BANK FOR INTERNATIONAL SETTLEMENTS

BIS Working Papers
No 963

The Fed takes on corporate credit risk: an analysis of the efficacy of the SMCCF

by Simon Gilchrist, Bin Wei, Vivian Z Yue and Egon Zakrajšek

Monetary and Economic Department

September 2021

JEL classification: E44, E58, G12, G14.

Keywords: Covid-19, credit market support facilities, diff-in-diff, event study, purchase effects.

This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

The Fed Takes on Corporate Credit Risk: An Analysis of the Efficacy of the SMCCF

Simon Gilchrist* Bin Wei† Vivian Z. Yue‡ Egon Zakrajšek§

September 2021

Abstract

We evaluate the efficacy of the Secondary Market Corporate Credit Facility (SMCCF), a program designed to stabilize the U.S. corporate bond market during the Covid-19 pandemic. The Fed announced the SMCCF on March 23, 2020, and expanded the program on April 9. Our results show that the two announcements significantly lowered credit and bid-ask spreads, the former almost entirely through a reduction in credit risk premia. The announcements had a differential effect on the program-eligible bonds relative to their ineligible counterparts, but this difference is not due to program eligibility per se, according to our results. Rather, the announcements restored the "normal" upward-sloping profile of the term structure of credit spreads by substantially reducing spreads at the short end of the maturity spectrum relative to spreads at the long end. Using an IV approach, we also document important announcement-induced spillovers across all bonds outstanding for issuers whose bonds were likely to be purchased by the facility. Finally, we show that the Fed's actual purchases had negligible effects on credit and bid ask spreads. Our results highlight the extraordinary power of modern central banks: when markets have trust in the central bank's ability to deliver on its promise, as exemplified by the iconic "whatever it takes" remark by Mario Draghi, the central bank needs to do less (if anything) to deliver on its promise.

JEL Classification: E44, E58, G12, G14
Keywords: Covid-19, credit market support facilities, diff-in-diff, event study, purchase effects

This is a substantially revised version of the paper that appeared under the same title in the CEPR and NBER working paper series, No. 15258 and No. 27809, respectively. We thank Manuel Adelino, Andrea Ajello, Bill English, Giovanni Favara, Kurt Lewis, Nellie Liang, Stefan Nagel, Lubomir Petrasek, Carolin Pflueger (discussant), Amiyatosh Purnanandam (discussant), and participants at numerous conferences and seminars for helpful comments and suggestions. Giulio Cornelli provided excellent research assistance. The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Bank for International Settlements or the Federal Reserve System.

*Department of Economics New York University and NBER. Email: sg40@nyu.edu

†Research Department Federal Reserve Bank of Atlanta. Email: bin.wei@atl.frb.org

‡Department of Economics Emory University and NBER. Email: vyue@emory.edu@

§Monetary and Economic Department Bank for International Settlements and CEPR. Email: egon.zakrajsek@bis.org

1 Introduction

The Covid-19 shock in early 2020 precipitated a perfect storm in the U.S. corporate bond market. The pandemic-induced "dash for cash" triggered a sharp selloff in U.S. fixed income (and other) markets, with fixed-income mutual funds registering unprecedented outflows (see Ma et al., 2020). A number of structural factors exacerbated strains in the corporate bond market. Importantly, the structure of ownership in the market has changed significantly since the Global Financial Crisis (GFC), as holdings of corporate bond mutual funds have risen dramatically over the past two decades (see Liang, 2020). Because investors in corporate bond mutual fund are offered daily liquidity—despite the fact that the underlying assets are significantly less liquid—the resulting "liquidity mismatch" made these funds especially vulnerable to runs (see Falato et al., 2021).

Equally important is the fact that since the GFC, intermediation in the market has remained concentrated in about a dozen or so primary dealers, most of whom are affiliated with major banks. The rapid growth of the U.S. Treasury market in recent years has outstripped the intermediation capacity of these bank-affiliated dealers, which was already constrained by the post-GFC regulations (see Duffie, 2020). Unsurprisingly, as the risk-off sentiment swept through financial markets in early March, prices of corporate bonds nosedived and credit spreads spiked.[1]

The Fed reacted swiftly to the turmoil roiling financial markets, unveiling a broad array of measures to limit the economic damage from the pandemic (see Clarida et al., 2021). Although these actions averted a wider market meltdown, liquidity in the corporate bond market, which is limited in best of circumstances, continued to deteriorate and credit spreads surged further. In response to these escalating strains, the Fed announced on March 23 what is arguably its most sweeping and dramatic intervention in the economy to date: the creation of the Primary Market Corporate Credit Facility (PMCCF) and the Secondary Market Corporate Credit Facility (SMCCF).[2]

The announcement, which market participants characterized as "whatever it takes" and "throwing the kitchen sink" at the markets had a significant effect: the S&P 500 stock price index rallied more than nine percent on the day; intermediate- and longer-dated Treasury yields rose about ten basis points; and investment-grade credit spreads narrowed 20 basis points, while high-yield spreads fell 30 basis points. Nonetheless, conditions in the corporate bond market remained strained. In response, the Fed moved further into uncharted territory and on April 9 announced updated terms for the two corporate bond-buying facilities. The most significant change in the updated terms was that eligible issuers now included companies recently downgraded from investment grade to "junk," the so-called fallen angels, an additional bold move intended to unfreeze the corporate credit markets.

In this paper, we evaluate the efficacy of the SMCCF and by looking "under the hood," inspect the mechanism through which it affected the corporate bond market. We focus on the SMCCF because of its historic importance—the first time the Fed directly supported corporate credit markets by

[1] As discussed by Schrimpf et al. (2020), large sales of U.S. Treasuries by some leveraged non-bank investors and foreign holders in early March further strained the balance sheet capacity of bank-affiliated dealers.

[2] The objective of the PMCCF was to support credit to businesses through the issuance of bonds and loans in the primary market. The SMCCF, by contrast, was established to provide liquidity to the market for outstanding corporate bonds. Both facilities were initially opened to the U.S. investment-grade companies only.

signalling a willingness to purchase outstanding corporate debt and potentially take a material amount of credit risk on its balance sheet. It is worth noting that the Bank of Japan, the Bank of England, and the European Central Bank have in the past launched similar corporate bond-buying programs in an effort to ease broad financial conditions and stimulate their economies. In fact, "credit easing" programs are now a standard part of the toolkit used by central banks to deliver monetary stimulus when constrained by the effective lower bound on nominal interest rates.[3] Understanding the efficacy of such programs and channels through which they affect broad financial conditions is thus critical for policy going forward.

Our empirical analysis offers three main takeaways. First, by significantly reducing credit and bid-ask spreads, the March 23 and April 9 announcements were very effective in alleviating strains in the corporate bond market. Second, our estimates indicate the announcement-induced narrowing of credit spreads was due almost entirely to a reduction in credit risk premia as opposed to a reduction in default risk. Third, and most strikingly, the key channel through which the Fed stabilized conditions in the market appears to have had nothing to do with whether a particular bond was eligible for purchase by the SMCCF. Rather, the two announcements had a disproportionate effect on credit spreads of all shorter-maturity bonds—a segment of the market where dislocations were especially severe—and on spreads of bonds, irrespective of their program eligibility, issued by companies that investors ex ante thought were likely going to be included in the program.

One interpretation of these results is that the Fed's forceful and prompt response to the panic that was beginning to engulf the financial system shored up investor confidence and improved market sentiment, results consistent with the theoretical framework of Hanson et al. (2020). A narrower interpretation of our results would argue that once the SMCCF was announced, investors recognized that the Fed's purchases were likely to target bonds issued by certain types of companies, rather than bonds below a certain maturity cutoff. Put differently, the announcements had a larger impact on the credit spreads of bonds issued by *companies* that were likely to be purchased, as opposed to on the spreads of *bonds* that were likely to be purchased.

Formally evaluating the impact of the SMCCF on the corporate bond market is complicated by the fact that the Fed announced, expanded, and operated the SMCCF in conjunction with a number of other emergency measures.[4] Research seeking to unpack the effects of the SMCCF on the corporate bond market from those of other programs that were simultaneously in play uses a difference-in-differences (DiD) methodology to isolate and estimate the direct effects of the program

[3] Brunnermeier and Krishnamurthy (2020), on the other hand, develop a corporate finance framework to guide central banks' interventions in credit markets in response to shocks such as the Covid-19 pandemic.

[4] In announcing the establishment of its corporate bond purchase programs on March 23, the Fed also revived the Term Asset-Backed Securities Loan Facility and expanded its quantitative easing program—launched on March 15—to include purchases of commercial mortgage-backed securities in its mortgage-backed security purchases; at the same time, the Fed noted that it expects to announce shortly another emergency lending program—to be called the Main Street Business Lending Program—designed to support credit to small and medium-sized businesses. Further complicating matters is the fact that in the days leading to the March 23 announcement, the Fed revived the Commercial Paper Funding Facility (March 17), the Primary Dealer Credit Facility (March 17), and the Money Market Mutual Fund Liquidity Facility (March 18). Similarly, the expansion of the SMCCF to "fallen angels" announced on April 9 was accompanied by the establishment of the Municipal Liquidity Facility and the Paycheck Protection Program Liquidity Facility.

on corporate bond prices and market liquidity measures.

The crucial identifying assumption underlying the DiD approach exploits the program's two key eligibility requirements: (*i*) bonds eligible for purchase by the SMCCF must have been rated as investment grade as of March 22, 2020; and (*ii*) they must have had a remaining maturity of less than or equal to five years when purchased. We therefore begin our analysis by estimating the differential effects of the March 23 and April 9 announcements on the program-eligible and ineligible bonds. Specifically, we use bond-level transactions data provided by the Trade Reporting and Compliance Engine (TRACE) to construct pairs of eligible and ineligible securities trading in the secondary market, with both types of securities issued by the *same* company.[5]

Using standard DiD analysis—which allows us to control for industry characteristics, as well as firm-specific characteristics such as size, age, and the overall degree of credit risk exposure faced by the firm—we document economically sizeable and statistically significant differences in credit spreads of the SMCCF-eligble bonds relative to their ineligible counterparts in response to both announcements. Using the same approach, we also document a significant improvement in market liquidity, as measured by the decline in bid-ask spreads, in response to the March 23 announcement. These results are in line with other findings in the literature.

Following Gilchrist and Zakrajšek (2012), we also decompose credit spreads into two components: a component capturing issuer-specific default risk and a residual component capturing credit risk premia or investor sentiment. According to our results, the announcement-induced narrowing of credit spreads was due almost entirely to a reduction in credit risk premia, or improvement in credit market sentiment, rather than to a reduction in the likelihood of default.

Next, we delineate what we consider to be the key impact of the two announcements: the restoration of the normal upward-sloping profile in the relationship between credit risk and maturity in the investment-grade segment of the market, as opposed to the announcements having a differential effect on the prices of eligible and ineligible securities. We show that in normal times, the relationship between investment-grade credit spreads and the bonds' remaining maturity, the "credit curve," is upward sloping. In early March, however, the curve inverted abruptly, with the long-short credit spread differential dropping deep into the negative territory.[6] The pandemic-induced inversion of the credit curve presents a confounding factor when evaluating the efficacy of the SMCCF vis-à-vis the program's impact on eligible versus ineligible bonds. At the same time, it implies a powerful channel through which announcements of such policies can affect credit markets in times of widespread financial distress.

To control for this confounding effect, we augment the baseline DiD specification with an interaction term, which allows the slope of the credit curve to shift in the post-announcement window.

