The Journal of FINANCE
The Journal of THE AMERICAN FINANCE ASSOCIATION

THE JOURNAL OF FINANCE • VOL. LXVIII, NO. 3 • JUNE 2013

# The Evolution of a Financial Crisis: Collapse of the Asset-Backed Commercial Paper Market

DANIEL COVITZ, NELLIE LIANG, and GUSTAVO A. SUAREZ*

**ABSTRACT**

This paper documents "runs" on asset-backed commercial paper (ABCP) programs in 2007. We find that one-third of programs experienced a run within weeks of the onset of the ABCP crisis and that runs, as well as yields and maturities for new issues, were related to program-level and macro-financial risks. These findings are consistent with the asymmetric information framework used to explain banking panics, have implications for commercial paper investors' degree of risk intolerance, and inform empirical predictions of recent papers on dynamic coordination failures.

SINCE THE MID-1980S, BANKS have moved an increasing volume of assets off their balance sheets and funded them through asset-backed commercial paper (ABCP) programs, bankruptcy-remote "paper companies" that issue short-term debt in the commercial paper market.[1] Traditionally, ABCP programs financed receivables from nonfinancial companies, but over time they increasingly financed a wider range of assets, including highly rated mortgage- and other asset-backed securities (ABS). By the end of 2006, ABCP outstanding in the United States had grown to $1.1 trillion, larger than the amount of unsecured (non-asset-backed) commercial paper outstanding and a significant part of the U.S. shadow banking system.[2]

However, in the summer 2007, ABCP outstanding began to plummet. The proximate cause of the contraction was mounting concerns about the default risk of subprime and other mortgages. As Figure 1 illustrates, outstanding ABCP shrank by $190 billion (almost 20%) in August, while yields soared and

*All authors are at the Federal Reserve Board. This paper represents the views of the authors and does not necessarily represent the views of the Board of Governors or other Federal Reserve staff. We are deeply indebted to two anonymous referees, Campbell Harvey (the Editor), and an Associate Editor for detailed feedback that greatly improved the paper. We thank seminar participants at the Federal Reserve Bank of San Francisco, the Yale Conference on Financial Crisis Research, the IADB-LFN, the IMF, and the Bank of Canada, as well as Viral Acharya, Franklin Allen, Adam Ashcraft, Markus Brunnermeier, William Dudley, Gary Gorton, Zhiguo He, Jeffrey Lacker, Eduardo Levi-Yeyati, Peter Lupoff, Gregory Nini, Philipp Schnabl, Jeremy Stein, and Wei Xiong for useful comments. We also thank Scott Aubuchon, Elisabeth Perlman, and Landon Stroebel for excellent research assistance.

[1] Acharya and Schnabl (2009) attribute this development to regulatory capital arbitrage. For alternative interpretations, see Arteta et al. (2010).

[2] Information on aggregate outstanding ABCP can be found on the Federal Reserve's website at http://www.federalreserve.gov/releases/cp/.

DOI: 10.1111/jofi.12023

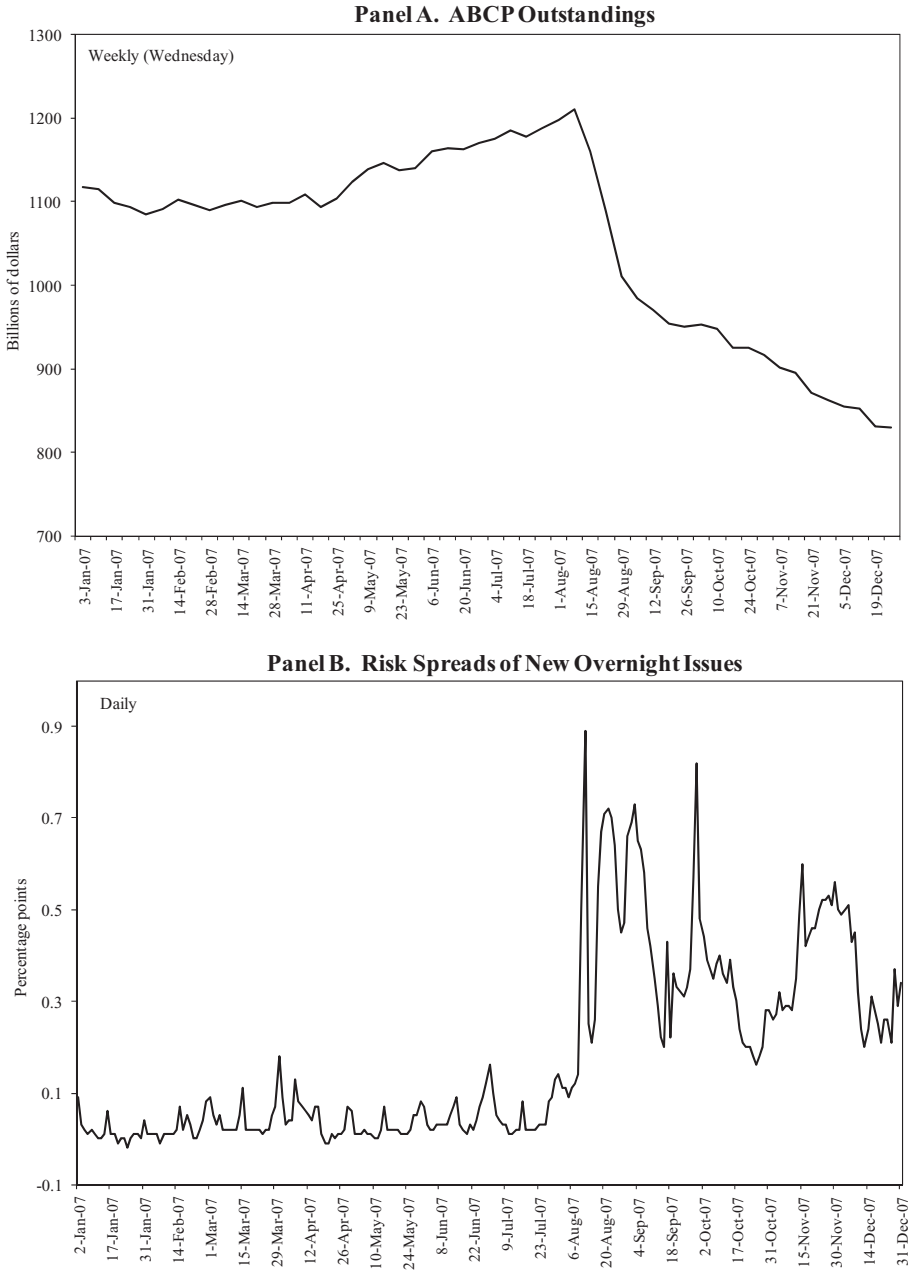


**Figure 1. ABCP: Outstandings, overnight risk spreads, and average maturity of new issues.** Panel A plots the face value of ABCP outstanding in the U.S. market in 2007. Panel B plots the spread of rates on AA-rated ABCP over the target federal funds rate for paper with maturity of 1–4 days. Panel C plots the average across ABCP programs of the number of days to maturity of newly issued paper. Data for all panels are from the Federal Reserve Board based on data from the Depository Trust and Clearing Corporation.

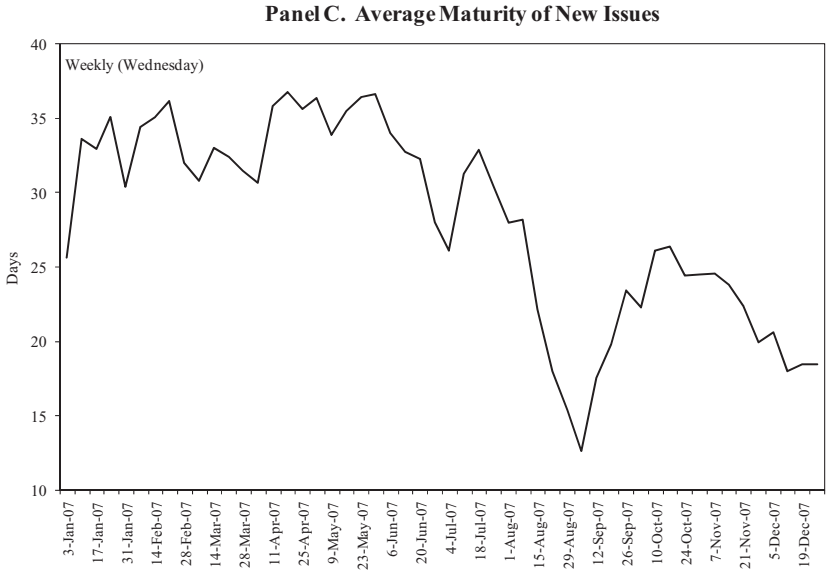


**Figure 1. Continued.**

maturities shortened for new issues. Outstanding ABCP fell by an additional $160 billion by the end of the year. The deep contraction likely contributed to the broader financial crisis because banking institutions sponsored and provided liquidity and credit support to ABCP programs, and because securitization markets relied on ABCP for funding and hence were likely adversely affected by the contraction in ABCP.

In this paper, we study the collapse of the ABCP market in 2007 to better understand the framework behind financial panics, as well as to improve our understanding of the risk intolerance of commercial paper investors and to shed light on a distinguishing assumption in recent theories of coordination failures in short-term credit markets.

Our analysis exploits a rich data set based on all transactions and amounts of paper outstanding at ABCP programs in the U.S. market in 2007. The data comprise proprietary information from the Depository Trust and Clearing Corporation (DTCC) on the prices, quantities, and maturities of almost 700,000 transactions by 339 ABCP programs, as well as weekly information on the maturity structure of program-level outstandings. These data are supplemented by hand-collected information from reports by major rating agencies on the type of program and the identities of the sponsors and liquidity providers to create a data set that is unparalleled in detail about ABCP programs.

The focus of our analysis is on the measurement and determinants of "runs" on ABCP programs.[3] A program is defined as entering a run during a week in

[3] The ABCP market was not the only market that experienced a run in the recent financial crisis. Gorton and Metrick (2012) study runs in the repurchase market in 2007 and 2008. In addition,

which it does not issue despite having 10% or more of its outstanding paper scheduled to mature; the program continues in a run until it issues again. The empirical analysis of runs considers a rich set of potential determinants, including program risk characteristics, program type, sponsor type, and macro-financial variables. In addition, we conduct an empirical investigation of the yield spreads and maturities of new issues for programs not in a run.

The main empirical results are as follows. First, a substantial number of ABCP programs experienced a run in the last 5 months of 2007. About 30% of programs were in a run within weeks of the onset of the ABCP crisis and nearly 40% of programs (more than 120 programs) were in a run at the end of 2007, and the odds of exiting a run were very low. Moreover, declines in outstandings at programs experiencing runs accounted for most of the decrease in ABCP outstanding in 2007. Second, runs in the crisis were not random but instead were significantly more likely at riskier programs, based on observable program characteristics, program type, sponsor type, and macro-financial variables. Third, for the programs that could issue, yield spreads and maturities of new issues had explainable variation during the crisis, and the determinants were similar to those that help to explain runs.

These results are consistent with previous findings from studies of bank panics that runs are caused by shocks with uncertain incidence in the cross section. This "asymmetric information" framework was first formalized by Chari and Jagannathan (1988) to explain bank panics. Gorton (1988), Calomiris and Gorton (1991), and Calomiris and Mason (2003) provide evidence in support of this view by showing that bank panics were triggered by an observable macroeconomic shock, and were generally at weaker banks. Analogously, we find that runs appeared to be triggered by a macro-financial shock, and that they were more likely at "weaker" programs, such as those with weaker liquidity support, lower ratings, and weaker sponsors. Moreover, investors in ABCP likely knew little about the actual exposures of individual programs to subprime or other risky mortgages, in part because some sponsors viewed their portfolios as proprietary investment strategies. Our finding that the determinants of runs, yields, and maturities were similar provides additional evidence that runs were not random and thus further supports the asymmetric information framework.

