury yield regressions range from about 25 to 36 percent, while the adjusted R^2s for the ten-year Treasury yield regressions range from about 8 to 15 percent. These adjusted R^2s are very significant and compare favorably to those for the forward rate forecasting models presented in Cochrane and Piazzesi (2005).

The VAR results show that the stock market returns are likewise highly predictable on the basis of ex ante data. In fact, the S&P 500 financial subindex displays a stunning amount of predictability, with adjusted R^2s ranging from 28 to 38 percent. These values far exceed most of the stock market predictability results previously documented in the literature.[7] The adjusted R^2s for the S&P 500 index returns are not as high, but are still very economically significant, with values ranging from about 11 to 17 percent.

Taken together, this evidence of predictability provides strong support for the notion that there were spillover or contagion effects to other markets as the credit crisis unfolded; cross-market linkages become much more important and significant during the subprime crisis. These results shed light on the earlier discussion about the nature of the contagion mechanism in financial markets. Our evidence that lagged ABX index returns contain significant information about future stock and bond market returns argues strongly that commonality in time varying risk premia may be an important mechanism in explaining apparent contagion or spillovers in financial markets. In contrast, if the time series properties of ABX index returns were due to illiquid pricing instead, lagged values of the ABX index would not contain information useful in forecasting bond and stock returns.

Turning next to the credit-market implications, the VAR results show that the shocks to the lower-rated ABX indexes translate into shocks in the size of the commercial paper market. In particular, the coefficients for the third ABX lags are significant when the BBB, and BBB− indexes are included in the specification. The signs of these coefficients are positive, indicating that a decline in the value of the ABX index is associated with a decline in the size of the commercial paper market. The significant coefficients are all positive in sign. These results are consistent with the model presented by Brunnermeier and Pedersen (2005) in which funding shocks in one market may translate into broad liquidity and valuation shocks in other markets, thereby generating pervasive contagion effects in financial markets.

The VAR results indicate that ABX index returns have significant forecast ability for the trading volume ratio. In particular, the first and third lagged ABX returns are negative and significant (at the ten-percent level) for each of the five ABX indexes. This implies that a downward shock in the value of the ABX indexes maps into a significant increase in the trading volume of financial firms relative to nonfinancial firms in the S&P 500 index. These results suggest that investors did not simply trade the market as the subprime distress event unfolded, but concentrated their trading in the financial sector. These results are again consistent with both the Brunnermeier and Pedersen (2005) funding illiqudity contagion mechanism as well as with the portfolio rebalancing implications of Allen and Gale (2000), Pritsker and Kodres (2002), and

[7]As examples of the recent market predictability literature, see Lettau and Ludvigson (2001) and Cochrane (2006),

others. These results are also consistent with the view that that contagion during the subprime crisis was spread through a risk-premium channel which, in turn, was associated with major portfolio rebalancing by market participants.

6. CONCLUSION

The 2007 subprime crisis provides an ideal opportunity for studying the effects of contagion in financial markets. We use data for the ABX indexes of subprime ABS CDOs to examine whether contagion occured across markets at the crisis developed. Motivated by the frequently adopted definition of contagion in the literature as a significant increase in cross-market linkages after a major distress event, we use a VAR framework to test for changes in the relation between the ABX market and other financial markets after the onset of the crisis.

The results provide dramatic evidence of an increase in cross-market linkages. Prior to the subprime crisis, ABX returns contain no useful information for forecasting returns in other major markets. After the crisis began, however, the ABX indexes became highly predictive for both Treasury bond and stock market returns. In many cases, the illiquid and lowest-rated ABX indexes are able to forecast Treasury bond and stock market returns up to three weeks ahead with surprisingly high adjusted R^2s. These results provide strong support that financial contagion spread across markets as the subprime crisis unfolded.