[5] TRACE is the vehicle developed by the Financial Industry Regulatory Authority (FINRA) that facilitates the mandatory reporting of over-the-counter transactions in eligible fixed income securities. According to an SEC-approved set of rules, all broker-dealers who are FINRA member firms have an obligation to report transactions in TRACE-eligible securities.

[6] The inversion was especially pronounced in the high-end of the investment-grade segment, a pattern consistent with a "dash for cash," whereby corporate bond investors amid the panic first tried to liquidate their holdings of most liquid securities, namely shorter-maturity, high-quality, investment-grade bonds (see Haddad et al., 2021).

Our results indicate that the announcement-induced change in the slope of the credit curve is statistically highly significant and large in economic terms: for example, within two days of the March 23 announcement, credit spreads on bonds with a remaining maturity of one year are estimated to narrow 100 basis points relative to bonds with a remaining maturity of ten years. Even more striking is the result that once we control for the announcement-induced shifts in the credit curve, there is no evidence of an independent effect on credit spreads of the SMCCF-eligible bonds from either announcement. Together, these results imply that whether a particular bond was or was not eligible for purchase by the facility had no additional effect on credit spreads.

From the perspective of theories that emphasize a lack of substitutability across securities with different characteristics these findings may appear puzzling. One possibility is that the maturity-eligibility criterion is too coarse of an indicator for whether a particular bond was likely to be purchased, and investors quickly recognized that there were certain companies whose outstanding bonds were more likely going to be purchased than those of other issuers. It could also be the case that the effects from the broadside of emergency measures announced and implemented by the Fed in mid-March had a larger impact on the credit spreads of *all* bonds issued by companies whose eligible securities were likely to be purchased, as opposed to affecting only the spreads of the SMCCF-eligible bonds.

We formally test these hypotheses by replacing the maturity-eligibility criterion in the DiD specification with the requirement that bonds have a remaining maturity of less than or equal to five years and were issued by companies whose bonds were eventually purchased by the facility once the program became operational in mid-June. In the narrow estimation windows bracketing the announcements used in our DiD analysis, investors, of course, did not know whether or not a given issuer's eligible bonds were going to be purchased. To address this issue, we develop an instrumental variable (IV) strategy based on information that was available to investors at announcement dates and which was highly informative of the likelihood that eligible bonds of a given issuer were ultimately purchased by the facility.

Using this approach, we provide further confirmation that the March 23 and April 9 announcements undid the inversion of the credit curve but did not induce an economically meaningful and statistically significant differential response of credit spreads between eligible and ineligible bonds. Our IV strategy also reveals a novel finding: the March 23 announcement led to a distinct bifurcation between credit spreads of bonds issued by companies whose eligible bonds were likely to be purchased by the SMCCF, relative to those issued by companies whose eligible bonds were unlikely to be included in the program. Evidently, the "whatever it takes" nature of the March 23 announcement affected credit spreads of all bonds issued by companies that investors ex ante perceived as likely to be covered by the program.

Finally, we consider the effect of the facility's actual purchases of individual corporate bonds on their credit and bid-ask spreads. Using intra-day transactions data that exactly identify the Fed's purchases, we show that credit spreads, on average, narrowed by a mere five basis points upon purchase, while the average decline in bid-ask spreads was only two basis points. In other words, the vast majority of the SMCCF's impact on the corporate bond market occurred before the Fed actually bought anything.

All told, our results are consistent with the notion that the primary effect of the Fed's corporate bond-purchase program worked through the announcements, which helped restore investor confidence and improve market sentiment during the acute phase of the panic. Also consistent with this notion are the results that the two announcements had a disproportionate effect on credit spreads of shorter-maturity bonds—a segment of the market where dislocations were especially severe—and on spreads of bonds, irrespective of their eligibility, issued by companies that investors ex ante thought were likely going to targeted by the program.

Our paper is related to a rapidly growing literature on the pandemic-induced dislocations in the U.S. corporate bond market and the Fed's response to the crisis.[7] For instance, D'Amico et al. (2020) analyze the effects of the March 23 and April 9 announcements on the corporate bond exchange-traded funds (ETFs) and CDX indexes and document that the two announcements had a significant positive effect on the directly eligible ETFs, as well as on the ETFs holding eligible bonds and their close substitutes; this effect can be seen in a discrete drop in the perceived credit risk of eligible bonds, especially following the April 9 announcement. Like us, Boyarchenko et al. (2020) use bond-level transactions data to study the impact of the March 23 announcement on the corporate bond market. By looking at cumulative changes in credit and bid-ask spreads, relative to their respective peaks reached during the week of March 16–20, 2020, they find that bonds that were eligible for purchase by the SMCCF experienced a significantly larger cumulative reduction in credit spreads compared with their ineligible counterparts.

Focusing on market liqudity, Kargar et al. (2021) show that liquidity conditions in the market improved notably for bonds that were eligible for the corporate bond-purchase programs, as well as for bonds that were ineligible. More broadly, O'Hara and Zhou (2021) examine the microstructure of liquidity provision during this period and show that the announcements of the Primary Dealer Credit Facility on March 17 and the corporate bond-purchase programs on March 23 were especially effective in improving dealer funding conditions, thereby helping to stabilize the market. Nozawa and Qiu (2021) analyze the reaction of credit spreads to the Fed's announcements in March and document significant differences in initial reactions across bonds with different credit ratings, which they interpret as evidence of market segmentation across ratings. Their variance-decomposition results indicate that a significant fraction of the observed narrowing in credit spreads following the March 23 and April 9 announcements is attributable to a reduction in default risk, as they find only

[7]The pandemic, of course, greatly affected functioning of other asset markets as well. Its impact on the U.S. Treasury market is analyzed in detail by Duffie (2020), Fleming and Ruela (2020), Schrimpf et al. (2020), He et al. (2021), and Kruttli et al. (2021); Augustin et al. (2021) focus on non-U.S. government bonds markets, while Bahaj and Reis (2020) analyze the pandemic-induced strains in dollar funding markets; Gormsen and Koijen (2020) and Cox et al. (2020) study the impact of the Covid-19 shock on U.S. equity markets; and Bi and Marsh (2020), Li and Lu (2020), and Wei and Yue (2020) examine disruptions in the U.S. municipal bond market. For related research on the effects of credit easing programs launched by the Bank of England and the European Central Bank in 2016, see D'Amico and Kaminska (2019), Grosse-Rueschkamp et al. (2019), Adelino et al. (2020), and Todorov (2020). The impact of the Bank of Japan's corporate bond-purchase program launched in 2010 is analyzed by Suganuma and Ueno (2018).

limited evidence for the liquidity channel driving this reaction.

Haddad et al. (2021), on the other hand, exploit the pandemic-induced divergence between the corporate cash market and its related market in credit derivatives. They show that during the period of most acute market turmoil, corporate bonds traded at a large discount to their corresponding credit default swap (CDS) contracts. Moreover, this so-called bond-CDS basis widened most for bonds at the safer end of the credit quality spectrum, a result that is difficult to square with standard default or risk premium channels. They also show that dislocations between the two markets disappeared quickly and attribute the recovery to Fed's actions.

Last but not least, Hanson et al. (2020) develop a theoretical model of how a credit facility such as the SMCCF could affect the corporate bond market. According to their framework, the primary effect of such a facility is to reduce both the uncertainty and risk premia in the market, a mechanism, as noted above, that is very much consistent with our empirical results. They also show that the establishment of such a facility provide investors with a valuable asymmetric put option that mitigates severe downside or tail risks, providing a further boost to corporate bond prices.

The road map for the remainder of the paper is as follows. We begin Section 2 with a brief overview of the SMCCF, followed by a description of our data sources and the construction of the key variables: transaction-level credit and bid-ask spreads. Section 3 outlines our empirical methodology (difference-in-differences) and presents results, which quantify the impact of the March 23 and April 9 announcements on credit and bid-ask spreads. Using intra-day transactions data that exactly identify the Fed's purchases of individual corporate bonds, we evaluate the SMCCF's implementation effects in Section 4. Section 5 concludes.

2 Data Sources and Methods

As discussed above, the Fed announced on March 23 an unprecedented corporate bond-buying program in response to severe strains in the U.S. corporate bond market. By establishing two emergency lending facilities pursuant to Section 13(3) of the Federal Reserve Act—the Primary Market Corporate Credit Facility and the Secondary Market Corporate Credit Facility—the Fed committed to buying a substantial amount of corporate debt in both the primary and secondary markets.[8]

The stated objective of the SMCCF was to provide liquidity to the market for outstanding corporate bonds through direct purchases of individual corporate securities and ETFs, whose pri-

[8]As discussed by Sastry (2018), Section 13(3) of the Federal Reserve Act, which was added to the act at the height of the Great Depression in 1932, granted the Fed enormous emergency lending powers. Notably, it granted the 12 Federal Reserve Banks the authority to "discount" for any "individual, partnership, or corporation" notes "endorsed or otherwise secured to the satisfaction of the Federal Reserve Bank[s]," subject to a determination by the Board of Governors of the Federal Reserve System of "unusual and exigent circumstances." While the Fed's aggressive use of Section 13(3) during the 2008–09 financial crisis successfully stabilized the financial system, the Congress responded to the Fed's use of Section 13(3) by narrowing that authority in the Dodd-Frank Act of 2010. Most importantly, any emergency lending must now be made through a "program or facility with broad-based eligibility," it cannot "aid a failing financial company" or "borrowers that are insolvent," and it cannot have "a purpose of assisting a single and specific company avoid bankruptcy." In addition, the Fed is prohibited from establishing a Section 13(3) program without the prior approval of the secretary of the Treasury.

Table 1: The Composition of the Initial Broad Market Listing

Sector	No. of issuers	Weight (%)	Issuer with the largest weight
Basic Industries	41	3.6	DuPont De Nemours Inc.
Capital Goods	70	7.4	General Electric Co.
Communications	33	7.8	AT&T Inc.
Consumer Cyclical	73	16.2	Toyota Motor Credit Corp.
Consumer Non-Cyclical	101	20.4	AbbVie Inc.
Energy	78	9.5	BP Capital Markets America Inc.
Insurance	72	8.0	Metropolitan Life Global Funding Inc.
Nonbank Financials	41	2.1	International Lease Finance Corp.
REITs	56	3.2	WEA Finance LLC
Technology	55	9.2	Apple Inc.
Transportation	18	2.6	Burlington North Santa Fe LLC
Utilities	156	10.4	NextEra Energy Capital Holdings Inc.

Note: This table reports the sectoral composition of the initial Broad Market Listing, announced on June 28, 2020, and effective as of June 5, 2020. See the text for details.
Source: Authors' calculations using data from the Federal Reserve Bank of New York.

mary investment objective was exposure to the broad U.S. corporate bond market. Eligible bonds were required to have been issued by U.S. companies and had to have a remaining maturity of five years or less. The maximum amount of bonds that the SMCCF was allowed to purchase in the secondary market of any eligible issuer was capped at ten percent of the issuer's maximum dollar amount of bonds outstanding on any day between March 22, 2019, and March 22, 2020. The March 23 announcement stipulated that the two corporate bond-buying facilities were open to only investment-grade U.S. companies.

On April 9, 2020, the Fed announced that the PMCCF and SMCCF would support, respectively, $500 billion of primary market purchases and $250 billion of secondary market purchases, backed by $75 billion provided by the Treasury Department using funding from the Coronavirus Aid, Relief, and Economic Security Act (CARES Act). In addition, the Fed expanded the two facilities to include certain fallen angels—companies that were rated at least Baa3/BBB- as of March 22, 2020, and were rated at least Ba3/BB- as of the date on which the SMCCF purchased their bonds. The SMCCF started buying corporate bond ETFs on May 12 and individual corporate bonds on June 16.[9] On July 28, the Fed announced an extension of the two corporate bond-buying facilities—which were initially scheduled to expire on or around September 30, 2020—through December 31, 2020, at which point, both facilities ceased purchasing eligible assets.