Our results also contribute to the literature that finds evidence of risk intolerance among commercial paper investors. Calomiris, Himmelberg, and Wachtel (1995) find that the unsecured commercial paper market is restricted to very high-quality firms. Calomiris (1995) finds that Penn Central's failure in 1970 triggered declines in commercial paper issued by other institutions; Gatev and Strahan (2006) find similar adverse spillover effects for commercial paper issuers following Enron's collapse in 2001.[4] Further, Pennacchi (2006) describes

Ivashina and Scharfstein (2010), Campello, Graham, and Harvey (2010), and Campello et al. (2011) document and study runs on lines of credit in 2008.

[4] Depositors are also found to be risk intolerant. Calomiris and Mason (1997) find that many months prior to the Chicago banking panic of June 1932, bank deposits shrank more for Chicago

money market mutual funds, the primary investors in commercial paper, as wanting to hold only very high-quality assets to limit the risk of "breaking the buck." A fund breaks the buck when its net asset value falls below $1 per share, in which case the fund's commitment to redeem shares at $1 can trigger a run.[5] Our finding of substantial numbers of runs on ABCP programs is also indicative of risk intolerance among commercial paper investors. However, our finding that spreads and maturities of new issues had explainable variation during the crisis suggests that commercial paper investors had a somewhat measured response to the risk of some programs.

Our results also have implications for theories of dynamic coordination failures involving short-term investors (see Acharya, Gale, and Yorulmazer (2011), He and Xiong (2012), Brunnermeier and Oehmke (2013)). We are unable to test these theories directly because we cannot identify whether investors in one transaction are the same investors in another transaction.[6] However, we do find evidence consistent with an important empirical prediction of Brunnermeier and Oehmke (2013), namely, that debt maturities shorten when asset volatilities increase. In their model, greater volatility implies that more information is revealed about an issuer's default probability at rollover dates, allowing short-term investors to extract rents from long-term investors. As a result, an issuer has an incentive to deviate from equilibrium with long-term debt by issuing more short-term debt.[7] Krishnamurthy (2010) documents that maturities in the commercial paper market shortened in the summer 2007; the contribution of our analysis is to link this shortening to the weakness of programs, as well as to measures of spreads and volatilities in interbank funding markets.

The remainder of this paper proceeds as follows. Section I discusses institutional details of the ABCP market, data, and summary statistics. Section II describes our definition and analysis of runs, and Section III presents our

banks that were relatively observably weak. Similarly, Calomiris and Wilson (2004) show that New York City banks' deposits shrank more or less depending on the perceived riskiness of the issuing banks during the Depression. Further, Calomiris and Powell (2001) show the same pattern for Argentine bank deposits during the 1990s.

[5] We are aware of only two money market funds that have broken the buck. In 1994 the net asset value of a fund that held structured notes fell to 0.96. The SEC later disallowed money market funds from holding the type of notes that led to the loss. In September 2008, a fund with relatively large exposures to Lehman Brothers debt broke the buck. A few days later, to stem redemptions from this and other funds, the Treasury Department established a guarantee program on existing money fund accounts, and the Federal Reserve created a liquidity facility to allow funds to liquidate their ABCP holdings in an orderly fashion (Duygan-Bump et al. (2013)).

[6] With data on investor distributions for each program, coordination problems could be tested by estimating the extent to which a more dispersed investor base was associated with runs. To our knowledge, such data do not exist.

[7] Another assumption in models of coordination failures is that liquidation of assets being funded is costly. Unfortunately, we do not have data on specific program assets and so cannot test this assumption. However, spreads on highly rated structured products jumped in 2007, most sharply for securities backed by subprime mortgages, suggesting that the liquidity of assets funded in the ABCP market had become impaired. See Campbell et al. (2011) for an analysis of the liquidity of asset-backed securities (ABS) markets during the financial crisis.

empirical analysis of maturities and yield spreads on newly issued ABCP. Section IV discusses implications for bank balance sheets and securitization markets, and Section V concludes.

## I. Institutional Details of the ABCP Market, Data, and Summary Statistics

### A. Investor Information about Risks of ABCP Portfolios

Investors appeared to have little understanding of the credit quality of ABCP portfolios leading up to the turmoil in August 2007. Indeed, Moody's Investors Service (Moody's hereafter) issued a report on July 20, just weeks before the crisis erupted, entitled "SIVs: An Oasis of Calm in the Subprime Maelstrom" (Moody's (2007)), suggesting little concern about the quality of assets. The idea that investors had a less than complete understanding of the risks associated with ABCP is also suggested by a J.P. Morgan research note published on August 16 ( J.P. Morgan Securities Inc. (2007)), which observed that "ABCP is a complex investment that would take volumes to explain completely."

Some information on ABCP holdings, aggregated across programs, was available in mid- to late-2007. In particular, Moody's reported in July that aggregate holdings of highly rated private-label mortgage-backed securities (MBS) for certain types of programs were about one-quarter of program assets (Moody's (2007)). However, programs viewed their specific holdings as proprietary investment strategies, prompting trade organizations representing securities dealers and investors—the Securities Industry and Financial Markets Association (SIFMA), the American Securitization Forum (ASF), and the European Securitization Forum (ESF)—to recommend improvements in disclosures of assets held in ABCP programs in September, more than a month after the crisis erupted.

In contrast to information about specific assets, information about each program's characteristics, type, and sponsor are available in a program's prospectus. In addition, rating agencies prepare periodic (typically annual) program-level reports to update information in the prospectus. Of the largest rating agencies, Moody's is the most comprehensive in covering the ABCP market.

### B. Program Characteristics

#### B.1. Liquidity and Credit Support

Liquidity support insures against broad market disruptions that might otherwise force a program to sell assets. At the end of July 2007, about 87% of programs had explicit liquidity support from at least one financial institution in the form of a bank back-up line. As an alternative, or in some cases a complement to liquidity support from a financial institution, 24% of programs at that time issued paper with options that allowed them to extend the maturity of the paper past its due date for a fixed period of time at a pre-set penalty rate (see Table I). This feature, in effect, requires investors to internalize the

**Table I**

## ABCP Program Types

This table describes ABCP programs by program type, as of July 2007 (when ABCP outstandings peaked). Data on outstandings are from DTCC and program characteristics are collected from reports by Moody's.

| Program Type | Assets | Number of Programs | Market Share of Outstandings (%) | Programs with Extendible Paper (%) | Programs with Credit Support (%) | Programs with Large US Bank Sponsors (%) | Programs with Small US Bank Sponsors (%) | Programs with Foreign Bank Sponsors (%) | Programs with Nonbank Sponsors (%) |
|---|---|---|---|---|---|---|---|---|---|
| Multi-seller | Diversified receivables and loans | 98 | 45 | 19 | 30 | 19 | 4 | 57 | 20 |
| Nonmortgage single seller | Credit-card receivables and auto loans | 40 | 11 | 62 | 28 | 8 | 10 | 8 | 74 |
| Mortgage single seller | Mortgages and mortgage-backed securities (MBS) | 11 | 2 | 67 | 0 | 9 | 9 | 0 | 82 |
| Securities arbitrage | Highly rated long-term securities, including MBS | 35 | 13 | 9 | 17 | 14 | 11 | 66 | 9 |
| Structured investment vehicle | Highly rated long-term securities, including MBS | 35 | 7 | 0 | 0 | 11 | 0 | 23 | 66 |
| CDO | Highly rated long-term securities, including MBS | 36 | 4 | 25 | 0 | 0 | 3 | 3 | 94 |
| Hybrid and other | N.A. | 84 | 18 | 20 | 10 | 5 | 2 | 12 | 81 |
| Total | | 339 | 100 | 24 | 16 | 10 | 5 | 30 | 55 |

program's liquidity risk, making it a weak form of support from an investor's perspective. From the point of view of ABCP investors, the extendibility option implies a risk of holding an asset that cannot be easily liquidated, should the issuer exercise the option of extending the maturity of the paper. Money market mutual funds, the typical investors in commercial paper, are sensitive not just about eventual repayment but also about the timing of repayment because these funds are exposed to withdrawals from their own short-term investors. In addition, SEC rules impose an upper limit on the average maturity of the portfolios of registered money market mutual funds.

Some programs also have credit support, a contractual commitment to support the program if its assets became impaired. Only 16% of programs had credit support at the end of July 2007 (see Table I). All programs with credit support in our data also had liquidity support.

### *B.2. Ratings*

Nearly all ABCP programs are rated by nationally recognized statistical rating organizations. Ratings reflect the ability of the program to pay in full and on time. Short-term prime ratings assigned by Moody's Investors Service are P-1 (the highest), P-2, and P-3 (the lowest). The vast majority of ABCP programs carry a P-1 rating by Moody's because they are secured by receivables and overcollateralized, they are secured by highly rated and presumably diversified pools of securities, or they have contractual support features (Moody's (2003)). Ratings generally determine the eligibility of paper for purchase by money market mutual funds.

## *C. Program Types*

Table I also summarizes the characteristics of ABCP program types. Multi-seller and single-seller programs are the traditional and most common program types. Such programs are bankruptcy-remote conduits that issue ABCP backed by receivables and loans purchased from multiple firms or a single firm, where bankruptcy-remoteness implies that the assets of the program are shielded from the bankruptcies of the firms that sell the assets to the program. At the end of July 2007, the ABCP market contained 98 multi-seller programs, 40 nonmortgage single-seller programs, and 11 mortgage single-seller programs (i.e., programs that primarily warehoused mortgages prior to their securitization); combined, these programs accounted for 58% of the market. Notably, single-seller programs were the most frequent users of extension options at that time, with more than 60% issuing extendible paper.

Securities arbitrage programs accounted for 13% of the market's outstanding paper at the end of July 2007. These programs purchase long-term, highly rated securities and are often sponsored by banks to reduce the regulatory capital charge that would be incurred if the assets were held on the bank's balance sheet; the sponsor banks typically provide liquidity support.

Structured investment vehicles (SIVs) also fund highly rated securities, and accounted for 7% of the market at the end of July 2007.[8] However, in contrast to the other types of programs, SIVs tend not to have explicit agreements for committed back-stop liquidity lines to cover the full amount of their short-term liabilities. Instead SIVs rely on "dynamic liquidity management" strategies, which involve liquidating assets to pay investors if needed. Specifically, unlike other program types, SIVs use mark-to-market accounting with liquidation clauses (or wind-down triggers) that transfer the control of the program to a trustee that could liquidate the SIV's assets if its junior liabilities or assets drop in value.

Collateralized debt obligations (CDOs) fund at least part of their senior tranche in the commercial paper market. While similar to SIVs in terms of their assets, CDOs do not actively manage their liabilities; they tend to rely instead on full liquidity lines from financial institutions. CDOs accounted for about 4% of the market at the end of July 2007.

Hybrid programs combine features of securities arbitrage and multi-seller programs, and accounted for about 8% of the market at the end of July 2007. Other programs not classified elsewhere accounted for another 10%.

### *D. Sponsor Types*

Sponsors of ABCP programs decide which assets to purchase and how to finance them. Sponsors may directly provide liquidity or credit support to their programs, or contract separately for such support. In July 2007, large U.S. banks (those with more than $500 billion in assets in mid-2007) sponsored mostly multi-seller programs (see Table I). With the salient exception of Citigroup, no large U.S. banks were substantially involved in sponsoring the SIV segment of the market in July 2007. Small U.S. banks sponsored a very modest share of the market. Foreign banks sponsored a substantial share of ABCP, about 30% of programs and, relative to domestic banks, were more likely to sponsor securities arbitrage programs. Nonbank institutions, such as mortgage lenders, finance companies, and asset managers, sponsored roughly 55% of active programs in July 2007. Nonbank sponsors can contract with commercial banks for full liquidity support, use extendibility features or dynamic liquidity management techniques, or offer less than full liquidity support (e.g., in the case of SIVs).