A key aspect of the study is that the results allow us to contrast among the different models of contagion that appear in the extensive literature on the subject. For example, the length of the forecast horizon, in many cases as long as three weeks, argues against the view that contagion is spread via the correlated-information channel. The reason for this is simply that we would expect that price-discovery in the highly-liquid stock and Treasury bond markets would occur much more rapidly if the source of contagion was correlated information. In contrast, the significant declines in the size of the credit market, as well as the increase in portfolio rebalancing in the financial sector associated with negative shocks in the ABS CDO market, provide evidence consistent with the view that contagion is spread via a liquidity channel as argued by Allen and Gale (2000), Brunnermeier and Pedersen (2005), and others. Finally, the increased degree of predictability in financial markets associated with the crisis is also consistent with contagion being spread via a risk-premium channel, consistent with Vayanos (2004), Acharya and Pedersen (2005), and others.

On the other hand, these results also leave us with a puzzle. The magnitude of the predictive power of the ABX index returns is so large as to raise questions as to whether it can be fully explained by any of the contagion mechanisms put forward in the literature. In particular, it could be argued that these results are also compatible with a behavioral “deer-in-headlights” reaction on the part of the market to extremely bad news.

REFERENCES

Acharya, Viral, and Lasse H. Pedersen, 2005, Asset Pricing with Liquidity Risk, *Journal of Financial Economics* 77, 375-410.

Allen, Franklin, and Douglas Gale, 2000, Financial Contagion, *Journal of Political Economy* 108, 1-33.

Allen, Franklin, and Douglas Gale, 2004, Financial Intermediaries and Markets, *Econometrica* 72, 1023-1061.

Andrade, Gregor, and Steven N. Kaplan, 1998, How Costly is Financial (not Economic) Distress? Evidence from Highly Leveraged Transactions that Became Distressed, *Journal of Finance* 53, 1443-1493.

Asquith, Paul, Robert Gertner, and David Scharfstein, 1994, Anatomy of Financial Distress: An Examination of Junk-Bond Issuers, *Quarterly Journal of Economics* 109, 625-658.

Bae, Kee Hong, Andrew Karolyi, and Rene Stulz, 2003, A New Approach to Measuring Financial Market Contagion, *Review of Financial Studies* 16, 717-764.

Brunnermeier, Markus K. and Lasse H. Pedersen, 2005, Predatory Trading, *Journal of Finance* 60, 1825-1863.

Brunnermeier, Markus K. and Lasse H. Pedersen, 2007, Market Liquidity and Funding Liquidity, *Review of Financial Studies*, forthcoming.

Carlin, Bruce I., Miguel S. Lobo, and S. Vishwanathan, 2007, Episodic Liquidity Crises: Cooperative and Predatory Trading, *Journal of Finance* 62, 2235-2274.

Clark, Kent and Eli Ofek, 1994, Mergers as a Means of Restructuring Distressed Firms: An Empirical Investigation, *Journal of Financial and Quantitative Analysis* 29, 541-565.

Cochrane, John H., 2006, The Dog that did not Bark: A Defense of Return Predictability, *Review of Financial Studies*, forthcoming

Cochrane, John H., and Monika Piazzesi, 2005, Bond Risk Premia, *American Economic Review* 95, 138-160.

Dornbusch, Rudiger, Yung Chul Park, and Stijn Claessens, 2000, Contagion: Understanding How it Spreads, *The World Bank Research Observer* 15, 177-197.

John, Kose, and Eli Ofek, 1995, Asset Sales and Increase in Focus, *Journal of Financial Economics* 37, 105-126.

Kahl, Matthias, 2002, Economic Distress, Financial Distress, and Dynamic Liquidation, *Journal of Finance* 57, 135-168.

Kaminsky, Graciela, Carmen Reinhardt, and Carlos Vegh, 2003, The Unholy Trinity of Financial Contagion, *Journal of Economic Perspectives* 17, 51-74.

Kindleberger, Charles, 1978, *Manias, Panics, and Crashes*, New York: Basic Books.