The term sheet of the SMCCF stipulated that the facility's direct purchases of individual securities in the secondary market will attempt to track "a broad, diversified market index of U.S. corporate bonds." To operationalize this notion, the Federal Reserve Bank of New York published on June 28, 2020, the initial Broad Market Listing (BML), a set of corporate bonds eligible for

[9]The PMCCF commenced its operations on June 29, 2020.

purchase by the SMCCF.[10] To get a sense of what credits the SMCCF was targeting, we report in Table 1 the composition of the initial BML. This first listing of eligible bonds, which went into effect on June 5, 2020, included securities issued by 794 U.S. companies in 12 broad sectors. The "Consumer Cyclical" and "Consumer Non-Cyclical" sectors had the largest weights of 16 percent and 20 percent, respectively. In the Consumer Cyclical sector, Toyota Motor Credit Corp. was the largest issuer, while AbbVie Inc., a biopharmaceutical company originated as a spinoff of Abbott Laboratories, was the largest issuer in the Consumer Non-Cyclical sector.[11]

The bond pricing data used in our analysis come from TRACE, a database containing information about individual corporate bond transactions in the secondary market. Most importantly, the TRACE database records the date and time of individual corporate bond transactions, transaction prices and volumes, the direction of a transaction (buy or sell), as well as information about whether a transaction is "dealer-to-customer" or "dealer-to-dealer." After running the TRACE data through filters developed by Dick-Nielsen and Poulsen (2019), we combine the resulting security-level transactions data with the information from the Mergent's Fixed Income Securities Database to obtain bond characteristics, such as bond type, coupon frequency and payout dates, seniority, date and amount of issuance, maturity date, and credit ratings.

We restrict our TRACE sample to transactions involving senior unsecured bonds with fixed coupon schedules that were issued by investment-grade U.S. companies. From this sample, we drop all transactions involving bonds with a remaining maturity of less that one year or more than 12 years. These filters ensure that prices in our sample are not unduly influenced by the potential liquidity anomalies arising from the bond's special features, such as an impending redemption, unusually long maturity by the standards of fixed income markets, or changes in its promised cash flows.[12]

The daily price for each bond in our sample is defined as the last transaction price recorded between 9 a.m. and 4:00 p.m. on a given business day. We refer to the corresponding dollar amount traded as the transaction amount or transaction volume.[13] Following Gilchrist and Zakrajšek (2012), we construct a credit spread for each bond on each trading day as the difference between the bond's yield-to-maturity implied by its daily price and the yield-to-maturity of a synthetic risk-free security that mimics exactly the cash flows of the corresponding corporate bond. The yield of the synthetic risk-free security is calculated from its hypothetical price, which is equal to the present value of the promised cash flows, discounted by the term structure of zero-coupon U.S. Treasury yields, as estimated on that day by Gürkaynak et al. (2007).

To measure liquidity at the security level, we utilize information about the type of counterparties

[10] The Federal Reserve Bank of New York published an updated Broad Market Listing roughly once a month through the remainder of the year.

[11] The subsequent Broad Market Listings had essentially the same sectoral composition.

[12] In fact, a vast majority of bonds purchased by the SMCCF were senior unsecured bonds with fixed coupon schedules; restricting our sample to fixed-coupon bonds thus facilitates comparisons with the sample of bonds purchased by the facility.

[13] As a robustness check, we also defined the daily price for each bond as a weighted average of all of its transaction prices between 9:00 a.m. and 4:00 p.m. on a given day, with weights equal to the corresponding transaction amounts. Using this alternative definition had a negligible effect on all the results reported in the paper.

Table 2: Summary Statistics of Selected Bond Characteristics

	Pre-Pandemic Period					Pandemic Period				
Variable	Mean	SD	P25	P50	P75	Mean	SD	P25	P50	P75
A. Sample of credit spreads[a]										
Credit spread (bps.)	99.4	63.2	56.1	84.7	128.0	158.8	152.9	61.4	109.3	204.9
Time-to-maturity (years)	4.8	2.5	2.7	4.4	6.8	4.5	2.6	2.3	4.1	6.5
Age (years)	4.3	4.2	1.7	3.4	5.9	4.6	4.4	1.8	3.7	6.3
Coupon rate (pct.)	3.7	1.1	3.0	3.5	4.1	3.6	1.1	2.9	3.5	4.0
Par amount ($ millions)	846.4	776.1	400.0	650.0	1000.0	845.2	766.3	420.0	650.0	1000.0
B. Sample of bid-ask spreads[b]										
Bid-ask spread (bps.)	45.4	48.1	16.1	29.4	55.6	61.1	75.6	15.5	32.2	73.9
Time-to-maturity (years)	4.6	2.5	2.6	4.2	6.5	4.3	2.6	2.1	3.9	6.2
Age (years)	4.0	3.5	1.8	3.3	5.6	4.4	3.7	1.9	3.8	6.0
Coupon rate (pct.)	3.5	1.0	2.9	3.4	4.0	3.5	1.0	2.8	3.4	4.0
Par amount ($ millions)	1129.1	936.7	500.0	990.5	1500.0	1106.8	926.5	500.0	850.0	1348.4

Note: The table reports summary statistics of selected bond characteristics in our broad matched sample of corporate bonds. Summary statistics are reported for two non-overlapping sample periods of equal length: the pre-pandemic period (Jan–Jul 2019) and the pandemic period (Jan–Jul 2020).

[a] The sample of credit spreads corresponds to a set of bonds for which we could compute daily credit spreads (see the text for details). Panel dimensions (Jan–Jul 2019): No. of bonds = 4,996; No. of firms = 957; and Observations =429,547. Panel dimensions (Jan–Jul 2020): No. of bonds = 5,453; No. of firms = 975; and Observations = 451,917.

[b] The sample of bid-ask spreads corresponds to a set of bonds for which we could compute daily bid-ask spreads (see the text for details). Panel dimensions (Jan–Jul 2019): No. of bonds = 4,425; No. of firms = 912; and Observations = 209,829. Panel dimensions (Jan–Jul 2020): No. of bonds = 4,908; No. of firms = 922; and Observations = 218,917.

involved in each recorded transaction. Specifically, on each business day, we define the bond's "bid" price as an arithmetic average of all prices generated by transactions involving dealers buying that bond from a non-dealer customer.[14] The bond's corresponding "ask" price, by contrast, is defined as an arithmetic average of all prices generated by transactions involving non-dealer customers buying that same bond from a dealer. Given the critical intermediary role of dealers in the corporate bond market, it is natural to expect that the bond's ask price will in general be higher that its bid price, and that the difference between the two will be indicative of the dealers' ability or willingness to provide principal-at-risk to ensure smooth functioning of the market. Lastly, we define the bond's "mid" price as an arithmetic average of all prices involving dealer-to-dealer transactions. Our proxy for the bond-specific bid-ask spread is then calculated as the difference between the bond's ask and bid prices, divided by the mid price.

In Panel A of Table 2, we report summary statistics for selected bond characteristics using the sample of bonds for which we constructed credit spreads; the corresponding statistics for the sample of bonds for which we were able to construct bid-ask spreads are reported in Panel B.[15] In each case, we focus on two sample periods: a pandemic period running from January through the end of July of 2020 and a comparable pre-pandemic period in 2019. According to Panel A, the average credit spread in our sample of bonds was about 100 basis points before the pandemic but shot up to almost 160 basis points over the first seven months of 2020. In general, the Covid-19 shock shifted the entire distribution of credit spreads notably to the right and significantly increased the dispersion of credit spreads in our sample.

As shown in Panel B, a similar, though less pronounced, shift also occurred in the distribution of bid-ask spreads. The more muted response of bid-ask spreads owes importantly to the fact that the sample of bonds for which we are able to calculate bid-ask spreads is by construction smaller than the sample of bonds for which we can compute credit spreads.[16] Note that the par values of bonds in the former sample are systematically larger than the par values of bonds in the latter sample, as this sample of bonds by construction includes securities that trade more frequently and thus are more liquid. Despite these differences, the remaining bond characteristics are very similar across the two samples.

[14]Non-dealer customers include corporate bond mutual funds, property-casualty and life insurance companies, pension funds, and other non-dealer investors in the U.S. corporate bond market.

[15]To ensure that our results are not unduly influenced by a small number of extreme observations, we drop from the credit spread sample all observations with credit spreads of less than one basis point or with credit spreads exceeding 2,000 basis points. From the bid-ask spread sample, we drop all observations with bid-ask spreads of less than one basis point or with bid-ask spreads exceeding 500 basis points.

[16]Recall that to construct bid-ask spreads, we require a minimum of three distinct transactions on each day: (*i*) a sale of the bond by a dealer to a non-dealer customer; (*ii*) a sale of the same bond by a non-dealer customer to a dealer; and (*iii*) a sale of the same bond between two dealers. As a result, the sample of bid-ask spreads will be smaller than the corresponding sample of credit spreads, as the construction of the latter requires only a single daily transaction.

3 Empirical Methodology and Results

We use a difference-in-differences approach to identify announcement effects of the SMCCF on the U.S. corporate bond market. The key identifying assumption underlying this approach relies on the fact that a given investment-grade issuer in our sample has outstanding bonds with maturity of less than or equal to five years—which were eligible for purchase by the SMCCF—as well as outstanding bonds with maturity greater than five years that were ineligible. Arguably, this dichotomy within a given issuer allows one to compare bond-level outcomes (i.e., changes in credit or bid-ask spreads) of the SMCCF-eligible bonds—the "treated" bonds—with outcomes of ineligible bonds that serve as the "control."

This natural identifying assumption presumes that issuer characteristics or other factors that may be correlated with the maturity of issuer's outstanding bonds do not confound the analysis. An obvious concern is that issuers whose outstanding bonds are on average of shorter maturities differ systematically from issuers whose outstanding bonds tend to be of longer maturities. Such differences could arise if riskier firms are more likely to issue shorter-maturity bonds compared with their more creditworthy counterparts. To the extent that the pandemic had a differential effect on firms across the credit risk spectrum, these differences would violate the key identifying assumption underlying the DiD approach. Another potential concern is that maturity itself is a confounding factor, which could occur if shorter-maturity bonds were more sensitive to the Covid-19 shock than longer-maturity bonds.

With these caveats in mind, we begin the analysis by constructing a matched sample of bonds, in which we try to minimize the maturity differential between the SMCCF-eligible and ineligible bonds for a given issuer. By construction, this approach differences out issuer-specific effects of policy announcements and allows us to directly estimate the impact of the two announcements on bonds below and above the five-year eligibility cutoff. There are, however, two limitations to this approach. First, this so-called narrow sample significantly limits the total number of bonds that we can consider in the analysis. Second, despite minimizing the maturity differential between eligible and ineligible bonds, the resulting average maturity gap between treated and control samples is nearly three years.

We therefore extend the analysis to a full sample of bonds; that is, instead of restricting the sample to pairs of bonds closest to the either side of the five-year maturity cutoff, we consider for each issuer *all* bonds with the remaining maturity between one and 12 years. In addition to allowing for a more comprehensive analysis in terms of coverage, the full sample allows us to estimate the effect of the two announcements on the credit-spread-maturity curve separately from the effects associated with the SMCCF eligibility, as defined by the five-year maturity cutoff. As we show below, the response of the credit-spread-maturity curve to the two policy announcements is in fact the key element behind the efficacy of actions undertaken by the Fed to stabilize credit markets.