[8] Most SIVs issued medium-term notes (senior liabilities with longer maturity than commercial paper), in addition to ABCP, to attenuate liquidity risks. SIVs also issued junior liabilities to absorb the first credit losses to attenuate credit risks to ABCP investors. At their peak in July 2007, there were 35 SIVs that accounted for $84 billion of U.S. ABCP. Moody's (2007) reports that assets under management in SIVs totaled almost $400 billion in July 2007. Medium-term notes financed about 65% of the assets; U.S. ABCP financed 21%; and Europeon commercial paper, repos, the rest and junior debt financed.

### E. Data and Summary Statistics

Our raw data include all transactions in the U.S. ABCP market in 2007: 693,762 primary market transactions (new issues) by 339 programs over 251 trading days. These data are from the Depository Trust and Clearing Corporation, the agent that electronically clears and settles both directly and dealer-placed commercial paper. The issues in the sample are discount instruments paying face value at maturity. For each transaction, DTCC provides the identity of the issuer, the face and settlement values of the transaction, and the maturity of the security. Using these data, we calculate implicit yields on new overnight paper (maturity of 1–4 days) paid by issuers using standard money market conventions (annualized yields are calculated under the assumption of a 360-day year). We calculate overnight risk spreads as the ABCP rate less the target federal funds rate, an overnight lending rate for banks set by the Federal Open Market Committee. We also obtain from DTCC a separate weekly file that contains program-level information on the amount and maturity distribution of outstandings. Further, we supplement the DTCC data with hand-collected information on program type, credit ratings, liquidity features, and sponsor identity from various reports written by Moody's.

As total outstanding ABCP plunged by nearly 30% from August to December 2007 (see Figure 1, Panel A), different program types were not hit equally hard. As Table II, Panel A shows, outstandings at multi-seller programs fell only about 10% from July to December, while outstandings at SIVs fell about 80% and mortgage single-seller programs virtually disappeared. These dramatic declines in outstandings are consistent with the possibility that investors were intolerant to risk and that paper issued by certain program types may have had some risk. The risk of paper issued by certain program types may have reflected relatively weak program characteristics, a possibility that we explore below in Sections II.C and II.D.

Programs that issued paper did so with shorter maturities and higher spreads than in the earlier part of 2007. For example, as Table II, Panel B and Figure 1, Panel B show, overnight ABCP yield spreads over the target federal funds rate across all program types soared to an average of 47 basis points in August, and remained high and volatile through the end of the year, up from monthly averages of between two and six basis points in the first 7 months of 2007. While the jump in spreads was evident across all program types in August, spreads for single-seller and SIVs continued to escalate in subsequent months, while spreads on multi-seller programs narrowed relatively slightly until year-end pressures intensified.[9]

In addition, as Figure 1, Panel C shows, the average maturity of new-issue paper dropped to about 21 days on average in the last 5 months of 2007, from 33 days on average in the first 7 months of the year. Although all program

[9] Spreads bumped up to an average of 53 basis points in December as strains in the market were likely compounded by typical year-end pressures, while spreads for multi-seller programs rose to 41 basis points. See Downing and Oliner (2007), Musto (1997), and Covitz and Downing (2007) for discussions of year-end effects in the commercial paper market.

**Table II**

## ABCP: Outstandings, Overnight Risk Spreads, and Average Maturity of New Issues, by Program Type

Panel A reports the amount of paper outstanding at the end of each month in 2007 for all program types in the U.S. ABCP market. Panel B reports the spread of rates on overnight ABCP issues, by program type, over the target federal funds rate. Spreads are weighted averages of spreads on individual transactions using face value of transactions as weights. Panel C reports the average number of days to maturity of newly issued paper. Data are from DTCC and program type classification is from Moody's.

Panel A: Outstandings

| Billions of Dollars, End of the Month | | Total | Multi-Seller | Non-mortgage Single Seller | Mortgage Single Seller | Securities Arbitrage | Structured Investment Vehicle | CDO | Hybrid and Other |
|---|---|---|---|---|---|---|---|---|---|
| 2007 | January | 1,061 | 455 | 121 | 32 | 159 | 63 | 41 | 190 |
| | February | 1,067 | 459 | 129 | 33 | 154 | 60 | 41 | 190 |
| | March | 1,070 | 480 | 122 | 25 | 148 | 56 | 46 | 193 |
| | April | 1,092 | 492 | 125 | 32 | 142 | 63 | 46 | 193 |
| | May | 1,125 | 503 | 126 | 35 | 149 | 65 | 46 | 202 |
| | June | 1,151 | 518 | 123 | 23 | 150 | 79 | 48 | 211 |
| | July | 1,163 | 525 | 126 | 23 | 148 | 84 | 47 | 210 |
| | August | 976 | 503 | 79 | 4 | 120 | 70 | 39 | 160 |
| | September | 927 | 484 | 74 | 2 | 133 | 49 | 33 | 153 |
| | October | 896 | 465 | 68 | 2 | 140 | 29 | 32 | 160 |
| | November | 838 | 461 | 55 | 1 | 117 | 22 | 31 | 152 |
| | December | 816 | 469 | 51 | 2 | 102 | 15 | 27 | 151 |

Panel B: Overnight Risk Spreads

| Percentage Points Month Average | | Total | Multi-Seller | Non-mortgage Single Seller | Mortgage Single Seller | Securities Arbitrage | Structured Investment Vehicle | CDO | Hybrid and Other |
|---|---|---|---|---|---|---|---|---|---|
| 2007 | January | 0.02 | 0.02 | 0.00 | 0.05 | 0.02 | 0.01 | 0.02 | 0.02 |
| | February | 0.02 | 0.02 | 0.01 | 0.04 | 0.03 | 0.01 | 0.03 | 0.03 |
| | March | 0.05 | 0.05 | 0.06 | 0.07 | 0.04 | 0.04 | 0.10 | 0.04 |
| | April | 0.05 | 0.05 | 0.05 | 0.06 | 0.04 | 0.04 | 0.09 | 0.04 |
| | May | 0.03 | 0.03 | 0.03 | 0.06 | 0.03 | 0.02 | 0.04 | 0.03 |
| | June | 0.06 | 0.06 | 0.07 | 0.09 | 0.06 | 0.05 | 0.07 | 0.05 |
| | July | 0.06 | 0.06 | 0.05 | 0.08 | 0.05 | 0.05 | 0.07 | 0.05 |
| | August | 0.47 | 0.44 | 0.42 | 0.76 | 0.47 | 0.44 | 0.51 | 0.55 |
| | September | 0.49 | 0.41 | 0.71 | 1.22 | 0.53 | 0.55 | 0.41 | 0.65 |
| | October | 0.34 | 0.24 | 0.83 | 1.51 | 0.42 | 0.55 | 0.50 | 0.47 |
| | November | 0.44 | 0.35 | 1.01 | 1.75 | 0.57 | 0.76 | 0.54 | 0.50 |
| | December | 0.53 | 0.41 | 0.91 | 1.92 | 0.69 | 1.11 | 0.75 | 0.53 |

(*Continued*)

**Table II**—*Continued*

Panel C: Average Maturity of New Issues

| Days to Maturity, Month Average | | Total | Multi-Seller | Non-mortgage Single Seller | Mortgage Single Seller | Securities Arbitrage | Structured Investment Vehicle | CDO | Hybrid and Other |
|---|---|---|---|---|---|---|---|---|---|
| 2007 | January | 33 | 25 | 36 | 16 | 37 | 47 | 45 | 35 |
| | February | 34 | 26 | 38 | 17 | 44 | 55 | 41 | 32 |
| | March | 32 | 24 | 35 | 17 | 35 | 43 | 42 | 34 |
| | April | 35 | 26 | 37 | 18 | 45 | 57 | 42 | 32 |
| | May | 35 | 26 | 40 | 16 | 49 | 56 | 40 | 32 |
| | June | 32 | 23 | 35 | 14 | 37 | 41 | 45 | 34 |
| | July | 30 | 23 | 36 | 16 | 36 | 42 | 34 | 30 |
| | August | 22 | 18 | 25 | 7 | 24 | 45 | 24 | 19 |
| | September | 19 | 16 | 21 | 7 | 18 | 25 | 27 | 18 |
| | October | 24 | 17 | 29 | 3 | 35 | 47 | 29 | 24 |
| | November | 22 | 20 | 22 | 2 | 25 | 22 | 28 | 22 |
| | December | 18 | 16 | 15 | 2 | 18 | 25 | 31 | 18 |

types experienced notable declines in the average maturity of new issues, single-seller programs that specialized in mortgages and SIVs that continued issuing experienced more pronounced drops in their average maturity of new issues (see Table II, Panel C). In the Internet Appendix we analyze the maturity staggering of debt contracts across investors.[10]

## II. Analysis of Runs

### *A. Defining Runs*

In traditional bank runs, depositors withdraw demand deposits from commercial banks. We define a run on a commercial paper program analogously as occurring when short-term creditors refuse to roll their positions. To characterize such an action as a run requires that short-term creditors are moving ahead of other economic agents, as with depositors trying to withdraw their funds before other depositors (as in numerous studies on depositor runs) or firms drawing on lines of credit before banks cut the lines (as in Ivashina and Scharfstein (2010), Campello, Graham, and Harvey (2010), and Campello et al. (2011)). This notion of moving ahead of others is plausible in short-term credit

[10] An Internet Appendix may be found in the online version of this article. In the Internet Appendix, we describe the cross-section and time-series variation in the degree of maturity staggering, measured as the weighted standard deviation of the maturity (in days) of paper outstanding, where outstanding issues are weighted by their face values. The results presented in the Internet Appendix suggest that average maturity and average maturity staggering are significantly correlated. We find that maturity staggering compressed roughly in line the average maturity of outstandings during the 2007 ABCP crisis. We also find that program types that exhibited longer average maturities also exhibited higher degrees of maturity staggering.

markets, as the last investor to roll its position may end up with payment delays and credit losses.

To measure runs on ABCP programs, we define program $i$ as in a run in any period $t$ in which it has more than 10% of its outstanding paper scheduled to mature but it does not issue.[11] The program is also considered to be in a run if it was defined as in a run in the prior period and does not issue in the current period. That is, programs in a run remain in a run until they issue. More formally:

$$\text{Run}_{it} = \begin{cases} 1 & \text{if } \dfrac{Maturing_{it}}{Outstanding_{it}} > 0.1 \text{ and } Issuance_{it} = 0 \\ 1 & \text{if } Run_{i(t-1)} = 1 \text{ and } Issuance_{it} = 0 \\ 0 & otherwise \end{cases} . \tag{1}$$

In our analysis, $t$ is a particular week because our data on program outstandings, used to measure the need to issue, are available only weekly. The condition that maturing paper is more than 10% of outstandings is intended to capture the need to issue. The condition that issuance is zero is intended to capture the inability to issue. The zero-issuance condition makes our definition of runs conservative in the sense that programs that issue even a small amount relative to the amount of maturing paper, perhaps at very high cost, will not be classified as in a run. Another reason our definition of runs may be conservative is that it classifies a program as not in a run even if the paper was issued in a non-arms-length transaction to the program's sponsor. Unfortunately, our data set does not contain the identity of investors, so we are unable to adjust for the possibility of non-arms-length transactions.

One additional limitation of our measure is that it may classify a program that is unable to issue in a given week as not in a run if the program has less than 10% of its outstanding paper scheduled to mature that week and was not classified as in a run in the prior week. We address this issue by dropping observations for which the following three conditions hold: issuance during the week is zero, less than 10% of the program's paper is scheduled to mature over the week, and the program was not in a run in the prior week. Importantly, all our results are both qualitatively and quantitatively similar if we include these observations.[12]

[11] The 10% cutoff is arbitrary and intended to capture the program's need to issue. About 10% of all ABCP outstanding in the U.S. market is typically scheduled to mature the next business day. Our main results do not depend on small variations in this percentage.