King, Mervyn, and Sushil Wadhwani, 1990, Transmission of Volatility between Stock Markets, *Review of Financial Markets* 3, 5-33.

Kiyotaki, Nobuhiro, and John Moore, 2002, *American Economic Review: Papers and Proceedings* 85, 62-66.

Kodres, Laura and Matthew Pritsker, 2002, A Rational Expectations Model of Financial Contagion, *Journal of Finance* 57, 769-800.

Kyle, Albert S. and Wei Xiong, 2001, Contagion as a Wealth Effect, *Journal of Finance* 56, 1401-1440.

Lettau, Martin, and Sydney Ludvigson, 2001, Consumption, Wealth, and Expected Returns, *Journal of Finance* 55, 815-849.

Longstaff, Francis A., 2004, The Flight-to-Liquidity Premium in U.S. Treasury Bond Prices, *Journal of Business* 77, 511-526.

Longstaff, Francis A., 2008, Train Wrecks: Asset Pricing and the Valuation of Severely Distressed Assets, Working paper, UCLA.

Longstaff, Francis A. and Arvind Rajan, 2008, An Empirical Analysis of the Pricing of Collateralized Debt Obligations, *Journal of Finance* 63, 529-563.

Opler, Tim C. and Sheridan Titman, 1994, Financial Distress and Corporate Performance, *Journal of Finance* 49, 1015-1040.

Pulvino, Todd C., 1998, Do Asset Fire Sales Exist? An Empirical Investigation of Commercial Aircraft Transactions, *Journal of Finance* 53, 939-978.

Rajan, Arvind, Glen McDermott, and Ratul Roy, 2007, *The Structured Credit Handbook*, John Wiley & Sons, Hoboken, NJ.

Scannell, Kara, Anita Raghavan, and Amir Efrati, 2008, The Subprime Cleanup Intensifies, *Wall Street Journal*, February 2, B1.

Shleifer, Andrei, and Robert W. Vishny, 1992, Liquidation Values and Debt Capacity: A Market Equilibrium Approach, *Journal of Finance* 47, 1343-1366.

Vayanos, Dimitri, 2004, Flight to Quality, Flight to Liquidity, and the Pricing of Risk, Working paper, London School of Economics.

Table 1

Countrywide Subprime ABS CDO Structure CWABS 2006-1. This table reports some of the contractual terms listed in the prospectus for this asset-backed CDO structure. The L in the initial pass-thru rate represents one-month Libor. The seniority ranking n/m means that the tranches seniority is n-th out of m tranches.

Tranche	Notional Amount	Price to Public	Under-Writer Fee	Initial Pass-thru Rate	Maturity	Initial Moody's Rating	Initial S&P Rating	Seniority Ranking
AF-1	147,232,000	100.0000	0.0521	L+ 0.130%	Nov 2025	Aaa	AAA	1/7
AF-2	22,857,000	99.9995	0.1042	5.281%	May 2027	Aaa	AAA	1/7
AF-3	90,995,000	99.9998	0.1563	5.384%	Jul 2033	Aaa	AAA	1/7
AF-4	21,633,000	99.9985	0.2500	5.714%	Sep 2034	Aaa	AAA	1/7
AF-5	38,617,000	99.9987	0.3333	5.884%	Jul 2036	Aaa	AAA	1/7
AF-6	44,200,000	99.9980	0.4167	5.526%	May 2036	Aaa	AAA	1/7
MF-1	13,260,000	99.9981	0.4167	5.917%	May 2036	Aa1	AA+	2/7
MF-2	12,155,000	99.9972	0.5000	6.016%	May 2036	Aa2	AA+	3/7
MF-3	7,293,000	99.9965	0.5833	6.115%	Apr 2036	Aa3	AA	4/7
MF-4	6,409,000	99.4627	0.8333	6.200%	Apr 2036	A1	AA-	5/7
MF-5	6,188,000	98.9985	1.0000	6.200%	Mar 2036	A2	A+	6/7
MF-6	5,525,000	98.5371	1.2500	6.200%	Feb 2036	A3	A	7/7
AV-1	139,560,000	100.0000	0.0522	L+0.080%	Jul 2028	Aaa	AAA	1/8
AV-2	115,712,000	100.0000	0.1033	L+0.190%	May 2035	Aaa	AAA	1/8
AV-3	25,042,000	100.0000	0.1033	L+0.300%	Jun 2036	Aaa	AAA	1/8
MV-1	14,320,000	100.0000	0.4167	L+0.390%	May 2036	Aa1	AA+	2/8
MV-2	13,067,000	100.0000	0.5000	L+0.410%	May 2036	Aa2	AA+	3/8
MV-3	7,518,000	100.0000	0.8333	L+0.440%	May 2036	Aa3	AA	4/8
MV-4	6,802,000	100.0000	0.9167	L+0.560%	Apr 2036	A1	AA-	5/8
MV-5	6,802,000	100.0000	0.9667	L+0.600%	Apr 2036	A2	A+	6/8
MV-6	5,907,000	100.0000	1.0000	L+0.660%	Mar 2036	A3	A	7/8
MV-7	5,549,000	100.0000	1.0833	L+1.300%	Mar 2036	Baa1	A	8/8