Another concern with relying solely on the maturity-eligibility criterion to identify the effects of the SMCCF announcements is the fact that the program was much more likely to purchase bonds of certain issuers. Indeed, the implementation of the program through the BML (see Table 1) suggests exactly that. To the extent that market participants anticipated that the program will targeted such issuers, one might expect the announcements to have differential effects across issuers, as well as across bonds within a given issuer. We show below that whether an issuer had bonds trading in the secondary market that were ultimately purchased by the SMCCF is in fact predictable based on observable pre-pandemic issuer characteristics. This was likely understood by investors as the program announcements were made. As a result, using the maturity-eligibility criterion to identify the effects of the two announcements will not reveal the full scope of the program because investors might have presumed that the goal of the program, at least in part, was not to target bonds below a certain maturity cutoff but rather bonds of certain issuers.

To address these issues, we propose a novel refinement to the baseline DiD strategy, which exploits the ex post information on whether an issuer's bonds were eventually purchased by the SMCCF. Because this approach relies on outcomes that were not observed by investors at the time of the two announcements, we develop an IV strategy to control for biases that might arise from relying on such ex post information.

3.1 DiD Results

In this subsection, we present the DiD estimates of the March 23 and April 9 announcements on credit and bid-ask spreads. We begin by describing the construction of the treatment and control groups of bonds used in the analysis. Next, we present the estimation results based on the narrow sample and then extend the analysis to the full sample of bonds.

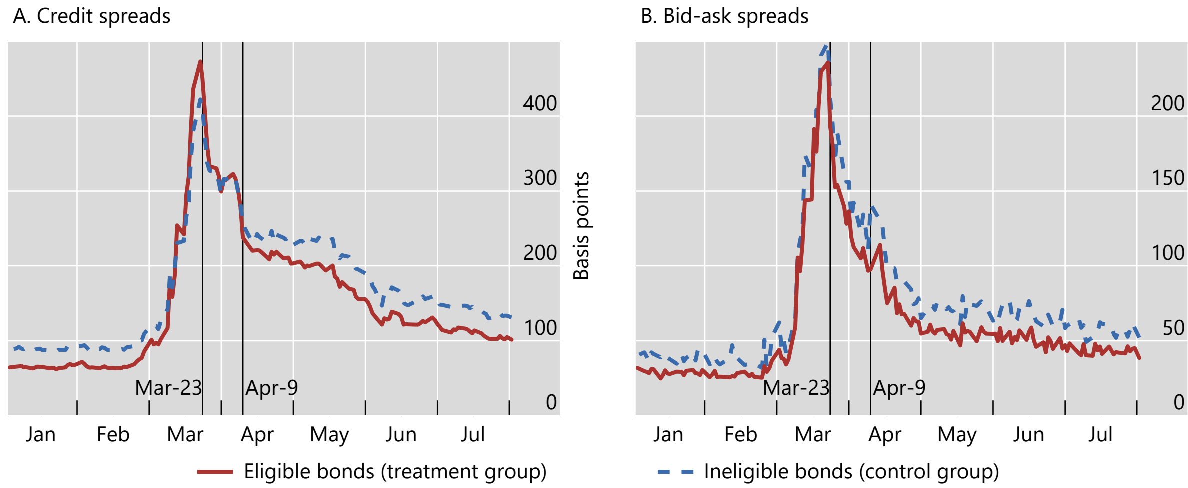
3.1.1 Treatment and Control Groups

Using our TRACE sample of corporate bonds, we construct the treatment and control groups as follows. First, we select all bonds whose issuer had an investment-grade rating as of March 22 and whose remaining maturity as of the March 23 announcement was less than or equal to five years; this sample of bonds was eligible for the purchase by the SMCCF as of the March 23 announcement. For each bond in this sample, we then identify all bonds issued by the same company, but whose remaining maturity is greater than five years; this second sample of bonds was not eligible to be purchased by the SMCCF. Note that bonds in the two samples were all issued by the same set of companies and thus are subject to the same underlying default risk.

Using these two samples of bonds, we construct the narrow treatment and control groups used in the DiD analysis. To construct the treatment group, we select from issuers with multiple bonds in the eligible sample, a bond with the remaining maturity closest to five years. Analogously, if there are multiple bonds in the ineligible sample that can be paired with the bond in the treatment group, we keep only the bond with the remaining maturity closest to five years—this sample constitutes our control group. In addition to being subject to the same underlying default risk, a pair of bonds from the narrow treatment and control groups has the remaining maturity that is as close as possible.[17]

[17]This matching process yielded 3,225 pairs of bonds, issued by 545 unique U.S. investment-grade companies during January through August 2020. The mean (median) difference in the remaining maturity across pairs of bonds is 2.7

Figure 1: SMCCF Eligible vs. Ineligible Corporate Bonds



Note: The red solid line in Panel A shows the daily average credit spread of the SMCCF-eligible corporate bonds (i.e., the narrow treatment group), while the dashed blue line shows the daily average credit spread of the SMCCF-ineligible corporate bonds (i.e., the narrow control group). The corresponding lines in Panel B show the daily average bid-ask spreads for the same two groups of bonds. See the text for details regarding the construction of the narrow treatment and control groups. Vertical lines at specified dates: Mar-23 = Fed announces the establishment of the P/SMCCF; and Apr-9 = Fed expands the facilities to include corporate bonds of issuers that were rated investment grade as of March 22 but were subsequently downgraded to junk.
Source: Authors' calculations using TRACE date.

The red line in the left panel of Figure 1 shows the daily average credit spread of bonds in the treatment group, while the blue line shows the corresponding average credit spread in the control group. The red and blue lines in the right panel show the evolution of the respective average bid-ask spreads. Before the realization of the potential economic impact of the Covid-19 shock rattled investor confidence in late February, the average credit spread in the control group was consistently above that in the treatment group. The gap between the credit spreads in the two samples was very stable around the average of about 25 basis points. This pattern is consistent with the fact that the average bid-ask spread in the treated sample was systematically below the average bid-ask spread in the control sample during this period. One could interpret that as indicating that bonds in our treated group were, on average, more liquid than their counterparts in the control group, due to their shorter maturity and possibly other bond or issuer characteristics.

In early March, when fears over the impact of the Covid-19 outbreak sparked a broad sell-off in risky assets, the gap between the two credit spread series started to close, disappearing completely during the bout of turmoil that swept through financial markets in mid-March. This acute risk-off period also saw a widespread deterioration in market liquidity, as the average bid-ask spreads in both samples shot up and converged at elevated levels. Following the Fed's March 23 announcement, credit spreads in both the treatment and control groups declined significantly. Interestingly, the

(2.3) years, while the 5th (95th) percentile is 0.5 (6.0) years.

size of the drop in the average credit spreads in the immediate aftermath of the announcement was virtually the same across the two groups.

The commensurate drop in credit spreads across the two groups in the wake of the March 23 announcement would suggest that what caused the spreads to narrow was not the announcement of the corporate bond-buying program per se. Rather, it was the Fed's "whatever it takes" pledge to keep the economy from collapsing under the weight of the Covid-19 pandemic, reflected in the opening sentence of the announcement, which stated that the Fed is "committed to using its full range of tools to support households, businesses and the U.S. economy overall." This interpretation is consistent with the decline in the average bid-ask spread in both samples in the days following the March 23 announcement, an indication that this extraordinary announcement significantly improved the overall functioning of the corporate bond market.

The Fed's April 9 announcement, by contrast, appears to have had a more differential effect on credit spreads in the treatment and control groups. In particular, the average credit spread in the treated sample fell more that the average credit spread in the control sample. This suggest that the April 9 follow-up announcement had a distinct impact on the corporate bond market. At the same time, the April 9 announcement appears to have had no differential effect on the average bid-ask spreads in the two groups of corporate bonds.

3.1.2 DiD Results Based on the Narrow Sample

To formally quantify the separate effects of the March 23 and April 9 announcements on the corporate bond market, we use the issuer-specific pairs of bonds in the treatment and control groups to estimate the following specification:

$$Y_{i,j,t} = \beta_1 \mathbb{1}[t \geq t^*] + \beta_2 \big(\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]\big) + \theta' \mathbf{X}_{i,j,t} + \eta_i + \epsilon_{i,j,t}, \tag{1}$$

where i indexes issuers and j indexes their outstanding bonds. In this specification, $Y_{i,j,t}$ denotes the outcome variable of interest, either a credit spread ($\text{CS}_{i,j,t}$) or the log of a bid-ask spread ($\ln \text{BAS}_{i,j,t}$) on bond j, a liability of issuer i, on business day t.[18] The 0/1-indicator variable $\mathbb{1}[t \geq t^*]$ equals one if the date t is greater than or equal to the specified announcement date t^*, either March 23 or April 9. The 0/1-indicator variable $\mathbb{1}[j \in E]$ equals one if bond j was eligible for purchase by the SMCCF.

The regression also includes a vector of covariates, denoted by $\mathbf{X}_{i,j,t}$, consisting of pre-determined bond characteristics that can affect credit and bid-ask spreads. These include the bond's (fixed) coupon rate, its remaining maturity, age, and the log of par value, as well as 0/1-indicator variables for whether the bond is callable, has credit enhancements, or is subject to covenants. The vector $\mathbf{X}_{i,j,t}$ also includes the indicator variable $\mathbb{1}[j = E]$, which controls for common factors affecting the SMCCF-eligible bonds across the pre- and post-treatment windows. Issuer fixed effect η_i controls for all (time-invariant) unobservable issuer characteristics within the estimation window.

[18] Taking logs of bid-ask spreads provides a useful transformation to control for heteroskedasticity, given that the distribution of bid-ask spreads is highly skewed.

Under the standard DiD identifying assumptions, the coefficient β_2 on the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$ thus quantifies the difference in the specified outcome variable between the SMCCF-eligible and ineligible bonds of the same issuer in response to the specified announcement. We estimate specification (1) by OLS in symmetric two-, five-, and ten-day windows bracketing the March 23 and April 9 announcements. The results of this exercise for credit spreads are reported in Panel A of Table 3, whereas Panel B shows the corresponding estimates for the bid-ask spreads.

In Panel A, it is instructive to first consider the estimates of β_1, the coefficient on the indicator variable $\mathbb{1}[t \geq t^*]$, which measures the change in the average credit spread in the post-treatment window relative to the pre-treatment window. In response to the March 23 announcement (columns 1–3), credit spreads narrowed, on average, about 30 basis points within the first two days following the announcement. Within five days, however, this effect has fully dissipated and within ten days of the announcement, spreads were, on average, 55 basis points higher than they were over the ten days before the announcement. This striking reversal in credit conditions is indicative of the turmoil that roiled the corporate bond market in late March as the news of the pandemic and associated policy responses unfolded.

The April 9 announcement (columns 4–6), by contrast, led to a clear improvement in overall credit conditions, as evidenced by the steady narrowing of the average credit spread in the post-announcement windows relative to the pre-announcement windows. The estimates of coefficient β_1 imply that the average credit spread fell more than 50 basis points in the two-day window and more than 70 basis points in the ten days following the April 9 announcement. These estimates serve as useful benchmarks when assessing the additional impact of the SMCCF announcements through the maturity-eligibility criterion.