[12] We identify extensions in our sample when an issue by an extendible program is reported outstanding past its original maturity date. Extendible programs are included in the sample of our regressions, and we apply the definition of runs in equation (1) to these programs as well. For example, if an extendible program issues no paper in week $t$ and more than 10% of its paper due, we say that this extendible program faces a run in week $t$, regardless of whether it has extended paper or not. Similarly, if a program extends an issue but continues issuing paper, we say that this

To our knowledge, no other empirical analyses of runs use transaction-level data on investor or depositor withdrawals. Recent studies define runs by the change in banks' deposits or wholesale liabilities, which reflects the net effect of inflows and outflows by various depositors and investors. Shin (2009) discusses retail and wholesale runs at Northern Rock in 2007; Oliveira, Schiozer, and Barros (2011) investigate determinants of runs at Brazilian banks in 2008; and Iyer and Peydró (2011) examine the effects of fraud at a major Indian bank on runs at banks that were connected through interbank deposits. De Graeve and Karas (2010) use an ex ante definition of bank runs in Russia as a supply shock in which deposit outflows are greater at uninsured banks than insured banks, but, like the other papers, they only observe the net change in deposits. Gorton and Metrick (2012) define a run in the repo market when investors increase spreads and haircuts, but they do not have transaction-level data for repos.

### *B. ABCP Runs and Events in Money Markets in 2007*

Runs on ABCP programs mounted quickly in August 2007. Runs, as defined in equation (1), were quite low each week from January to July 2007, but then shot up in August as the financial market turmoil erupted (see Figure 2). Starting in August, the percent of ABCP programs experiencing a run each week climbed sharply through September to above 30% of all ABCP programs, and by the end of 2007 more than 40% of programs were in a run. As a result, after no ABCP program had defaulted for many years (from at least 2001 to July 2007), two programs defaulted in August, accounting for 2% of outstandings, and an additional three programs defaulted by December. Similarly, although two programs had extended before August, extensions did not escalate sharply until August, and an additional 19 programs were extended by year-end. The total share of ABCP outstanding that defaulted reached about 3% by the end of 2007.

The programs we identify as experiencing runs between July and December 2007 accounted for a substantial portion of the decline in ABCP outstanding depicted in Figure 1. ABCP outstanding at programs that experienced a run between July and December 2007 dropped 81% between July 25 and December 26, 2007. By contrast, ABCP outstanding at programs that did not experience a run decreased 2% over the same period. Taking into account the relative share of outstandings of programs that were in a run, roughly 95% of the decline in ABCP between July and December 2007 can be attributed to decreases at programs that experienced runs.

To assess our identification of runs, we evaluate the likelihood that a program exits a run. Quick exits from runs would seem inconsistent with the intuitive notion that a run is an absorbing state in which a program is essentially shut out of the market. The estimated unconditional hazard rate over time of the probability that a program in a run would exit the run state is represented

program faces no run in week $t$. We check the robustness of our results by excluding the programs with extendibility features from our sample in the regression for runs.

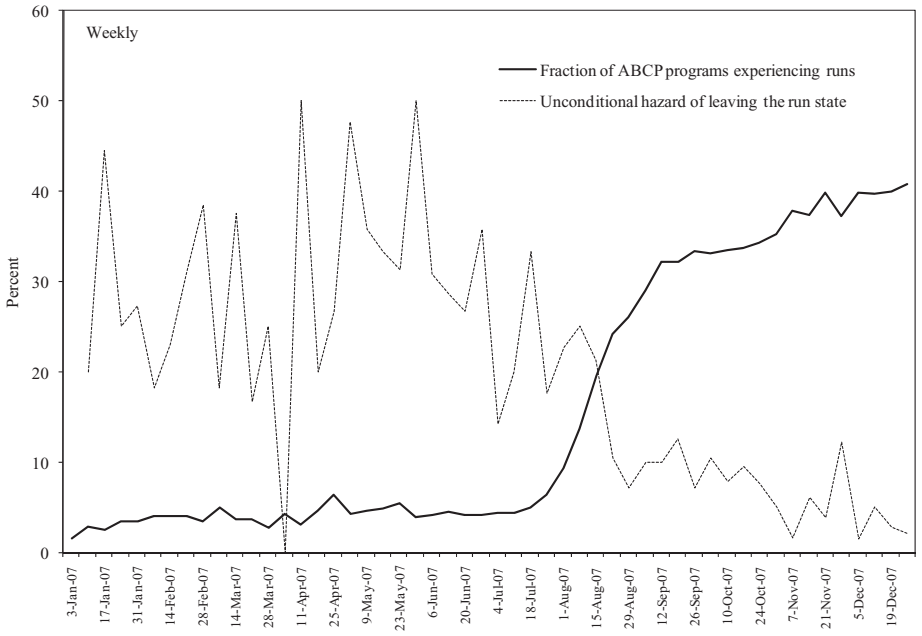


**Figure 2. Runs on ABCP programs.** The solid line plots the percent of programs experiencing a run. We define a program as experiencing a run in weeks when it does not issue paper but has at least 10% of paper maturing or when the program continues to not issue paper after experiencing a run in the previous week (see equation (1) in the text). The dotted line plots the unconditional probability of not experiencing a run in a given week after having experienced a run in the previous week (i.e., the hazard rate of exiting a run). The figure is based on weekly data from DTCC on paper outstanding, maturities, and issuance for 339 ABCP programs in 2007.

by the dotted line in Figure 2. In the first 7 months of the year, the estimated hazard rate is high on average, and generally ranges from around 20% to 50%, suggesting that the few identified runs during that period may not have been "true" runs in the sense of the programs being unable to subsequently issue new paper. In contrast, the estimated hazard rate fell notably in early August and then declined to near zero by the end of the year, suggesting that the many identified runs from August to December were indeed runs.

The proximate cause of the runs was mounting concerns about exposures of ABCP programs to subprime mortgages. In early August, BNP Paribas halted redemptions from three affiliated money market mutual funds, announcing that it could no longer value the holdings of U.S. subprime MBS held in the funds (see Table III). The European Central Bank (ECB) immediately announced that it would supply reserves as needed to promote stability, which totaled $130 billion on August 9, and the Federal Reserve made a similar announcement on August 10. The spread of U.S. LIBOR over overnight index swap (OIS) rates, an indicator of banks' willingness to lend to one another, shot up (see Figure 3, Panel A).

**Table III**
**Calendar of Events in Money Markets in 2007**

| Month | Events in Money Markets |
|---|---|
| July | • Countrywide's disappointing earnings announcement (July 24) |
| August | • American Home Mortgage declares bankruptcy (Aug 6) |
| | • Three single-seller mortgage ABCP programs extend the maturity of their paper (Aug 6) |
| | • BNP halts redemptions at three affiliated funds (Aug 9) |
| | • ECB injects liquidity in money markets (Aug 9) |
| | • Federal Reserve provides liquidity (Aug 10) |
| | • Canadian ABCP market seizes up (Aug 14) |
| | • Countrywide taps on its credit lines (Aug 16) |
| | • Federal Reserve cuts primary credit rate 50 basis points (Aug 17) |
| | • An ABCP program affiliated with KKR Financial extends the maturity of its paper (Aug 20) |
| | • Two SIV programs default on their ABCP (Aug 22–23) |
| | • A second ABCP program affiliated with KKR Financial extends the maturity of its paper (Aug 23) |
| | • Clarification that investment-quality ABCP is accepted as discount-window collateral at the Federal Reserve (Aug 24) |
| September | • An SIV program sponsored by Cheyne Capital Management draws on its credit lines (Aug 30) |
| | • Moody's downgrades or places under review the ratings of several ABCP programs issued by SIVs (Sept 5) |
| | • SIFMA, the American Securitization Forum, and the European Securitization Forum recommend disclosure of holdings by ABCP programs (Sept 12) |
| | • Federal Reserve cuts the target federal funds target rate by 50 basis points (Sept 18) |
| October | • Citigroup, Bank of America, and JP Morgan Chase propose the M-LEC to backstop paper issued by SIVs (Oct 15) |
| | • An SIV program sponsored by Cheyne Capital Management defaults (Oct 17) |
| | • An SIV program sponsored by IKB Credit Management defaults (Oct 18) |
| | • Federal Reserve cuts the target federal funds rate by 25 basis points (Oct 31) |
| November | • Moody's Investors Service downgrades and places under review several SIVs (Nov 7) |
| December | • S&P downgrades many SIVs (Dec 7) |
| | • Federal Reserve cuts the target federal funds rate by 25 basis points (Dec 11) |
| | • Federal Reserve establishes the Term Auction Facility (TAF) and coordinates foreign exchange swap lines with other major central banks (Dec 12) |
| | • Citigroup announces that it will support its own-sponsored SIVs (Dec 13) |
| | • First TAF auction (Dec 17) |
| | • Citigroup, Bank of America, and JP Morgan Chase abandon the idea of M-LEC (Dec 21) |

It is worth noting, however, that, while concerns about subprime mortgages appeared to precipitate turmoil in the ABCP market, the evolution of such turmoil through August and over the remainder of the year seemed not to coincide precisely with shifts in sentiment about subprime mortgages. Indeed, the return on the AAA-rated tranche of the ABX, which had been negative, turned positive in the second half of August (See Figure 3, Panel B), even as

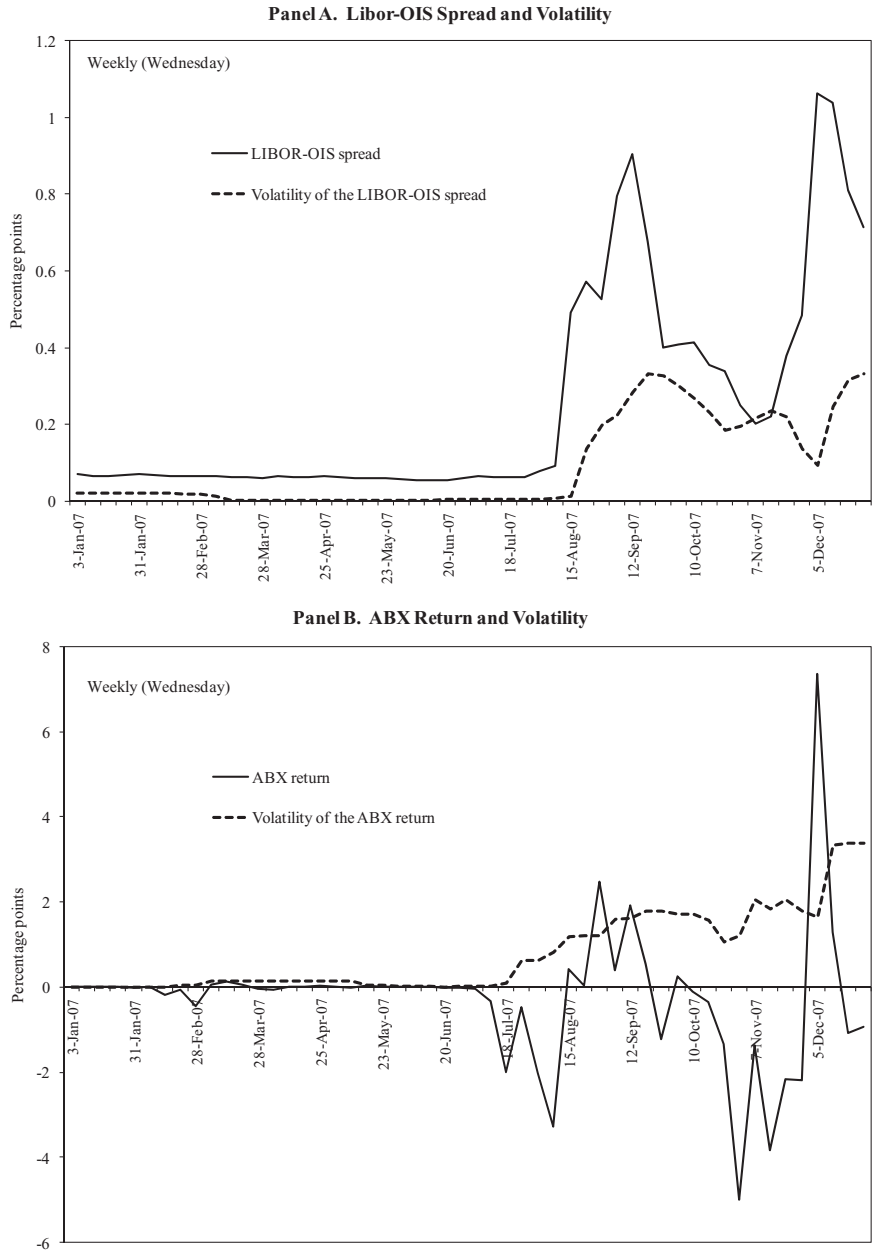


**Figure 3. Measures of financial market risk.** Panel A plots the weekly average spread of 1-month U.S. LIBOR over comparable maturity OIS and its volatility (Source: British Bankers Association and Prebon). Panel B plots the weekly return on the ABX.HE index for AAA-rated tranches of MBS originated in the first half of 2006 and its volatility (Source: JPMorgan Chase & Co.).

the number of ABCP programs in a run continued to accumulate. Both the LIBOR-OIS spread and ABX return are highlighted and discussed in detail in Gorton and Metrick (2012) as measures of broad market stress in the fall 2007.