Table 2

Summary Statistics for ABX Home-Equity CDO Tranches. This table reports summary statistics for the indicate ABX indexes. Prices are quoted relative to a $100 notional position. The sample consists of daily closing prices for the January 25, 2006 to December 26, 2007 period.

Index	Rating	Mean	Standard Deviation	Minimum	Median	Maximum	*N*
ABX HE 1	AAA	99.35	1.88	90.09	100.26	100.38	486
	AA	98.06	4.75	77.58	100.31	100.73	486
	A	93.51	12.04	47.11	100.12	100.51	486
	BBB	87.53	20.66	25.00	99.83	101.20	486
	BBB−	84.54	23.29	21.83	99.24	102.19	486
ABX HE 2	AAA	97.36	4.52	79.97	99.57	100.12	362
	AA	92.60	12.56	51.47	99.50	100.12	362
	A	83.67	21.36	33.59	95.04	100.12	362
	BBB	72.98	27.82	18.61	83.00	100.58	362
	BBB−	68.70	28.83	16.63	73.32	100.94	362
ABX HE 3	AAA	93.74	8.31	68.92	99.08	100.09	236
	AA	82.99	20.07	37.47	97.42	100.09	236
	A	68.35	27.58	24.00	81.82	100.01	236
	BBB	54.35	25.77	17.56	61.43	98.35	236
	BBB−	50.01	23.61	16.84	54.30	97.47	236
ABX HE 4	AAA	86.75	10.15	66.41	91.44	99.33	109
	AA	68.67	20.32	34.67	78.06	97.00	109
	A	49.04	15.93	23.97	56.65	81.94	109
	BBB	33.83	10.24	19.88	39.56	56.61	109
	BBB−	31.27	9.20	18.90	36.73	50.33	109

Table 3

Timeline of the 2007 Subprime Crisis. Source: Reuters.