Turning to these estimates, the entries in columns (1)–(3) indicate that the March 23 announcement induced a significant—in both statistical and economic terms—narrowing of credit spreads on the SMCCF-eligible bonds compared with their ineligible counterparts. Within the two- and five-day windows bracketing the announcement, the estimates of β_2—the coefficient on the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$—imply an additional narrowing of credit spreads of 26 basis points and 23 basis points, respectively, on the SMCCF-eligible bonds relative to ineligible bonds issued by the same set of companies. Consistent with the finding that the March 23 announcement led to only a short-lived improvement in overall credit conditions, the estimated announcement effect for the eligible bonds shrinks to eight basis points in the ten-day window, though it remains statistically significant at conventional levels.

Whereas the March 23 announcement effects on credit spreads are estimated to dissipate over time, we see the opposite pattern in response to the April 9 announcement. As shown in columns (4)–(6), the estimated announcement effects for the SMCCF-eligible bonds increase (in absolute value) with the window length. In the two-day window, the April 9 announcement induced a decline in credit spreads on the eligible bonds of 11 basis points, which increased to 17 basis points in the five-day window and to 24 basis points in the ten-day window. These results indicate that the April 9 announcement had a much more lasting effect on credit spreads than the March 23 announcement,

Table 3: The Impact of the SMCCF Announcements on the Corporate Bond Market (DiD Estimates Based on the Narrow Sample)

	Mar-23 Announcement			Apr-9 Announcement		
	2-day	5-day	10-day	2-day	5-day	10-day
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
A. Credit spreads						
$\mathbb{1}[t \geq t^*]$	−0.31***	0.05	0.55***	−0.52***	−0.69***	−0.72***
	(0.04)	(0.03)	(0.04)	(0.02)	(0.02)	(0.02)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$	−0.26***	−0.23***	−0.08**	−0.11***	−0.17***	−0.24***
	(0.07)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
R^2	0.76	0.70	0.65	0.91	0.90	0.89
No. of firms	487	523	544	513	537	552
No. of bonds	1,395	1,812	2,181	1,477	1,813	2,146
Observations	3,934	8,656	16,466	4,174	9,106	17,316
B. Bid-ask spreads						
$\mathbb{1}[t \geq t^*]$	−0.29***	−0.25***	−0.12***	0.02	−0.20***	−0.46***
	(0.06)	(0.04)	(0.03)	(0.05)	(0.03)	(0.03)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$	−0.11	−0.14**	−0.10**	0.00	−0.00	−0.05
	(0.09)	(0.06)	(0.04)	(0.07)	(0.05)	(0.04)
R^2	0.11	0.12	0.12	0.31	0.31	0.33
No. of firms	310	359	395	337	381	423
No. of bonds	985	1,426	1,855	1,089	1,527	1,950
Observations	1,888	4,134	8,052	2,150	4,904	9,468

Note: The dependent variable in Panel A is $\mathrm{CS}_{i,j,t}$, the credit spread of bond j (issued by firm i) on business day t, whereas in Panel B, the dependent variable is $\ln \mathrm{BAS}_{i,j,t}$, the log of the corresponding bid-ask spread. The entries in the table denote the OLS estimates of coefficients associated with the specified explanatory variable: $\mathbb{1}[t \geq t^*] = 0/1$-indicator variable that equals one if date t is greater than or equal to the specified announcement date t^* and zero otherwise; and $\mathbb{1}[j = E] = 0/1$-indicator variable that equals one if bond j was eligible for purchase by the SMCCF as of March 22 and zero otherwise. All specifications include a vector of bond-specific controls (not reported) and issuer fixed effects. Asymptotic standard errors reported in parentheses are clustered at the issuer level: * $p < .10$; ** $p < .05$; and *** $p < .01$.

a finding consistent with the persistent gap between the red and blue lines in the left panel of Figure 1 that emerged after April 9.

The April 9 announcement effects are estimated quite precisely—the standard error is a mere three basis points—and hence indicate a high degree of statistical significance. Moreover, these estimates are quite large in economic terms compared with the overall effect of the announcement. In the ten-day window, for instance, the April 9 announcement induced a decline of 72 basis points across all credit spreads and an additional decline of 24 basis points in spreads on the SMCCF-eligible bonds.

In Panel B of Table 3, we report the results from the analogous exercise using the log of bid-ask spreads as the dependent variable. The log transformation of bid-ask spreads implies that the estimated announcement effects reported in the table are expressed in *percentage* changes in bid-ask spreads. To convert them back to original units (basis points), we multiply the relevant coefficients by the sample mean of bid-ask spreads in the specified window.

According to the estimates of β_1, the coefficient on the announcement indicator $\mathbb{1}[t \geq t^*]$, the March 23 announcement (columns 1–3) significantly improved liquidity conditions in the corporate bond market. On average, bid-ask spreads fell almost 60 basis points within two days of the announcement, and while some of that decline was subsequently reversed, we still observe a decline of nearly 25 basis points in the average bid-ask spread within the ten-day window. The improvement in liquidity is even more pronounced after the April 9 announcement (columns 4–6), as the average bid-ask spread fell about 50 basis points within the ten-day window. Note that these announcement effects are all highly statistically significant.

While the two announcements significantly improved overall liquidity conditions in the market, the effect on the SMCCF-eligible bonds is limited to the March 23 announcement. According to our estimates, the March 23 announcement compressed bid-ask spreads of the eligible bonds by an additional 25 basis points or so within the five-day window, with the effect diminishing to about 20 basis points in the ten-day window. Consistent with the market commentary that the April 9 announcement was focused more on credit risk as opposed to liquidity concerns, the estimated effect on bid-ask spreads for the SMCCF-eligible bonds is essentially zero in all windows following the announcement.[19] Lastly, it is worth pointing out that standard errors associated with the estimated announcement effects for bid-ask spreads tend to be somewhat larger than their counterparts in credit-spread regressions. As discussed above, this partly reflects the noticeably smaller sample sizes used in the estimation of the bid-ask-spread regressions.

3.1.3 DiD Results Based on the Full Sample

We now extend the above DiD analysis to all available bonds with remaining maturity between one and 12 years. We thus relax the assumption that a firm must have a pair of bonds outstanding with

[19]The perception that the April 9 announcement was more focused on credit risk is due in large part to the inclusion of fallen angels in the corporate bond-buying programs. We analyze the impact of the April 9 announcement on fallen angels in Appendix A.

maturity above and below the five-year cutoff, which defines the SMCCF eligibility. Using this full sample, we re-estimate equation (1) and report the results in Table 4. Broadly speaking, the results for both credit spreads (Panel A) and bid-ask spreads (Panel B) based on the full sample are fully consistent with—if anything, they strengthen—the findings reported in Table 3.

Turning first to credit spreads (Panel A), note that the estimates of β_1—the coefficient on the announcement indicator $\mathbb{1}[t \geq t^*]$ measuring the average response of credit spreads to the two announcements—exhibit the same pattern and are of a similar magnitudes as the estimates based on the narrow sample. In response to the March 23 announcement (columns 1–3), credit spreads narrowed, on average, 26 basis points within the two-day window before widening 56 basis points, on average, within the ten-day window. In response to the April 9 announcement (columns 4–6), by contrast, the average credit spread fell steadily: 50 basis points with the two-day window and more than 70 basis points within the ten-day window.

We see a similar pattern in the estimates of coefficient β_2 on the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$, which measures the additional response of credit spreads of the SMCCF-eligible bonds. In response to the March 23 announcement (columns 1–3), credit spreads on such bonds narrowed an additional 48 basis points within the two-day window, with the announcement effect waning to 18 basis points within the ten-day window—note that these estimates are about twice as large as those based on the narrow sample. In contrast, the estimated effects for the SMCCF-eligible bonds following the April 9 announcement based on the full sample (columns 4–6) are roughly of the same magnitude as those based on the narrow sample. The full-sample estimates imply an additional statistically significant narrowing of credit spreads for the SMCCF-eligible bonds of 6 basis points within two days of the April 9 announcement, 18 basis points within five days, and 26 basis points within ten days of the announcement.

Panel B reports the estimation results for the log of bid-ask spreads. As before, the estimated overall effects of the two announcements—as captured by the coefficient β_1 on the announcement indicator $\mathbb{1}[t \geq t^*]$—based on the full sample are quite similar to those based on the narrow sample. In the ten-day window, the average bid-ask spread is estimated to decline more than 15 basis points in response to the March 23 announcement (column 3), while the April 9 announcement is estimated to reduce the average bid-ask spread about 45 basis points over the same horizon (column 6).

The full-sample estimates of coefficient β_2 on the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$ are also comparable to their corresponding estimates based on the narrow sample. At the ten-day horizon, the full-sample estimates of β_2 imply an additional statistically significant narrowing of bid-ask spreads of nearly 20 basis points for the SMCCF-eligible bonds in response to the March 23 announcement (column 3) and five basis points in response to the April 9 announcement (column 6). These results confirm that liquidity conditions for the eligible bonds improved significantly more in response to the March 23 announcement compared with the April 9 announcement.

All told, the narrow sample estimates of the two announcement effects and their full-sample counterparts all imply significant improvements in overall market conditions—in terms of both lower credit and bid-ask spreads—as well as in outcomes specific to bonds eligible for purchase by

Table 4: The Impact of the SMCCF Announcements on the Corporate Bond Market
(DiD Estimates Based on the Full Sample)

	Mar-23 Announcement			Apr-9 Announcement		
	2-day	5-day	10-day	2-day	5-day	10-day
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
A. Credit spreads						
$\mathbb{1}[t \geq t^*]$	-0.26^{***}	0.05	0.56^{***}	-0.50^{***}	-0.68^{***}	-0.71^{***}
	(0.03)	(0.03)	(0.04)	(0.02)	(0.03)	(0.03)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$	-0.48^{***}	-0.36^{***}	-0.18^{***}	-0.06^{***}	-0.18^{***}	-0.26^{***}
	(0.05)	(0.04)	(0.05)	(0.02)	(0.03)	(0.03)
R^2	0.72	0.67	0.62	0.91	0.89	0.88
No. of firms	492	539	552	509	546	560
No. of bonds	2,597	2,879	3,061	2,647	2,858	3,049
Observations	9,679	21,002	40,014	9,938	21,930	41,827
B. Bid-ask spreads						
$\mathbb{1}[t \geq t^*]$	-0.38^{***}	-0.26^{***}	-0.12^{***}	0.05	-0.17^{***}	-0.46^{***}
	(0.05)	(0.03)	(0.03)	(0.04)	(0.03)	(0.02)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$	-0.06	-0.18^{***}	-0.13^{***}	-0.09^{*}	-0.07^{**}	-0.05^{*}
	(0.06)	(0.04)	(0.03)	(0.05)	(0.03)	(0.03)
R^2	0.14	0.15	0.14	0.32	0.32	0.34
No. of firms	318	399	455	382	439	483
No. of bonds	1,554	1,907	2,219	1,719	2,067	2,334
Observations	4,316	9,461	18,324	4,611	10,697	20,925

Note: The dependent variable in Panel A is $\mathrm{CS}_{i,j,t}$, the credit spread of bond j (issued by firm i) on business day t, whereas in Panel B, the dependent variable is $\ln \mathrm{BAS}_{i,j,t}$, the log of the corresponding bid-ask spread. The entries in the table denote the OLS estimates of coefficients associated with the specified explanatory variable: $\mathbb{1}[t \geq t^*]$ = 0/1-indicator variable that equals one if date t is greater than or equal to the specified announcement date t^* and zero otherwise; and $\mathbb{1}[j = E]$ = 0/1-indicator variable that equals one if bond j was eligible for purchase by the SMCCF as of March 22 and zero otherwise. All specifications include a vector of bond-specific controls (not reported) and issuer fixed effects. Asymptotic standard errors reported in parentheses are clustered at the issuer level: * $p < .10$; ** $p < .05$; and *** $p < .01$.

the SMCCF. The March 23 announcement led to an economically significant narrowing of both credit and bid-ask spreads on the eligible bonds, while the effect of the April 9 announcement was for the most part concentrated on credit spreads of such bonds. Across the two announcements, our ten-day window estimates imply a total decline of 45 basis points in credit spreads and roughly a 25 basis point reduction in bid-ask spreads for the SMCCF-eligible bonds relative to their ineligible counterparts. By any stretch of the imagination, these are sizable program-specific effects, especially since the Fed has yet to purchase a single corporate bond in that time frame.