### C. Cross-Sectional Regressions of the Probability of Experiencing a Run

To analyze the determinants of runs, we first estimate a cross-sectional probit model for the latent probability of program $i$ experiencing a run in any week in the sample period on program characteristics, program type, and sponsor type.[13] More formally,

$$\Pr(Run_i = 1) = F\Bigg(\alpha + \sum_h \beta_h Program\ characteristics_{hi} + \sum_j \eta_j Program\ type_{ji} + \sum_k \gamma_k Sponsor\ type_{ki}\Bigg), \tag{2}$$

where $F$ denotes the cumulative distribution function of a standard normal variable.

The model is estimated separately for two time periods: the first is from February to July 2007, before spreads ballooned and outstandings plummeted (the pre-crisis period); the second is from August through December 2007, the period of market turmoil (the crisis period).[14] The possibility that coefficients on the program variables might change with the crisis is suggested by Martinez-Peria and Schmukler (2001). We use standard errors that are robust to cross-sectional correlations.

The first group of explanatory variables in the specification control for program characteristics. Specifically, $Program\ characteristic_{hi}$ denotes characteristic $h$ for program $i$. The first characteristic variable is *Extendibility*, which equals one for programs that have the option to extend the maturity of their paper at the issuer's request. Extensions are a weak form of liquidity support, as investors are essentially absorbing the liquidity risk. A second program characteristic variable, *Number of liquidity providers*, proxies for the strength of support in the event of a rollover disruption. A third characteristic variable, *Lower rating*, equals one for programs rated below P-1 by Moody's in the month before the beginning of the sample period (January 2007 for the pre-crisis period and July 2007 for the crisis period). A fourth program characteristic, *Credit support*, equals one when programs have contractual commitments from financial institutions to support the program in the event of asset impairment. A

[13] We obtain very similar results when using a logit model.

[14] We excluded the last two weeks of December from our estimations because sizable year-end effects are typical in this market. Spreads tend to rise in the days ahead of the year-end then fall once into the new year (see Downing and Oliner (2007) and Musto (1997)). Similarly, gross issuance falls in the days before the year-end as issuers issue longer paper earlier in December to get past the year-end or turn to other sources for funds. Because our measure of runs could pick up typical year-end behavior rather than unusual stresses in this market, we excluded the last 2 weeks of December.

final program characteristic variable is *Initial average maturity of outstandings*, defined as the average maturity of a program's outstanding commercial paper in the month prior to the beginning of the respective sample, as programs with shorter-term liabilities might be more susceptible to runs.

The specification also includes controls for program type, as investors might have looked to these indicators as broad signals of potential exposure to subprime mortgages. The variable $Program\ type_{ji}$ equals one if program $i$ is type $j$ and equals zero otherwise. The set of $j$ program types includes multi-sellers, nonmortgage single-seller conduits, mortgage single-seller conduits, securities arbitrage programs, SIVs, and CDOs; hybrids and other are the omitted group.

The third set of variables controls for the type of sponsor. The variable $Sponsor\ type_{ki}$ equals one if program $i$ is sponsored by an institution of type $k$ and equals zero otherwise. The set of $k$ sponsors includes *Small U.S. bank sponsor*, *Non-U.S. bank sponsor*, and *Nonbanking sponsor*; the omitted category is large U.S. banks.

The results from the cross-sectional regressions are shown in Table IV.[15] A first finding from these regressions is that runs in the crisis period (column 2) were significantly more likely at programs with relatively weak characteristics. In particular, in the crisis period, the estimated marginal effect of *Extendibility* is positive and significant at the 1% level, and the marginal effect for *Number of liquidity providers* is negative and significant at the 1% level, indicating that runs were more likely at programs with weaker liquidity support.[16] In addition, the effect of *Lower rating* was positive and significant in the crisis period, indicating that programs perceived to be weak were more likely to be in a run. In the pre-crisis period (column 1), the set of significant program characteristics is similar to that in the crisis period, though the estimated marginal effects are smaller in absolute magnitude and less significant.[17] The marginal effect of *Initial average maturity of outstandings* is insignificant in both periods.

Runs also seemed more likely at program types likely to be exposed to subprime mortgages, and again the effects are generally stronger in the crisis period than in the pre-crisis period. In particular, the marginal effect of *Multi-seller* was negative and significant at the 1% level in the crisis period,

[15] From the full sample of ABCP programs with transaction data from DTCC, we exclude 107 programs for which information on some program characteristic, program type, or sponsor type is not available from reports. The most common missing characteristic is the number of liquidity providers; for the cross-sectional regressions, the sample is reduced by 40 observations in the crisis period and 34 observations in the pre-crisis period. The results for the larger sample (not requiring data on number of liquidity providers) do not change the findings as reported in Table IV.

[16] When we exclude the 60 programs with the extendibility feature from our sample, about one-third of which actually extended at some time during the 5 months of the crisis period and therefore were unlikely to issue even as paper came due, the estimates are mostly unchanged.

[17] We dropped *Initial lower rating* from the estimation in the pre-crisis period because it is a perfect predictor of runs. Thus, we exclude the three observations with low initial rating in the pre-crisis period. The estimated marginal effects are basically unchanged for all other variables.

**Table IV**

## Cross-Sectional Regressions of the Probability of Experiencing a Run

This table reports the results of estimating the probit model in equation (2) using a cross-section of ABCP programs:

$$\Pr(Run_i = 1) = F\left(\alpha + \sum_h \beta_h Program\ characteristics_{hi} + \sum_j \eta_j Program\ type_{ji} + \sum_k \gamma_k Sponsor\ type_{ki}\right).$$

The dependent variable is the probability of experiencing a run as defined in equation (1) at any point over the sample (February to July 2007 in column (1) and August to December 2007 in column 2). $F$ denotes the cumulative distribution function of a standard normal random variable. *Program characteristics* include: an indicator for extendibility (which equals one for programs that have the option to extend the maturity of their paper at the issuer's request), the number of liquidity providers, an indicator for initial lower rating (which equals one for programs rated below P-1 by Moody's 1 month before the sample), an indicator for credit support (which equals one when sponsoring financial institutions commit to support the program in the event of asset impairment), and the initial average maturity of commercial paper outstanding. *Program type*$_{ji}$ equals one if program $i$ is type $j$ and equals zero otherwise. The set of $j$ program types includes multi-sellers, nonmortgage single-seller conduits, mortgage single-seller conduits, securities arbitrage programs, SIVs, CDOs, and other programs (the omitted category). *Sponsor type*$_{ki}$ equals one if program $i$ is sponsored by an institution of type $k$ and equals zero otherwise. The set of $k$ sponsors includes large U.S. banks (the omitted category), small U.S. banks, non-U.S. banks, and nonbanking institutions. Perfect predictors of success or failure are dropped from the regression. The table reports estimated marginal effects, and robust standard errors are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

| | | February–July 2007 (1) | August–December 2007 (2) |
|---|---|---|---|
| Program characteristics | Extendibility | 0.185* | 0.344*** |
| | | (0.095) | (0.062) |
| | Number of liquidity providers | −0.009* | −0.018*** |
| | | (0.005) | (0.006) |
| | Initial lower rating | dropped | 0.249* |
| | | (perf. pred.) | (0.139) |
| | Credit support | 0.132 | 0.030 |
| | | (0.090) | (0.093) |
| | Initial average maturity of outstandings | −0.002 | 0.003 |
| | | (0.002) | (0.003) |
| Program type variables | Multi-seller | −0.143** | −0.268*** |
| | | (0.065) | (0.096) |
| | Nonmortgage single seller | −0.003 | 0.120 |
| | | (0.103) | (0.123) |
| | Mortgage single seller | −0.021 | 0.214 |
| | | (0.135) | (0.178) |
| | Securities arbitrage | 0.015 | −0.216 |
| | | (0.108) | (0.141) |
| | Structured investment vehicle | −0.002 | 0.322*** |
| | | (0.115) | (0.070) |
| | CDO | 0.307** | 0.292*** |
| | | (0.123) | (0.078) |

(*Continued*)

**Table IV**—*Continued*

| | | February–July 2007 (1) | August–December 2007 (2) |
|---|---|---|---|
| Sponsor type variables | Small U.S. bank sponsor | – 0.085 | 0.213* |
| | | (0.097) | (0.124) |
| | Non-U.S. bank sponsor | – 0.162*** | 0.126 |
| | | (0.062) | (0.104) |
| | Nonbanking sponsor | – 0.118 | 0.108 |
| | | (0.083) | (0.104) |
| | Observations | 240 | 245 |
| | Pseudo-$R^2$ | 0.134 | 0.255 |

suggesting fewer concerns about diversified conduits with little or no mortgage holdings; the corresponding effect in the pre-crisis period was significant at the 5% level and notably smaller in absolute magnitude. The marginal effect of *Mortgage single-seller* is positive though insignificant in the crisis period, and near zero in the pre-crisis period; the insignificance of this effect in the crisis period is somewhat surprising and likely reflects the high correlation between *Mortgage single-seller* and *Extendibility*. In addition, the estimated effects for *Structured investment vehicles* and *CDOs,* categories of programs with exposure to subprime mortgages, are positive and significant in the crisis period; only the marginal effect for *CDOs* is significant in the pre-crisis period.[18] The estimated effects for *Securities arbitrage* programs, which also tended to fund subprime mortgages, were insignificant in both periods.

Further, the cross-sectional regression results provide some evidence that runs during the crisis were more likely at programs with arguably weaker sponsors. In particular, the marginal effect for *Small U.S. bank sponsor* in the crisis period is positive and significant at the 10% level, while the estimated effects for other sponsor types are insignificant. Before the crisis, the only significant sponsor-type effect is that for *Non-U.S. bank sponsor*, which is significant at the 1% level and negative.

Overall, the results from the cross-sectional regressions indicate that runs were not random, but instead were significantly more likely at riskier programs, with risk measured based on observable program characteristics, program type, and sponsor type. Moreover, the estimated effects of various determinants of runs are larger and more significant during the crisis, suggesting that investors make stronger distinctions across programs in periods of greater uncertainty.

[18] Some SIVs may be contractually mandated to stop issuing paper when their wind-down clauses are triggered. Unfortunately, we do not have information on wind-down events. However, our findings on the relationship between runs and the other explanatory variables are largely the same when excluding SIVs from the regressions.