Late 2006	The U.S. housing market slows after 2 years of increases in official interest rates. Delinquencies rise, a wave of bankruptcies.
Feb 7	Europe's biggest bank HSBC holdings blamed soured U.S. subprime loans for its first-ever profit warning.
Feb 13	Countrywide shares drop as Fremont General Corp., one of the largest providers of subprime loans, says it has stopped offering some second mortgages.
Apr 2	Subprime lender New Century Financial Corp. files for bankruptcy.
Jun 20	Two Bear Stearns funds sell $4 billion of assets to cover redemptions and expected margin calls after making bad bets on securities backed by subprime mortgages.
Jul 10	Standard & Poor's said it may cut ratings on some $12 billion of subprime debt.
Jul 17	Bear Stearns says two hedge funds with subprime exposure have very little value; credit spreads soar.
Jul 20	Home foreclosures rose 9 percent in July from June and soared 93 percent from a year ago.
Aug 9	French bank BNP Paribas bars investors from redeeming cash in $2.2 billion worth of funds, telling the markets it is unable to calculate the value of the asset-backed securities funds.
Aug 10	Central banks pump billions of dollars into banking systems in a concerted effort to beat back a credit crisis.
Aug 17	Fed surprises by cutting its discount rate by half a percentage point to 5.75 percent, cites tightening credit markets.
Sep 13	UK mortgage lender Northern Rock sought emergency financial support from the Bank of England. The report sparked a run on the bank's deposits by worried savers.
Oct 1	Swiss bank UBS said it would write down $3.4 billion in its fixed-income portfolio and elsewhere, first quarterly loss in 9 years.
Oct 15	Bank of America, Citigroup, and JP Morgan Chase plan fund to pool assets from stressed SIVs to prevent a fire sale of these assets.
Oct 30	Merrill Lynch ousts Chairman and Chief Executive Stan O'Neal after reporting biggest quarterly loss in company's history.
Nov 4	Citigroup announces a further $8-11 billion of subprime-related writedowns and losses. Charles Prince resigns as CEO.
Dec 6	Treasury, lenders set plan to bring reset relief to many of the 2 million homeowners facing higher rates.
Dec 12	Central banks coordinate the launch of a new temporary term auction facility to address pressures in short-term funding markets.

Table 4

VAR Estimation Results for ABX Index Returns. This table reports the t-statistics for the indicated coefficients from the estimation of the VAR specification shown below. In this specification, ABX_i denotes the ABX index return that appears as the dependent variable while ABX_j denotes the ABX index return whose lagged values (along with lagged values of ABX_i) appear as explanatory variables. Thus, each VAR specification involves two different ABX index return series. The dummy variables I_{2006} and I_{2007} take value one for the indicated year, and zero otherwise. $p(\gamma_2 = 0)$ denotes the p-value for the hypothesis that the four γ_{2k} coefficients are jointly zero; $p(\gamma_3 = 0)$ denotes the p-value for the hypothesis that the four γ_{3k} coefficients are jointly zero. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level. The sample period is January 25, 2006 to December 31, 2007 (100 weekly observations).

$$ABX_{it} = \gamma_0 + \sum_{k=1}^{4} \gamma_{1k} ABX_{i,t-k} + \gamma_{2k} I_{2006}\ ABX_{j,t-k} + \gamma_{3k} I_{2007}\ ABX_{j,t-k} + \epsilon_{it}$$