3.2 Inspecting the Mechanism

In this section, we zero in on the economic mechanisms that could explain the above results. We focus on the response of credit spreads to the two announcements and consider two specific questions. First, to what extent are the announcement-induced declines in credit spreads due to a reduction in default risk as opposed to a drop in credit risk premia or improvements in investor sentiment. And second, to what extent do these declines in credit spreads reflect the bonds' eligibility for the purchase program versus the fact that they were simply of shorter maturities.

3.2.1 Default Risk versus Credit Risk Premia

To control for the pandemic-induced fluctuations in default risk, we follow Gilchrist and Zakrajšek (2012) and decompose credit spreads into a component that captures issuer-specific time-varying default risk and a residual component that can be thought of as capturing investor attitudes toward corporate credit risk. Specifically, we estimate the following regression:

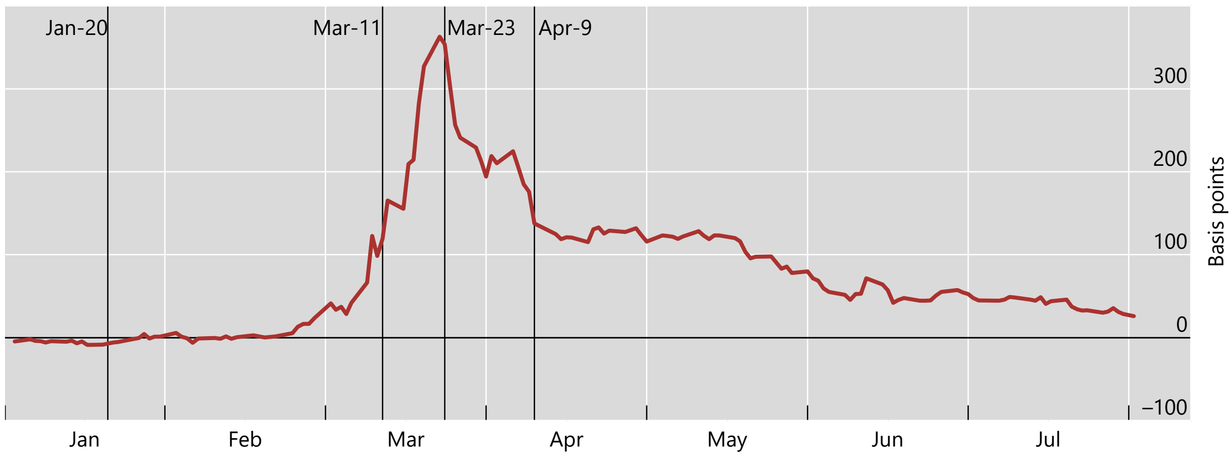
$$\ln \mathrm{CS}_{i,j,t}^{(\tau)} = \alpha_0 + \alpha_1 \mathrm{DD}_{i,t}^{(\tau)} + \lambda' \mathbf{Z}_{i,j,t} + \nu_{i,j,t}^{(\tau)}, \tag{2}$$

where $\mathrm{CS}_{i,j,t}^{(\tau)}$ is the credit spread of bond j (issued by firm i) with the remaining maturity of τ years, and $\mathrm{DD}_{i,t}^{(\tau)}$ denotes the *distance-to-default* for issuer i over horizon τ, an option-theoretic default-risk indicator based on the firm's equity valuations and its volatility, as well as the firm's leverage (see Merton, 1974).

We estimate equation (2) by OLS using daily TRACE data from June 2002 to December 2019 and use the resulting parameter estimates to predict credit spreads over the January–July 2020 period.[20] As discussed by Gilchrist and Zakrajšek (2012), this empirical approach tries to remove equity investors' assessment of default risk of individual firms from the underlying credit spreads. The estimated residual $\hat{\nu}_{i,j,t}^{(\tau)}$, the (log) credit spread "pricing error," reflects a portion of the credit spread that is not attributable to issuer's default risk and which we interpret as an estimate of the credit risk premium. When averaged across issuers, the resulting average residual credit spread—the so-called excess bond premium (EBP)—captures fluctuations in the average price of bearing

[20] We start the estimation in June 2002, when TRACE data first became available, and stop in December 2019 to avoid any "look-ahead" bias when predicting credit spreads during the pandemic; see Appendix B for details.

Figure 2: Credit Risk Premium During the Covid-19 Pandemic



Note: The solid red line shows the time-series of the cross-sectional average of the residual credit spreads (see the text for details). Vertical lines at specified dates: Jan-20 = Chinese officials acknowledge that Covid-19 might be transmissible between humans; Mar-11 = WHO declares Covid-19 a pandemic; Mar-23 = Fed announces the establishment of the P/SMCCF; and Apr-9 = Fed expands the facilities to include corporate bonds of issuers that were rated investment grade as of March 22 but were subsequently downgraded to junk.
Source: Authors' calculations using data from TRACE, CRSP, and S&P's Compustat.

U.S. corporate credit risk, above and beyond the compensation that investors in the corporate bond market require for expected defaults.

Figure 2 plots this daily estimate of the credit risk premium during the Covid-19 pandemic. The March run-up in our estimate of the average credit risk premium is comparable in magnitude to the increase in the Gilchrist and Zakrajšek (2012) original estimate of the EBP in the aftermath of the collapse of Lehman Brothers in September 2008. In addition, the increase in the average credit risk premium during the pandemic accounts for roughly three-fourth of the total rise in the average credit spread for our sample of bonds. This suggests that much of the rise in credit spreads in response to the Covid-19 shock can be attributed to increases in credit risk premia, or a deterioration in credit market sentiment, as opposed to increases in the likelihood of default.

In Table 5, we report the results from re-estimating the baseline DiD specification (1), using the residual credit spreads as the dependent variable.[21] It is important to note that because the distance-to-default increases with the horizon (i.e., the bond's remaining maturity τ), such variation in default risk is not automatically picked up by the inclusion of issuer fixed effects in the regression specification. Nonetheless, the estimates of coefficients β_1 and β_2 using the residual credit spreads as the dependent variable are almost identical—in terms of both their magnitudes and temporal patterns—as those that use the actual credit spreads as the dependent variable (see Table 4). This finding implies that the announcement-induced declines in the average credit spread, as well as the additional declines in credit spreads of the SMCCF-eligible bonds, are due primarily to a reduction

[21] Because measuring distance-to-default requires equity prices, the sample of bonds used in this exercise corresponds to a subset of U.S. issuers in the TRACE database that are publicly listed.

Table 5: The Impact of the SMCCF Announcements on Credit Risk Premia

	2-day	5-day	10-day
Explanatory Variables	(1)	(2)	(3)
A. Mar-23 announcement			
$\mathbb{1}[t \geq t^*]$	-0.30^{***}	-0.01	0.44^{***}
	(0.04)	(0.04)	(0.05)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$	-0.46^{***}	-0.37^{***}	-0.22^{***}
	(0.05)	(0.05)	(0.06)
R^2	0.67	0.61	0.55
No. of firms	339	362	368
No. of bonds	1,825	1,950	2,028
Observations	7,321	15,850	30,014
B. Apr-9 announcement			
$\mathbb{1}[t \geq t^*]$	-0.49^{***}	-0.64^{***}	-0.68^{***}
	(0.03)	(0.03)	(0.03)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$	-0.06^{**}	-0.17^{***}	-0.26^{***}
	(0.03)	(0.03)	(0.04)
R^2	0.88	0.87	0.85
No. of firms	352	362	367
No. of bonds	1,826	1,924	2,012
Observations	7,311	16,208	31,095

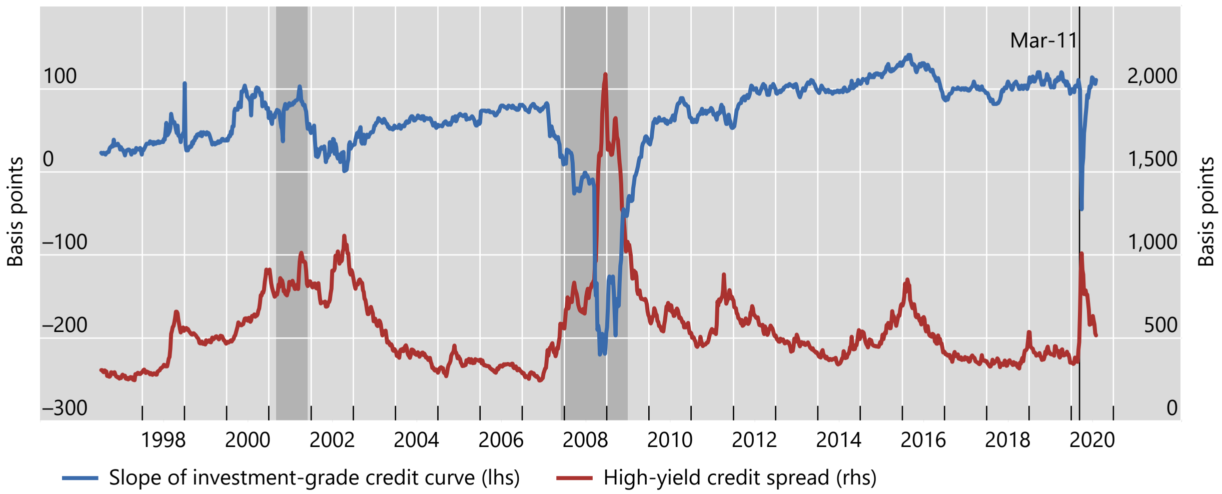
Note: The dependent variable in all specifications is $\text{RCS}_{i,j,t}$, the residual credit spread of bond j (issued by firm i) on business day t (see the text for details). The entries in the table denote the OLS estimates of coefficients associated with the specified explanatory variable: $\mathbb{1}[t \geq t^*] = 0/1$-indicator variable that equals one if date t is greater than or equal to the specified announcement date t^* and zero otherwise; and $\mathbb{1}[j = E] = 0/1$-indicator variable that equals one if bond j was eligible for purchase by the SMCCF as of March 22 and zero otherwise. All specifications include a vector of bond-specific controls (not reported) and issuer fixed effects. Asymptotic standard errors reported in parentheses are clustered at the issuer level: * $p < .10$; ** $p < .05$; and *** $p < .01$.

in credit risk premia, or an improvement in credit market sentiment, rather than to a reduction in default risk, at least as perceived by equity markets.

3.2.2 The Role of Maturity

Recall that the key identifying assumption underlying estimation strategy based on the program-eligibility criteria maintains that there are no significant shifts in credit spreads across the maturity spectrum that are not directly due to the Fed's announcements, which define treated bonds as those having a remaining maturity of less than or equal to five years. To understand the extent to which this assumption is plausible, we first examine the dynamics of the slope of the U.S. investment-grade credit curve. We then use our bond-level data to zero in on the movements in the credit curve during the pandemic.