*D. Panel Regressions of the Probability of Experiencing a Run*

We next examine the determinants of runs using a probit model of the latent probability of program $i$ experiencing a run in week $t$. The panel specification allows the inclusion of one additional program characteristic variable and four macro variables in the estimations. The resulting specification is as follows:

$$\Pr(Run_{it}=1) = F\Bigg(\alpha+\sum_{g}\beta_g Program\ characteristics_{g,it}+\sum_{j}\eta_j Program\ type_{ji} + \sum_{k}\gamma_k Sponsor\ type_{ki}+\sum_{l}\delta_l Macro\ variables_{lt}\Bigg). \quad (3)$$

The set of program characteristics, $g$, differs from $h$ in equation (2) in that *Lower rating* varies by week in equation (3), and equation (3) also includes the weekly *CDS spread of the main liquidity provider*, a measure of the perceived risk of the main liquidity provider. This variable should capture investors' views about the ability of the main liquidity provider to meet its obligations to support the program. The main liquidity provider is defined as the one that contributes the highest percentage of committed liquidity lines and that also provides at least 20% of the lines.

As in the cross-sectional analysis, we estimate the model separately for the pre-crisis and crisis periods. For each period, we estimate two specifications: in the first, the set of macro variables, $l$, in equation (3) includes *Spread of one-month LIBOR over OIS* and its volatility; in the second specification, $l$ consists of *Return on the ABX index* and its volatility. A higher and more volatile LIBOR-OIS spread should reflect greater concerns about the ability of banking firms to access short-term funding in interbank markets. Declines in the ABX return could reflect investors' views about the deterioration in the asset quality and solvency of ABCP programs since they were perceived to be exposed to subprime mortgage assets. We cluster standard errors at the program level to account for the likely correlation in errors within a particular program across time.[19]

The results from the panel regressions are shown in Table V. Looking first at the coefficients on program characteristics suggests again that runs were associated with weaker contractual liquidity support and lower ratings. In the crisis period (columns 3 and 4), the marginal effects for *Extendibility*, *CDS spread of the main liquidity provider,* and *Lower rating* are positive and significant at the 1% or 5% level in both specifications.[20] In the pre-crisis period

[19] We exclude 430 (754) week-program observations in the crisis (pre-crisis) period that have less than 10% of paper maturing. The results are very similar when including these observations.

[20] The CDS spread of the main liquidity provider is not available for 130 programs. Results for regressions based on the larger sample without the CDS spread are largely the same as the results reported in Table V. In particular, the coefficients are significant and with the same sign for the indicators for extendibility, lower rating, multi-seller, securities arbitrage, SIVs, and small U.S. bank sponsor, as well as for the volatility of the LIBOR-OIS spread and the volatility of the ABX return.

**Table V**

## Panel Regressions of the Probability of Experiencing a Run

This table reports the results of estimating the probit model in equation (3) from the text using panels of weekly observations of ABCP programs from February to July 2007 (columns 1 and 2) and from August to December 2007 (columns 3 and 4):

$$\Pr(Run_{it} = 1) = F\left(\alpha + \sum_g \beta_g Program\ characteristics_{g,it} + \sum_j \eta_j Program\ type_{ji} + \sum_k \gamma_k Sponsor\ type_{ki} + \sum_l \delta_l Macro\ variables_{lt}\right).$$

The dependent variable is the probability of experiencing a run during week $t$ as defined in equation (1). $F$ denotes the cumulative distribution function of a standard normal random variable. *Program characteristics* include: an indicator for extendibility (which equals one for programs that have the option to extend the maturity of their paper at the issuer's request); the number of liquidity providers; the 5-year CDS spread on week $t$ for the institution listed as the main liquidity provider for program $i$; a time-varying indicator for lower rating (which equals one for programs rated below P-1 by Moody's in week $t$); an indicator for credit support (which equals one when sponsoring financial institutions commit to support the program in the event of asset impairment); and the initial average maturity of commercial paper outstanding. *Program type*$_{ji}$ and *Sponsor type*$_{ki}$ are defined as in Table IV. In columns 1 and 3, the *Macro variables* are the weekly average *Spread of one-month LIBOR over OIS* and its volatility. In columns 2 and 4, the *Macro variables* are the weekly *Return on the ABX* index and its volatility. Perfect predictors of success or failure are dropped from the regression. The table reports estimated marginal effects, and standard errors clustered by program are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

| | | February–July 2007 (1) | February–July 2007 (2) | August–December 2007 (3) | August–December 2007 (4) |
|---|---|---|---|---|---|
| Program characteristics | Extendibility | −0.010 | −0.009 | 0.462*** | 0.467*** |
| | | (0.028) | (0.028) | (0.116) | (0.116) |
| | Number of liquidity providers | −0.022** | −0.022** | −0.008 | −0.008 |
| | | (0.010) | (0.010) | (0.007) | (0.007) |
| | CDS spread of main liquidity provider | 0.236* | 0.273 | 0.359*** | 0.277** |
| | | (0.131) | (0.167) | (0.119) | (0.117) |
| | Lower rating | dropped | dropped | 0.345*** | 0.345*** |
| | | (perf. pred.) | (perf. pred.) | (0.118) | (0.121) |
| | Credit support | 0.010 | 0.009 | 0.092 | 0.094 |
| | | (0.030) | (0.029) | (0.121) | (0.122) |
| | Initial average maturity of outstandings | −0.001 | −0.001 | 0.001 | 0.001 |
| | | (0.001) | (0.001) | (0.002) | (0.002) |
| Program type variables | Multi-seller | −0.056* | −0.055* | −0.239*** | −0.240*** |
| | | (0.029) | (0.028) | (0.072) | (0.072) |
| | Nonmortgage single seller | −0.017 | −0.017 | −0.060 | −0.064 |
| | | (0.026) | (0.026) | (0.127) | (0.127) |
| | Mortgage single seller | dropped | dropped | 0.030 | 0.032 |
| | | (perf. pred.) | (perf. pred.) | (0.166) | (0.169) |
| | Securities arbitrage | 0.017 | 0.017 | −0.231*** | −0.229*** |
| | | (0.040) | (0.039) | (0.049) | (0.050) |

(*Continued*)

**Table V**—*Continued*

| | | February–July 2007 (1) | February–July 2007 (2) | August–December 2007 (3) | August–December 2007 (4) |
|---|---|---|---|---|---|
| | Structured investment vehicle | dropped (perf. pred.) | dropped (perf. pred.) | 0.302*** (0.116) | 0.314*** (0.114) |
| | CDO | −0.025** (0.011) | −0.025** (0.011) | −0.043 (0.161) | −0.031 (0.167) |
| Sponsor type variables | Small U.S. bank sponsor | −0.031** (0.013) | −0.031** (0.013) | 0.382** (0.159) | 0.384** (0.160) |
| | Non-U.S. bank sponsor | −0.036* (0.020) | −0.035* (0.021) | 0.127 (0.110) | 0.119 (0.110) |
| | Nonbanking sponsor | −0.024 (0.028) | −0.022 (0.028) | 0.072 (0.088) | 0.062 (0.089) |
| Macro variables | Spread of 1-month LIBOR over OIS | −0.117 (0.815) | | 0.040 (0.028) | |
| | Volatility of the spread of one-month LIBOR over OIS | 0.136 (0.558) | | 0.582*** (0.127) | |
| | Return on the ABX index | | 0.010 (0.007) | | 0.000 (0.003) |
| | Volatility of the return on the ABX index | | −0.010 (0.036) | | 0.116*** (0.023) |
| | Observations | 2,088 | 2,088 | 2,319 | 2,319 |
| | Number of programs | 123 | 123 | 144 | 144 |
| | Pseudo-$R^2$ | 0.152 | 0.154 | 0.269 | 0.271 |

(columns 1 and 2), the marginal effects for *Number of liquidity providers* are negative and significant at the 5% level in both specifications, and the effects for *CDS spread of the main liquidity provider* are positive and significant at the 10% level in one specification. The initial average maturity of outstandings is not significantly correlated with the probability of experiencing a run.[21]

The results for program type are also similar to the corresponding results from the cross-sectional model of runs. In the crisis period, the marginal effects on *Multi-seller* are again negative and significant at the 1% level, while the marginal effects for *Structured investment vehicle* are again positive and significant at the 1% level, suggesting that perceived exposures to subprime mortgages led to runs. Estimated effects for *Securities arbitrage* are negative and significant at the 1% level in the crisis period. In the pre-crisis period, the marginal effects of most program-type variables are insignificant or small.

The results for sponsor types in the panel regressions are similar to the corresponding results from the cross-sectional regressions. In particular, in the

[21] In the Internet Appendix, we expand the regressions on the probability of a run in Table V to include a proxy for program-level maturity staggering as an explanatory variable. The results suggest that, after controlling for program and sponsor characteristics and macro-risk factors, maturity staggering is not significantly correlated with the probability of runs during the crisis.

crisis period, the marginal effects of *Small U.S. bank sponsor* are positive and significant at the 5% level, while the effects of other sponsor type coefficients are insignificant. In the pre-crisis period, the effects for *Small U.S. bank sponsor* and *Non-U.S. bank sponsor* are significant but small.

In terms of macro-financial risks, the marginal effects for *Volatility of the spread of one-month LIBOR over OIS* and *Volatility of the return on the ABX index* are both positive and significant at the 1% level in the crisis period, while the corresponding effects in the pre-crisis period are insignificant. These results suggest that uncertainties about interbank funding markets and subprime mortgage values may have been important determinants of runs in the last 5 months of 2007.

Overall, the results from the panel regressions of runs suggest that runs were not random, and that the determinants of runs were stronger in the crisis period than in the pre-crisis period. In particular, during the crisis, runs were more likely at programs with weaker support, greater exposure to subprime mortgages, and weaker sponsors. Runs were also related to macro-financial uncertainty during the crisis.

## III. Risk Spreads and Maturities of New-Issue ABCP

This section examines the risk spreads and average maturities of new issues in the pre-crisis and crisis periods. The dependent variable for the model of spreads is $Spread_{it}$, defined as the weighted (by face value) average yield spread over the target federal funds rate paid by program $i$ on day $t$ to issue overnight (1–4 day) paper. The independent variables in the spread regressions differ from the set in equation (3) only in that the time-varying variables are measured at a daily frequency.

The dependent variable for the model of maturities is $Average\ maturity_{it}$, defined as the weighted (by face value) average maturity, in days, of new issues by program $i$ in week $t$. The independent variables in the maturity regressions are identical to those in equation (3).

### A. Panel Regressions of Risk Spreads

The results from the spread regressions, shown in Table VI, suggest that programs with weaker characteristics faced higher funding costs, particularly in the last 5 months of 2007. The coefficients on *Extendibility, Number of liquidity providers, CDS spread of main liquidity provider,* and *Lower rating* are significant at the 5% level or better with the expected signs in the crisis period (columns 3 and 4). In the pre-crisis period (columns 1 and 2), only *Extendibility, CDS spread of main liquidity provider,* and *Lower rating* are significant, and the estimated coefficients are an order of magnitude smaller than in the crisis period. For example, programs with extension options paid, on average, about 40 basis points more than other programs in the crisis period, but only three basis points more than other programs in the pre-crisis period.