ABX_i	ABX_j	γ_{21}	γ_{22}	γ_{23}	γ_{24}	γ_{31}	γ_{32}	γ_{33}	γ_{34}	p($\gamma_2 = 0$)	p($\gamma_3 = 0$)	Adj. R^2
AAA	AA	0.40	0.40	0.42	0.43	7.23	−1.52	4.14	0.02	0.970	0.000	0.647
	A	−0.09	−0.14	−0.11	−0.10	4.33	0.26	4.18	−1.63	0.999	0.000	0.593
	BBB	0.07	0.04	0.03	0.07	3.88	−0.03	2.80	1.13	0.999	0.000	0.548
	BBB−	0.04	−0.01	−0.01	0.03	2.26	0.26	2.52	0.82	0.999	0.001	0.466
AA	AAA	−0.09	−0.03	0.12	0.14	2.83	−0.60	−5.22	2.50	0.999	0.000	0.423
	A	−0.05	−0.07	−0.09	−0.07	3.12	3.57	−1.07	−0.77	0.999	0.000	0.317
	BBB	0.12	0.11	0.09	0.08	1.85	2.11	1.65	2.17	0.999	0.000	0.281
	BBB−	0.06	0.03	0.03	0.02	0.83	3.46	1.41	0.50	0.999	0.001	0.236
A	AAA	−0.18	−0.12	0.16	0.22	1.39	−3.23	−4.64	4.62	0.999	0.000	0.543
	AA	0.18	0.14	0.31	0.34	3.32	−7.15	0.16	1.72	0.994	0.000	0.571
	BBB	0.06	−0.00	0.02	0.08	2.32	1.55	2.49	3.08	0.999	0.000	0.348
	BBB−	0.01	−0.04	−0.02	0.04	1.46	2.04	1.46	1.79	0.999	0.017	0.279
BBB	AAA	−0.31	0.10	0.13	0.18	−2.76	0.63	−2.85	−0.98	0.992	0.008	0.258
	AA	0.03	0.15	0.24	0.20	−0.41	−1.89	−0.13	−3.25	0.995	0.012	0.250
	A	−0.34	−0.24	−0.01	−0.41	−0.27	0.71	−0.50	−4.94	0.983	0.000	0.333
	BBB−	−0.26	−0.13	0.38	−0.15	0.69	0.53	3.46	−0.12	0.992	0.010	0.254
BBB−	AAA	−0.39	−0.01	0.15	0.30	−1.66	−0.12	−1.94	−0.49	0.995	0.176	0.081
	AA	0.11	0.16	0.25	0.25	−0.18	−1.93	−0.05	−2.46	0.998	0.065	0.108
	A	−0.17	−0.35	−0.08	−0.45	−0.34	0.40	−0.61	−4.44	0.984	0.001	0.208
	BBB	−0.04	−0.25	0.10	−0.06	0.93	1.42	2.16	−0.38	0.999	0.098	0.097

Table 5

VAR Estimation Results for Other Financial Markets. This table reports the t-statistics for the indicated coefficients from the estimation of the VAR specification shown below. In this specification, Y denotes the financial market variable that appears as the dependent variable while ABX denotes the ABX index return whose lagged values (along with lagged values of Y) appear as explanatory variables. The dummy variables I_{2006} and I_{2007} take value one for the indicated year, and zero otherwise. $p(\gamma_2 = 0)$ denotes the p-value for the hypothesis that the four γ_{2k} coefficients are jointly zero; $p(\gamma_3 = 0)$ denotes the p-value for the hypothesis that the four γ_{3k} coefficients are jointly zero. One-Year Treasury and Ten-Year Treasury denote weekly changes in the respective constant maturity Treasury yields. S&P 500 Financials denotes the weekly return (excluding dividends) of the financial stocks in the S&P 500 index. S&P 500 denotes the weekly return (excluding dividends) on the S&P 500 index. Commercial Paper denotes the weekly change in the amount of commercial paper outstanding. Trading activity denotes the ratio of trading volume for the S&P 500 financials to the total trading volume for the S&P 500 index. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level. The sample period is January 25, 2006 to December 31, 2007 (100 weekly observations).

$$Y_t = \gamma_0 + \sum_{k=1}^{4} \gamma_{1k} Y_{t-k} + \gamma_{2k} I_{2006}\ ABX_{t-k} + \gamma_{3k} I_{2007}\ ABX_{t-k} + \epsilon_{it}$$