Figure 3: Slope of the Investment-Grade Credit Curve



Note: The blue line shows the slope of the investment-grade credit curve, defined as the average credit spread on U.S. investment-grade corporate bonds with remaining maturity greater than ten years less the average credit spread on U.S. investment-grade corporate bonds with remaining maturity between one and five years. The red line shows the average credit spread on U.S. high-yield corporate bonds. The vertical shaded regions denote the NBER-dated recessions; and vertical line at Mar-11 = WHO declares Covid-19 a pandemic.
Source: ICE BofA/ML indexes.

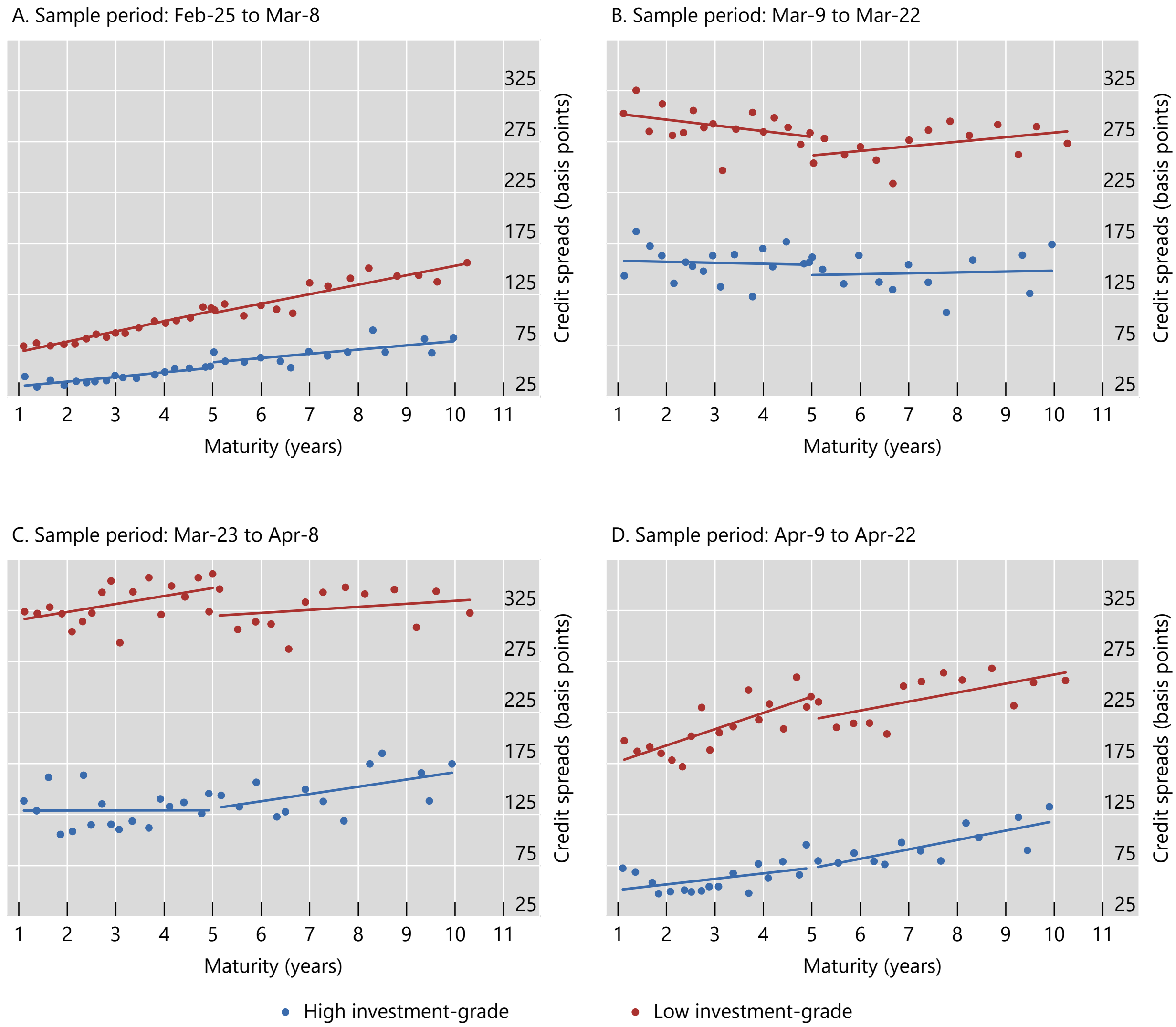
In Figure 3, we plot the slope of the investment-grade credit curve (the blue line) along with the benchmark high-yield corporate bond credit spread (the red line) since 1997. As shown, the credit curve is typically upward sloping—credit spreads on longer-term investment-grade corporate bonds generally exceed those on their shorter-term counterparts. However, as the growing realization of the pandemic's economic fallout roiled the markets in mid-March, the credit curve inverted abruptly, with the long-short credit spread differential dropping deep into the negative territory. At the same time, the high-yield credit spreads more than doubled, jumping from about 500 basis points to more than 1,000 basis points.

A similar inversion in the investment-grade credit curve—accompanied by a jump in high-yield credit spreads—is evident at the peak of the GFC in the autumn of 2008. Such inversion, however, is noticeably absent during the bursting of the tech bubble in 2001 and the associated recession. These patterns are consistent with the notion that the investment-grade credit curve inverts during periods of acute and widespread financial distress.

Figure 4 zeroes in on the dynamics of the credit curve during the pandemic. Specifically, it shows the cross-sectional relationship between credit spreads and maturity in our TRACE sample of investment-grade bonds during the various phases of the pandemic. Within the investment-grade segment of the market, we distinguish between "high" and "low" investment-grade bonds, with the former plotted in blue and the latter in red.

Panel A captures the early phase of the pandemic-induced turmoil in the market. While credit spreads had widened some during this period, the slope of credit curve in both segments of the

Figure 4: Investment-Grade Credit Curve During the Covid-19 Pandemic



Note: Each panel shows the binscatter plot of the relationship between credit spreads and maturity in the investment-grade segment of the U.S. corporate bond market during the specified period of the Covid-19 pandemic. "High" investment-grade bonds are those whose average credit rating across Moody's, S&P, and Fitch ratings categories is in the "Aaa/AAA" and "Aa/AA" categories, while "low" investment-grade bonds are those whose average credit rating is in the "A/A" and "Baa/BBB" categories. In case the average of issuer ratings across the three rating agencies was not an integer, we applied the "floor" function to the resulting average.
Source: Authors' calculations using TRACE date.

investment-grade market remained stable and upward sloping. As the crisis gathered momentum in mid-March (Panel B), credit spreads spiked. In addition, the credit curve inverted, as credit spreads of shorter-maturity bonds increased considerably more than credit spreads of their longer-maturity counterparts. The inversion was also more pronounced in the high investment-grade segment of the market, where the increase in spreads on shorter-maturity bonds was especially large. These patterns are consistent with a "dash for cash," whereby corporate bond investors during the nadir of the pandemic-induced panic first tried to liquidate their holdings of most liquid securities, namely shorter-maturity, high-quality, U.S. investment-grade bonds (see Haddad et al., 2021).[22]

The third phase (Panel C) captures the period following the March 23 announcement but before the April 9 announcement. During this period, credit spreads widened further, on balance, while the inversion of the credit curve lessened somewhat. The final phase (Panel D) focuses on the couple of weeks following the April 9 announcement. Although credit spreads remained elevated, credit curves for both high and low investment-grade bonds are again upward sloping, with slopes of comparable magnitude to those seen during the initial phase of the crisis (Panel A).

These patterns suggest that one of the key aspects of the announcement effects reported above was to restore the normal upward slope of the investment-grade credit curve. They also imply that one must control for such shifts in the credit curve when assessing the impact of the announcement effects through the five-year eligibility cutoff. To do so, we augment the baseline DiD specification (1) with an interaction term, which allows the slope of the credit curve to shift in the post-announcement window. Specifically, we estimate:

$$\text{CS}_{i,j,t} = \beta_1 \mathbb{1}[t \geq t^*] + \beta_2\big(\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]\big) + \beta_3\big(\mathbb{1}[t \geq t^*] \times \tau_{i,j,t}\big) + \theta' \mathbf{X}_{i,j,t} + \eta_i + \epsilon_{i,j,t}, \quad (3)$$

where $\tau_{i,j,t}$ denotes the remaining maturity of bond j at time t. Because the remaining maturity $\tau_{i,j,t}$ is included in the control vector $X_{i,j,t}$, the coefficient β_3 captures shifts in the slope of the credit curve in response to the specified announcement. The coefficient β_2 then captures the direct effect of the SMCCF eligibility, after controlling for shifts in the credit curve that affect both eligible and ineligible bonds.

Table 6 summarizes this exercise, with Panel A containing the estimation results using credit spreads as the dependent variable and with Panel B showing the results for the credit risk premia (i.e., the residual credit spreads). As shown in Panel A, the estimates of the coefficient β_3 on the interaction term $\mathbb{1}[t \geq t^*] \times \tau_{i,j,t}$ are positive and statistically significant for both announcements. Consistent with Figure 4, the estimated slope effect, five basis points within the ten-day window of both announcements (columns 3 and 6), is large in economic terms.

Strikingly, once we control for this shift in the credit curve, there is no evidence of an independent announcement effect on credit spreads of the SMCCF-eligible bonds—the estimated β_2 coefficients on the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$ are both economically small and statistically indistinguishable from zero at conventional significance levels. The results reported in Panel B show the same pattern for the residual credit spreads, which strip out firm-level default risk inferred from equity prices.

The green dots in Figure 5 show the estimated announcement effects on credit spreads across maturities, constructed using the coefficient estimates reported in Panel A of Table 6; the associated 95-percent confidence intervals are shown by the corresponding shaded bands. The estimated credit curves are upward sloping and imply economically large differences in the announcement effects