**Table VI**

## Panel Regressions of Risk Spreads on Overnight ABCP Issues

This table reports the results of estimating the following equation using panels of daily observations of ABCP programs from February to July 2007 (columns 1 and 2) and from August to December 2007 (columns 3 and 4):

$$Spread_{it} = \alpha + \sum_{g} \beta_g Program\ characteristics_{g,it} + \sum_{j} \eta_j\ Program\ type_{ji} + \sum_{k} \gamma_k Sponsor\ type_{ki} + \sum_{l} \delta_l Macro\ variables_{lt} + \varepsilon_{it}.$$

The dependent variable, $Spread_{it}$, is the spread over the target federal funds rate paid by program $i$ on day $t$ to issue overnight paper (1–4 days of maturity). *Program characteristics* include: an indicator for extendibility (which equals one for programs that have the option to extend the maturity of their paper at the issuer's request); the number of liquidity providers; the 5-year CDS spread on week $t$ for the main liquidity provider for program $i$; a time-varying indicator for lower rating (which equals one for programs rated below P-1 by Moody's in week $t$); an indicator for credit support (which equals one when sponsoring financial institutions commit to support the program in the event of asset impairment); and the initial average maturity of commercial paper outstanding. $Program\ type_{ji}$ and $Sponsor\ type_{ki}$ are defined as in Table IV. In columns 1 and 3, the *Macro variables* are the weekly average *Spread of one-month LIBOR over OIS* and its volatility. In columns 2 and 4, the Macro variables are the weekly *Return on the ABX index* and its volatility. Standard errors clustered by program are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

| | | February–July 2007 (1) | February–July 2007 (2) | August–December 2007 (3) | August–December 2007 (4) |
|---|---|---|---|---|---|
| Program characteristics | Extendibility | 0.032*** | 0.032*** | 0.393** | 0.396** |
| | | (0.009) | (0.009) | (0.160) | (0.162) |
| | Number of liquidity providers | −0.001 | −0.001 | −0.010** | −0.010** |
| | | (0.001) | (0.001) | (0.004) | (0.004) |
| | CDS spread of main liquidity provider | 0.073*** | 0.090*** | 0.291*** | 0.374*** |
| | | (0.016) | (0.020) | (0.096) | (0.118) |
| | Lower rating | 0.076*** | 0.076*** | 0.408*** | 0.416*** |
| | | (0.009) | (0.009) | (0.145) | (0.141) |
| | Credit support | 0.001 | 0.002 | −0.110 | −0.110 |
| | | (0.006) | (0.006) | (0.073) | (0.072) |
| | Initial average maturity of outstandings | 0.000 | 0.000 | 0.000 | 0.000 |
| | | (0.000) | (0.000) | (0.002) | (0.002) |
| Program type variables | Multi-seller | −0.005 | −0.005 | −0.138** | −0.135** |
| | | (0.012) | (0.012) | (0.064) | (0.063) |
| | Nonmortgage single seller | −0.006 | −0.005 | 0.175 | 0.185 |
| | | (0.023) | (0.023) | (0.155) | (0.155) |
| | Mortgage single seller | 0.005 | 0.004 | 0.564** | 0.548** |
| | | (0.014) | (0.014) | (0.240) | (0.254) |
| | Securities arbitrage | −0.013 | −0.014 | −0.013 | −0.011 |
| | | (0.012) | (0.012) | (0.098) | (0.097) |
| | Structured investment vehicle | 0.007 | 0.007 | 0.055 | 0.045 |
| | | (0.013) | (0.013) | (0.135) | (0.137) |

(*Continued*)

**Table VI**—*Continued*

| | | February–July 2007 (1) | February–July 2007 (2) | August–December 2007 (3) | August–December 2007 (4) |
|---|---|---|---|---|---|
| | CDO | – 0.020 | – 0.022 | (dropped) | (dropped) |
| | | (0.014) | (0.013) | | |
| Sponsor type variables | Small U.S. bank sponsor | 0.060*** | 0.060*** | 0.146 | 0.130 |
| | | (0.010) | (0.009) | (0.182) | (0.179) |
| | Non-U.S. bank sponsor | 0.018*** | 0.019*** | 0.123 | 0.132 |
| | | (0.005) | (0.006) | (0.083) | (0.083) |
| | Nonbanking sponsor | 0.025*** | 0.027*** | 0.164** | 0.180*** |
| | | (0.005) | (0.005) | (0.063) | (0.064) |
| Macro variables | Spread of one-month LIBOR over OIS | – 0.563 | | 0.172*** | |
| | | (0.554) | | (0.038) | |
| | Volatility of the spread of one-month LIBOR over OIS | 12.819*** | | 0.208** | |
| | | (0.988) | | (0.091) | |
| | Return on the ABX index | | – 0.005*** | | 0.045*** |
| | | | (0.001) | | (0.004) |
| | Volatility of the return on the ABX index | | 0.004 | | – 0.019 |
| | | | (0.005) | | (0.025) |
| | Constant | 0.015 | 0.012 | 0.148 | 0.227** |
| | | (0.041) | (0.013) | (0.109) | (0.105) |
| | Observations | 6,053 | 6,053 | 4,967 | 4,967 |
| | Number of programs | 104 | 104 | 97 | 97 |
| | $R^2$ | 0.056 | 0.043 | 0.274 | 0.267 |

Similarly, lower ratings appeared to raise spreads by about 40 basis points in the crisis period and eight basis points in the pre-crisis period.

In terms of program types, those programs with likely exposures to subprime mortgages appeared to pay significantly more than other programs in the crisis period, but not in the pre-crisis period. In particular, significant coefficients suggest multi-seller programs paid about 14 basis points less than other programs in the crisis, while mortgage single-sellers paid about 55 basis points more than other programs. None of the coefficients on program type were significant in the pre-crisis period.[22]

For sponsor type, the coefficients on *Nonbanking sponsor* are positive and significant at the 5% level or better in both periods, with larger coefficients in the crisis period. Coefficients on small bank and non-U.S. bank sponsor types are significant but small in the pre-crisis period, and generally insignificant in the latter period. The coefficients on *Spread of one-month LIBOR over OIS* and its volatility are positive and statistically significant at the 5% level or better in the crisis period, suggesting that uncertainty in interbank markets was correlated with increases in spreads in the ABCP market.

[22] The dummy variable for CDOs is excluded from the regression in the crisis period because there are no CDO observations with all explanatory variables included in the regression.

*B. Panel Regressions of Maturities*

The results from the maturity regressions, presented in Table VII, indicate that maturities of new issues were shorter in the crisis period for programs with relatively risky characteristics and likely exposures to subprime mortgages. For instance, the coefficients on *Extendibility* and *Lower rating* are negative and significant (at various significance levels) in the crisis period. In addition, the coefficients on *Number of liquidity providers* and *Credit support,* variables indicating stronger support, are positive and significant (at various levels) in the crisis period (columns 3 and 4). Moreover, the coefficients on *Nonmortgage single-seller* and *Mortgage single-seller* are negative and significant (at various levels) in the crisis period, suggesting that relatively undiversified programs and programs with high mortgage exposures issued at shorter maturities. As in the analysis of runs and spreads, the estimated effects for the pre-crisis period (columns 1 and 2) are relatively weak. The exceptions are the coefficients on *CDO*, which are significant and positive in the pre-crisis period but not in the crisis period.

The results also provide some evidence that maturities of new issues shortened during weeks in which macro-financial risk was greater. For example, the coefficient on *Spread of one-month LIBOR over OIS* and the corresponding volatility measure are significant at the 1% and 5% levels, respectively, in the crisis period. However, the coefficient on *Return on the ABX index* is also negative, which is inconsistent with greater contemporaneous concerns about subprime mortgages causing maturities to shorten. Coefficients on the macro-financial variables are insignificant in the pre-crisis period.

An additional result from the maturity regressions is that the coefficients on *Initial average maturity of outstandings* are close to one and significant at the 5% level or better in the pre-crisis period, as maturities were fairly persistent in that period. But the coefficients (about 0.36) are markedly smaller, though still significant at the 5% level in the crisis period, as programs shortened maturities of new issues during the last 5 months of 2007.

The results linking shorter maturities to lower ratings, program types exposed to subprime mortgages, and macro-financial uncertainty support a key empirical prediction of the model in Brunnermeier and Oehmke (2013), specifically, that maturities shorten when a program's assets become riskier. In their model, financial issuers, which are typically unable or unwilling to commit to a maturity structure, in some circumstances have an incentive to issue more short-term debt, despite the increased rollover risk. This is because investors in short-term debt have the potential to dilute investors in long-term debt by not rolling over when negative information about the issuer's default probability is revealed. Thus, maturity shortening arises from a contractual externality among creditors of different maturities, an externality that is greater when the volatility of assets being funded is high, as default-relevant information is more likely to be revealed in the short run when asset volatility is high.

**Table VII**

## Panel Regressions of Average Maturity of New Issues

This table reports the results of estimating the following equation using panels of weekly observations from February to July 2007 (columns 1 and 2) and from August to December 2007 (columns 3 and 4):

$$Average\ maturity_{it} = \alpha + \sum_{g} \beta_g Program\ characteristics_{git} + \sum_{j} \eta_j\ Program\ type_{ji} + \sum_{k} \gamma_k Sponsor\ type_{ki} + \sum_{l} \delta_l Macro\ variables_{lt} + \varepsilon_{it}.$$

The dependent variable, $Average\ maturity_{it}$, is the average maturity (in days) of new issues of ABCP for program $i$ in week $t$. *Program characteristics* include: an indicator for extendibility (which equals one for programs that have the option to extend the maturity of their paper at the issuer's request), the number of liquidity providers, the 5-year CDS spread on week $t$ for the institution listed as the main liquidity provider for program $i$, a time-varying indicator for lower rating (which equals one for programs rated below P-1 by Moody's in week $t$), an indicator for credit support (which equals one when sponsoring financial institutions commit to support the program in the event of asset impairment), and the initial average maturity of commercial paper outstanding. *Program* $type_{ji}$ and *Sponsor* $type_{ki}$ are defined as in Table IV. In columns 1 and 3, the *Macro variables* are the weekly average *Spread of one-month LIBOR over OIS* and its volatility. In columns 2 and 4, the *Macro variables* are the weekly *Return on the ABX index* and its volatility. Standard errors clustered by program are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

| | | February–July 2007 (1) | February–July 2007 (2) | August–December 2007 (3) | August–December 2007 (4) |
|---|---|---|---|---|---|
| Program characteristics | Extendibility | 7.225 | 7.201 | −6.327** | −6.115* |
| | | (6.299) | (6.341) | (3.055) | (3.199) |
| | Number of liquidity providers | 0.322 | 0.338 | 0.731*** | 0.731*** |
| | | (0.217) | (0.223) | (0.164) | (0.166) |
| | CDS spread of main liquidity provider | −11.275 | −19.041 | −5.332 | −5.249 |
| | | (24.212) | (28.464) | (8.783) | (9.091) |
| | Lower rating | 2.965 | 2.692 | −12.018*** | −11.794*** |
| | | (3.157) | (3.160) | (3.235) | (3.179) |
| | Credit support | −1.143 | −1.079 | 11.599** | 11.772** |
| | | (4.689) | (4.712) | (5.519) | (5.549) |
| | Initial average maturity of outstandings | 1.027*** | 1.024*** | 0.357** | 0.356** |
| | | (0.162) | (0.161) | (0.159) | (0.161) |
| Program type variables | Multi-seller | −2.475 | −2.541 | −7.978 | −8.297 |
| | | (3.669) | (3.665) | (5.467) | (5.470) |
| | Nonmortgage single seller | 1.896 | 1.827 | −16.179** | −16.500** |
| | | (6.893) | (6.898) | (7.401) | (7.416) |
| | Mortgage single seller | −9.477 | −9.084 | −17.533*** | −16.938*** |
| | | (10.294) | (10.270) | (5.315) | (5.280) |
| | Securities arbitrage | 4.379 | 4.523 | −4.313 | −4.787 |
| | | (6.901) | (6.900) | (8.269) | (8.290) |
| | Structured investment vehicle | 2.359 | 2.400 | −7.132 | −6.757 |
| | | (6.407) | (6.434) | (10.968) | (11.155) |

(*Continued*)

**Table VII**—*Continued*

| | | February–July 2007 (1) | February–July 2007 (2) | August–December 2007 (3) | August–December 2007 (4) |
|---|---|---|---|---|---|
| | CDO | 14.614*** | 14.920*** | 8.586 | 8.463 |
| | | (4.853) | (4.928) | (5.219) | (5.172) |
| Sponsor type variables | Small U.S. bank sponsor | 4.211 | 4.754 | 18.481* | 18.877* |
| | | (6.013) | (6.279) | (10.116) | (10.036) |
| | Non-U.S. bank sponsor | – 6.971 | – 7.426 | – 3.194 | – 3.058 |
| | | (6.048) | (6.081) | (4.897) | (4.908) |
| | Nonbanking sponsor | – 3.875 | – 4.283 | – 2.031 | – 2.037 |
| | | (4.166) | (4.205) | (5.155) | (5.175) |
| Macro variables | Spread of one-month LIBOR over OIS | 132.070 | | – 9.411*** | |
| | | (189.638) | | (2.431) | |
| | Volatility of the spread of one-month LIBOR over OIS | 26.177 | | – 17.917** | |
| | | (107.050) | | (7.259) | |
| | Return on the ABX index | | – 0.497 | | – 0.873*** |
| | | | (1.460) | | (0.237) |
| | Volatility of the return on the ABX index | | 6.770 | | – 1.826 |
| | | | (4.737) | | (1.316) |
| | Constant | – 1.590 | 7.035 | 25.969*** | 20.749** |
| | | (11.792) | (7.798) | (9.879) | (9.492) |
| | Observations | 2,494 | 2,494 | 1,655 | 1,655 |
| | Number of programs | 124 | 124 | 120 | 120 |
| | $R^2$ | 0.269 | 0.270 | 0.156 | 0.146 |

Overall, the results from the risk spread and maturity regressions suggest that investors made significant distinctions across programs in the new issue market in the crisis period, while distinctions were substantially more modest in the pre-crisis period. These results suggest a somewhat measured response among commercial paper investors—at least with respect to programs that could issue—in contrast to the apparent risk intolerance observed for programs that were subject to runs.