Y	ABX	γ_{21}	γ_{22}	γ_{23}	γ_{24}	γ_{31}	γ_{32}	γ_{33}	γ_{34}	p($\gamma_2 = 0$)	p($\gamma_3 = 0$)	Adj. R^2
One-Year Treasury	AAA	−0.36	−0.21	−0.11	−0.16	2.68	2.71	3.50	0.44	0.988	0.000	0.249
	AA	0.48	0.06	0.09	0.10	3.94	1.43	5.12	−0.73	0.993	0.000	0.322
	A	−0.53	0.49	−0.84	−0.67	0.47	0.77	6.47	−0.21	0.760	0.000	0.364
	BBB	−0.16	0.14	−0.20	−0.06	−0.05	−0.47	5.57	1.35	0.999	0.000	0.303
	BBB−	−0.08	0.41	−0.50	−0.06	0.22	−1.11	5.43	2.60	0.983	0.000	0.323
Ten-Year Treasury	AAA	0.25	−0.20	0.17	0.69	0.69	2.60	0.79	1.57	0.887	0.009	0.081
	AA	1.51	1.58	0.68	0.50	1.44	1.30	2.59	1.13	0.337	0.003	0.135
	A	−0.48	0.45	−1.07	−0.88	0.75	0.66	3.00	0.97	0.638	0.002	0.131
	BBB	−0.37	0.05	−0.77	0.31	0.63	0.47	3.48	0.56	0.931	0.000	0.155
	BBB−	−0.13	0.91	−1.26	0.29	1.37	0.33	2.61	1.46	0.716	0.001	0.152
S&P 500 Financials	AAA	−0.90	−0.09	0.26	0.26	3.17	−1.86	1.12	1.92	0.905	0.007	0.287
	AA	−0.90	−0.13	0.19	0.08	3.67	−2.61	3.48	1.00	0.903	0.000	0.363
	A	−1.28	−0.93	−0.70	−0.44	1.86	−0.50	3.76	0.71	0.462	0.000	0.359
	BBB	−0.50	−0.76	−0.94	−0.11	1.76	0.79	3.58	1.18	0.756	0.000	0.386
	BBB−	−0.34	−0.75	−0.44	0.32	2.04	1.84	2.35	0.06	0.861	0.000	0.355

Table 5 Continued

Y	ABX	γ_{21}	γ_{22}	γ_{23}	γ_{24}	γ_{31}	γ_{32}	γ_{33}	γ_{34}	p($\gamma_2 = 0$)	p($\gamma_3 = 0$)	Adj. R^2
S&P 500	AAA	−1.09	0.73	−0.09	0.41	2.16	0.60	0.33	1.78	0.646	0.073	0.116
	AA	−1.53	−0.01	−0.38	−0.30	2.31	−0.28	2.25	1.29	0.626	0.016	0.151
	A	−1.41	−0.15	−0.42	−0.11	0.72	0.61	2.70	1.19	0.665	0.007	0.168
	BBB	−0.43	−0.25	−0.38	0.66	0.41	1.70	2.42	0.48	0.941	0.002	0.176
	BBB−	−0.33	−0.35	0.04	0.73	0.96	2.53	1.28	0.15	0.942	0.004	0.165
Commercial Paper	AAA	0.02	−0.20	1.15	−0.15	−0.27	−0.02	0.64	2.13	0.820	0.185	0.190
	AA	−0.61	0.37	1.15	2.05	0.20	−0.58	1.20	1.31	0.197	0.358	0.215
	A	−1.33	0.55	0.07	0.99	−1.13	−0.18	1.93	1.15	0.600	0.117	0.210
	BBB	−1.93	1.00	−0.17	0.38	−0.67	−0.90	2.47	0.67	0.285	0.096	0.176
	BBB−	−1.94	1.26	−0.61	1.43	−0.94	−0.90	2.75	0.56	0.221	0.062	0.247
Trading Activity	AAA	−0.32	1.23	−0.47	0.14	−4.99	−1.40	−1.79	−0.59	0.668	0.000	0.918
	AA	−0.91	−0.06	−0.88	−0.14	−5.88	−0.05	−3.35	−0.28	0.858	0.000	0.925
	A	−0.91	1.06	−1.24	0.96	−3.88	0.20	−3.89	−1.04	0.504	0.000	0.927
	BBB	−0.69	−0.02	−0.80	0.01	−3.42	−0.43	−4.24	−1.55	0.872	0.000	0.930
	BBB−	−0.72	0.35	−0.75	0.71	−3.31	−0.63	−3.94	−2.19	0.869	0.000	0.929