### *C. Common Determinants of Runs, Spreads, and Maturities during the Crisis*

The analysis of runs on ABCP programs during the crisis, as well as of risk spreads and maturities of programs that were not in a run, reveal substantial common determinants. Coefficients on program risk characteristics indicate that the factors that make a program more likely to experience a run are similar to the factors that would raise spreads and reduce maturities of issues by programs not in a run. In particular, extendibility, number of liquidity providers, and program rating are significant with the expected sign in all three outcomes. The coefficients on the CDS premium of the main liquidity provider have the expected sign for all three outcomes, though they are not significant

in the maturity regressions. In terms of program type, the coefficients indicate that runs are less likely and spreads are lower for multi-seller programs, while spreads are higher and maturities are shorter for mortgage single-seller programs.

The coefficients on sponsor type are not entirely consistent across the analysis of different dependent variables. In particular, programs sponsored by small banks are more likely to experience a run, but those that issue have longer maturities. In addition, while programs sponsored by nonbank sponsors that issue are more likely to have higher spreads, a nonbank sponsor does not appear to be related to shorter maturities or a greater likelihood of a run.

However, the coefficients on the greater volatility of the LIBOR-OIS spread are consistent in that runs are more likely, ABCP spreads are higher, and maturities shorter when the volatility of the LIBOR-OIS spread is elevated. The commonality in determinants is additional evidence that investor behavior in the crisis was not random, and also suggests a somewhat nuanced view of risk intolerance of commercial paper investors.

## IV. Implications for Bank Balance Sheets and Securitization Markets

The empirical findings presented in Sections II and III imply a channel for the runs on ABCP programs to affect the broader financial markets in late 2007. As investors ran from programs with weaker program supports, such as those with riskier main liquidity providers, the explicit and implicit supports provided by banks may have been called on, which in turn would have caused bank balance sheets to increase. Banks may have also become uncertain about further future draws on their commitments and, as a result, increased the uncertainty about the availability of funds to other banks, thereby magnifying the effects of the initial ABCP runs.

The large degree to which banks ultimately supported the ABCP market is suggested by the low share of actual defaults and extensions relative to the drop in outstanding ABCP. As mentioned earlier, only 3% of paper defaulted by the end of 2007, while ABCP outstanding dropped by about 35%. Although some programs were likely able to sell their assets to pay maturing commercial paper, the conventional wisdom among market participants was that banks were significantly supporting the market.[23] Indeed, nearly all programs had contractual support of some kind, and some support may have been provided through non-arms-length transactions with sponsors.

The contraction in the ABCP market also restricted the market for new securitizations. In particular, as ABCP programs became vulnerable to runs, they stopped purchasing AAA-rated tranches of new ABS and MBS. The contraction in the ABCP market combined with the pullback in the repo market, another market used to fund highly rated securities with short-term debt, made finding buyers for new securitizations increasingly difficult, and banks had to look for

[23] Similarly, Acharya, Schnabl, and Suarez (2013) find that the equity prices of banks with greater commitments to support ABCP programs underperformed around August 9, 2007.

other ways to fund their origination of mortgages and other loans. As a consequence, at a time when banks were concerned about further calls on their explicit and implicit commitments to support ABCP, they also lost access to securitization as a source of funding, further magnifying the effects of ABCP runs.

Our finding that ABCP programs experienced runs also suggests that banks in developed countries with credible deposit insurance systems may be exposed to sudden drops in their own liquidity through their implicit and explicit support of ABCP programs or other conduits in the shadow banking system.[24]

## V. Conclusion

The ABCP market contracted about $350 billion in the last 5 months of 2007. Our empirical analysis suggests that the contraction reflected, in part, a substantial number of runs by investors. Moreover, we find that runs were not random during this crisis period, but were instead more likely among programs with relatively weak characteristics, such as weaker liquidity support and lower ratings, and they also appeared to increase with macro-financial risks. These findings are broadly consistent with the well-established notion in the banking literature that runs are caused by a shock (in this case subprime mortgages) with unknown incidence in the cross section of programs. These findings are also broadly consistent with studies in the literature showing that investors in the commercial paper market are intolerant to risk. In particular, our results suggest that investors identified programs that appeared relatively weak across some dimension and then ran or priced such programs out of the market. Additional results, however, suggest that, for the programs that could issue, yield spreads and maturities of new issues showed predictable variation based on program characteristics and macro-financial measures. These last results point to a somewhat measured investor response to risks in the commercial paper market. The maturity regressions also show that maturity structures were endogenous in that they shortened for relatively risky programs and during periods when macro-financial volatility increased, consistent with a recent theory of coordination failures.

Initial submission: January 22, 2010; Final version received: January 17, 2012
Editor: Campbell Harvey

## REFERENCES

Acharya, Viral V., Douglas Gale, and Tanju Yorulmazer, 2011, Rollover risk and market freezes, *Journal of Finance* 66, 1177–1209.

Acharya, Viral V., and Philipp Schnabl, 2009, How banks played the leverage "game," in Viral V. Acharya, and Matthew Richardson, eds.: *Restoring Financial Stability: How to Repair a Failed System* (New York University Stern School of Business and John Wiley & Sons, New York).

[24] Gorton (2007) makes a similar point.

Acharya, Viral V., Philipp Schnabl, and Gustavo Suarez, 2013, Securitization without risk transfer, *Journal of Financial Economics* 107, 515–536.

Arteta, Carlos O., Mark Carey, Ricardo Correa, and Jason Kotter, 2010, Revenge of the steamroller: ABCP as a window on risk choices, Working paper, Federal Reserve Board.

Brunnermeier, Markus, and Martin Oehmke, 2013, The maturity rat race, *Journal of Finance* 68, 483–521.

Calomiris, Charles W., 1995, Financial fragility: Issues and policy implications, *Journal of Financial Services Research* 9, 241–257.

Calomiris, Charles W., and Gary Gorton, 1991, The origins of banking panics: Models, facts, and bank regulation, in R. Glenn Hubbard, ed.: *Financial Markets and Financial Crises* (University of Chicago Press and NBER, Chicago).

Calomiris, Charles W., Charles P. Himmelberg, and Paul Wachtel, 1995, Commercial paper, corporate finance, and the business cycle: A microeconomic perspective, *Carnegie-Rochester Conference Series on Public Policy* 42, 203–250.

Calomiris, Charles W., and Joseph R. Mason, 1997, Contagion and bank failures during the Great Depression: The June 1932 Chicago banking panic, *American Economic Review* 87, 863–883.

Calomiris, Charles W., and Joseph R. Mason, 2003, Fundamentals, panics, and bank distress during the Depression, *American Economic Review* 93, 1615–1647.

Calomiris, Charles W., and Andrew Powell, 2001, Can emerging market bank regulators establish credible discipline? The case of Argentina, 1992–99, in Frederic S. Mishkin, ed.: *Prudential Supervision: What Works and What Doesn't* (University of Chicago Press and NBER, Chicago).

Calomiris, Charles W., and Berry Wilson, 2004, Bank capital and portfolio management: The 1930s "capital crunch" and the scramble to shed risk, *Journal of Business* 77, 421–456.

Campbell, Sean, Daniel Covitz, Karen Pence, and William Nelson, 2011, Securitization markets and central banking: An evaluation of the term asset-backed securities facility, *Journal of Monetary Economics* 58, 518–531.

Campello, Murillo, Erasmo Giambona, John R. Graham, and Campbell R. Harvey, 2011, Liquidity management and corporate investment during a financial crisis, *Review of Financial Studies* 24, 1944–1979.

Campello, Murillo, John R. Graham, and Campbell R. Harvey, 2010, The real effects of financial constraints: Evidence from a financial crisis, *Journal of Financial Economics* 97, 470–487.

Chari, V. V., and Ravi Jagannathan, 1988, Banking panics, information, and rational expectations equilibrium, *Journal of Finance* 43, 749–761.

Covitz, Dan, and Chris Downing, 2007, Liquidity or credit risk? The determinants of very short-term corporate yield spreads, *Journal of Finance* 62, 2303–2328.

De Graeve, Ferre, and Alexei Karas, 2010, Identifying VARs through heterogeneity: An application to bank runs, Working paper, Central Bank of Sweden.

Downing, Chris, and Steven Oliner, 2007, The term structure of commercial paper rates, *Journal of Financial Economics* 83, 59–86.

Duygan-Bump, Burcu, Patrick Parkinson, Eric Rosengren, Gustavo A. Suarez, and Paul Willen, 2013, How effective were the Federal Reserve emergency liquidity facilities? Evidence from the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility, *Journal of Finance* 68, 715–737.

Gatev, Evan, and Philip E. Strahan, 2006, Banks' advantage in hedging liquidity risk: Theory and evidence from the commercial paper market, *Journal of Finance* 61, 867–892.

Gorton, Gary, 1988, Banking panics and business cycles, *Oxford Economic Papers* 40, 751–781.

Gorton, Gary, 2007, Banks, banking, and crises, *NBER Reporter* 4, 11–14.

Gorton, Gary, and Andrew Metrick, 2012, Securitized banking and the run on repo, *Journal of Financial Economics* 104, 425–451.

He, Zhiguo, and Wei Xiong, 2012, Dynamic debt runs, *Review of Financial Studies* 25, 1799–1843.

Ivashina, Victoria, and David Scharfstein, 2010, Bank lending during the financial crisis of 2008, *Journal of Financial Economics* 97, 319–338.

Iyer, Rajkamal, and José-Luis Peydró, 2011, Interbank contagion at work: Evidence from a natural experiment, *Review of Financial Studies* 24, 1337–1377.

J.P. Morgan Securities Inc., 2007, Short-term fixed income research note: An ABCP cheat sheet.

Krishnamurthy, Arvind, 2010, How debt markets malfunctioned in the crisis, *Journal of Economic Perspectives* 24, 3–28.

Martinez-Peria, Maria S., and Sergio L. Schmukler, 2001, Do depositors punish banks for bad behavior? Market discipline, deposit insurance, and banking crises, *Journal of Finance* 56, 1029–1051.

Moody's Investors Service, 2003, The fundamentals of asset-backed commercial paper.

Moody's Investors Service, 2007, SIVs: An oasis of calm in the sub-prime maelstrom.

Musto, David K., 1997, Portfolio disclosures and year-end price shifts, *Journal of Finance* 52, 1563–1588.

Oliveira, Raquel de F., Rafael F. Schiozer, and Lucas A. B. de C. Barros, 2011, Too big to fail perception by depositors: An empirical investigation, Working paper, Central Bank of Brazil.

Pennacchi, George, 2006, Deposit insurance, bank regulation, and financial system risks, *Journal of Monetary Economics* 53, 1–30.

Shin, Hyun Song, 2009, Reflections on Northern Rock: The bank run that heralded the global financial crisis, *Journal of Economic Perspectives* 23, 101–119.

## Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

**Appendix S1:** Internet Appendix