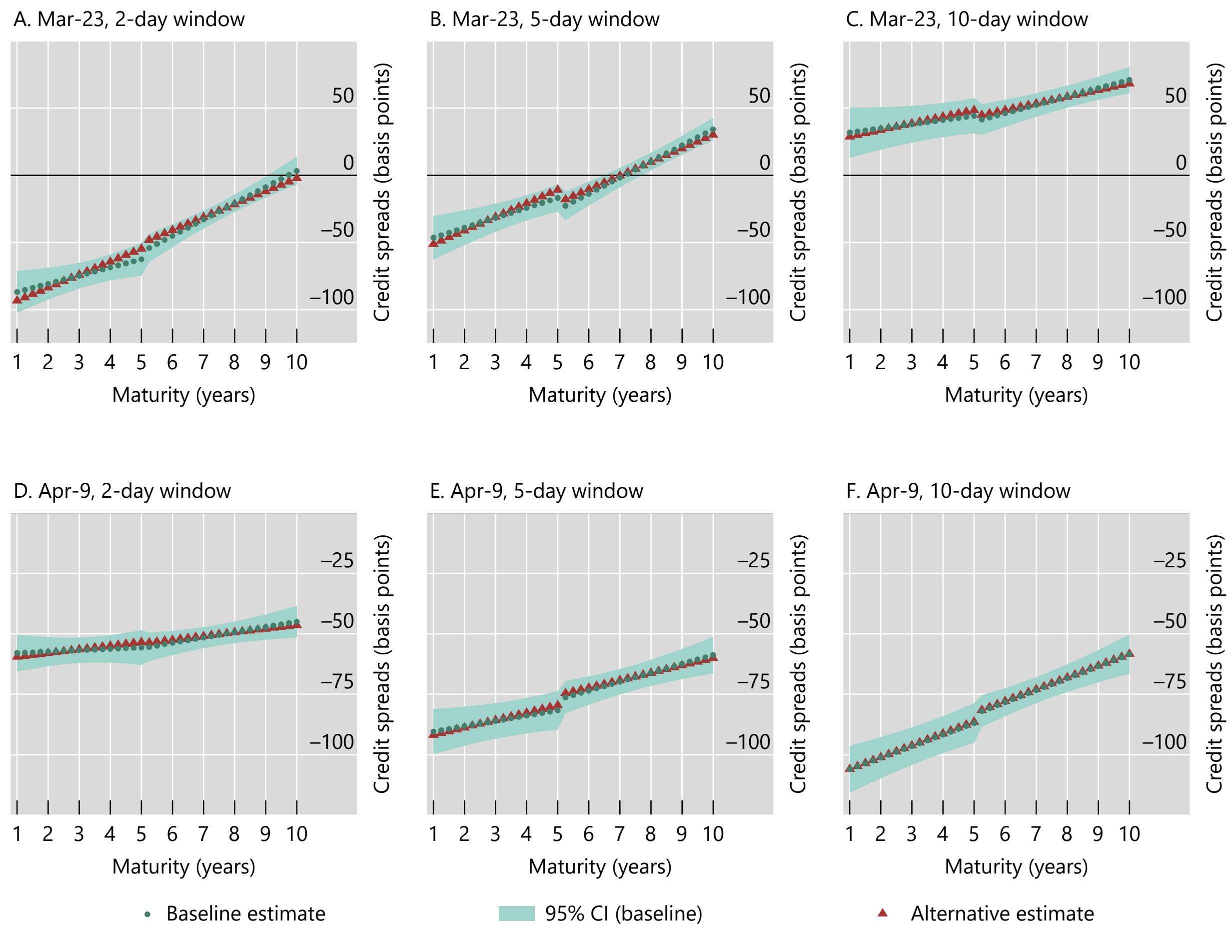
[22] Cesa-Bianchi and Eguren-Martin (2021) document a related "dash for dollars," by comparing the performance of U.S. dollar-denominated bonds with that of non-dollar bonds during the pandemic.

Table 6: The Impact of the SMCCF Announcements on the Corporate Bond Market
(Allowing for Shifts in the Slope of the Credit Curve)

	Mar-23 Announcement			Apr-9 Announcement		
	2-day	5-day	10-day	2-day	5-day	10-day
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
A. Credit spreads						
$\mathbb{1}[t \geq t^*]$	−0.99***	−0.72***	0.18	−0.62***	−0.91***	−1.07***
	(0.14)	(0.13)	(0.13)	(0.06)	(0.07)	(0.07)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$	−0.04	0.10	0.05	0.00	−0.04	−0.04
	(0.08)	(0.07)	(0.06)	(0.04)	(0.04)	(0.04)
$\mathbb{1}[t \geq t^*] \times \tau_{i,j,t}$	0.10***	0.10***	0.05***	0.02*	0.03***	0.05***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
R^2	0.72	0.67	0.62	0.91	0.89	0.88
No. of firms	492	539	552	509	546	560
No. of bonds	2,597	2,879	3,061	2,647	2,858	3,049
Observations	9,679	21,002	40,014	9,938	21,930	41,827
B. Credit Risk Premia						
$\mathbb{1}[t \geq t^*]$	−0.99***	−0.81***	0.04	−0.57***	−0.84***	−1.02***
	(0.16)	(0.15)	(0.15)	(0.06)	(0.08)	(0.08)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$	−0.05	0.12	0.03	−0.01	−0.05	−0.05
	(0.09)	(0.07)	(0.07)	(0.04)	(0.04)	(0.04)
$\mathbb{1}[t \geq t^*] \times \tau_{i,j,t}$	0.09***	0.11***	0.05***	0.01	0.03***	0.05***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
R^2	0.67	0.61	0.55	0.88	0.87	0.85
No. of firms	339	362	368	352	362	367
No. of bonds	1,825	1,950	2,028	1,826	1,924	2,012
Observations	7,321	15,850	30,014	7,311	16,208	31,095

Note: The dependent variable in Panel A is $\mathrm{CS}_{i,j,t}$, the credit spread of bond j (issued by firm i) on business day t, whereas in Panel B, the dependent variable is $\mathrm{RCS}_{i,j,t}$, the residual credit spread of bond j (issued by firm i) on business day t (see the text for details). The entries in the table denote the OLS estimates of coefficients associated with the specified explanatory variable: $\mathbb{1}[t \geq t^*] = 0/1$-indicator variable that equals one if date t is greater than or equal to the specified announcement date t^* and zero otherwise; $\mathbb{1}[j = E] = 0/1$-indicator variable that equals one if bond j was eligible for purchase by the SMCCF as of March 22 and zero otherwise; $\tau_{i,j,t}$ = bond j's remaining maturity. All specifications include a vector of bond-specific controls (not reported) and issuer fixed effects. Asymptotic standard errors reported in parentheses are clustered at the issuer level: * $p < .10$; ** $p < .05$; and *** $p < .01$.

Figure 5: Announcement Effects on the Investment-Grade Credit Curve



Note: The green dots in Panels A–C show the estimated baseline effects for the specified window of the Mar-23 announcement on credit spreads across maturities, whereas Panels D–F show the corresponding effects of the Apr-9 announcement; the shaded green bands in the panels represent the 95-percent confidence intervals associated with the baseline estimates of the announcement effects (see Table 6). The red triangles in the panels shows the alternative estimates of the two announcement effects, implied by the regression specification that allows the response of the spread-maturity slope to differ above and below the five-year program eligibility cutoff (see the text for details).
Source: Authors' calculations using TRACE date.

across maturities. In the two-day window following the March 23 announcement (Panel A), our estimates imply a reduction of nearly 100 basis points in credit spreads for bonds with a remaining maturity of one year and essentially zero impact on spreads of bonds with a remaining maturity of ten years. Moreover, the entire curve shifts noticeably higher and flattens somewhat as the estimation window lengthens (Panels B and C). In response to the April 9 announcement (Panels D–E), by contrast, both the level and slope effects grow stronger with the length of the estimation window. When summed up across the two announcements, our estimates based on the ten-day window imply an announcement-induced differential of about 100 basis points between bonds with remaining maturities of one and ten years.

The estimates shown in Figure 5 incorporate the SMCCF-eligibility effects through the possibility of a shift in the curve at the five-year maturity cutoff. However, one can clearly see that such shifts are not economically meaningful nor statistically significant. Moreover, the magnitude of any such effect is dwarfed by the magnitude of the differential response across the entire maturity spectrum.

Specification (3) imposes the restriction that an announcement can shift the position of the credit curve for bonds below the five-year maturity cutoff but does not allow for the change in the slope of the curve on either side of the cutoff. The red triangles plotted in Figure 5 show the estimated announcement effects when we relax this assumption. Specifically, these alternative estimates allow both the intercept and slope of the credit curve to respond differently, depending on whether the bonds' remaining maturities are above or below the five-year cutoff.

These estimates clearly indicate that neither announcement had a differential effect on the slope of the credit curve for the SMCCF-eligible bonds relative their ineligible counterparts. Rather, both announcements influenced credit spreads across the maturity continuum in a constant manner. This finding further confirms our earlier result, which showed no independent effect on credit spreads of the SMCCF-eligible bonds in response to either announcement.

All told, the results in Table 6 and Figure 5 indicate that once we control for the announcement-induced shifts in the slope of the credit curve, the SMCCF's maturity-eligibility criterion was for all practical purposes irrelevant for gauging the impact of the two announcements on the corporate bond market. The March 23 and April 9 announcements, likely in conjunction with other policies that were announced or enacted simultaneously, effectively stabilized conditions in corporate credit markets and ultimately restored the upward-sloping profile of the investment-grade credit curve. Whether a particular bond was or was not eligible for purchase by the facility appears to have had no additional effect on these outcomes.

3.3 Issuer Spillover Effects

The finding that program eligibility based on the maturity cutoff is largely irrelevant for assessing the impact of the SMCCF announcements on the corporate bond market is a puzzling result from the perspective of theories that emphasize a lack of substitutability across bonds with differing characteristics. One possible explanation for this result is that the maturity-eligibility criterion is too coarse of an indicator for whether a particular bond was likely to be purchased by the Fed and that investors quickly recognized that bonds of certain issuers were more likely to be purchased. Indeed, as noted above, the publication of the initial BML by the New York Fed on June 28 would be consistent with this hypothesis.

It is also possible that the effects from the wide array of emergency measures implemented by the Fed had a larger impact on the credit spreads of bonds issued by *companies* that were likely to be purchased, as opposed to on the spreads of *bonds* that were likely to be purchased. Such a scenario, for example, would occur if the investors viewed the announcements as promises to support issuers (or groups of issuers in certain industries) rather than the holders of eligible securities of such issuers. In this case, the announcements would affect prices of all bonds of a given issuer—a spillover effect—rather than just prices of their SMCCF-eligible bonds.

To investigate these hypotheses, we replace the maturity-eligibility criterion with the requirement that bonds have a remaining maturity of less than or equal to five years and were issued by companies whose bonds were eventually purchased by the facility once it commenced with purchases of individual corporate bonds on June 16. In particular, we re-estimate specification (3), but interact the SMCCF-eligibility indicator $\mathbb{1}[j = E]$ with a 0/1-indicator $\mathbb{1}[i = P]$, which equals one if issuer i had outstanding bonds that were eventually purchased by the SMCCF and zero otherwise; we also include separately the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[i = P]$ to determine whether the announcements had an effect on credit spreads of all bonds of such issuers, rather than only on the spreads of their eligible bonds. Specifically, we estimate

$$\begin{aligned} \mathrm{CS}_{i,j,t} = \beta_1 \mathbb{1}[t \geq t^*] &+ \beta_2 \big(\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]\big) + \beta_3 \big(\mathbb{1}[t \geq t^*] \times \tau_{i,j,t}\big) \\ &+ \beta_4 \big(\mathbb{1}[t \geq t^*] \times \mathbb{1}[i = P]\big) + \beta_5 \big(\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E] \times \mathbb{1}[i = P]\big) \\ &+ \theta' \mathbf{X}_{i,j,t} + \eta_i + \epsilon_{i,j,t}. \end{aligned} \tag{4}$$

In this specification, the coefficient β_4 measures the announcement-induced spillover effect across all bonds of an issuer whose eligible bonds were ultimately purchased by the SMCCF. In the immediate wake of the announcements, investors, of course, did not know whether or not a given issuer's eligible bonds were going to be purchased by the facility. We therefore develop an IV strategy based on ex ante information that was available to investors at the time of the announcements and was highly informative of the extent to which eligible bonds of a given issuer were likely to be purchased by the facility.

We do so by first constructing a set of issuer-specific pre-pandemic characteristics and use them to predict whether an issuer had bonds outstanding that were ultimately purchased by the facility. Specifically, we estimate a logit model for the event $\mathbb{1}[i = P]$, using a set of time-invariant pre-pandemic issuer characteristics, denoted by $\mathbf{Z}_i$, as explanatory variables.[23] Using the resulting parameter estimates, we then construct the fitted values of this event, denoted by $\hat{P}_i$, which provide an estimate of the ex ante likelihood that issuer i's eligible bonds were purchased by the SMCCF. These predicted values—interacted with the announcement and the SMCCF-eligibility indicators—then provide a full set of instruments for the terms involving $\mathbb{1}[i = P]$ in regression (4).[24]

We compute the issuer-specific characteristics using daily TRACE data from January 1 to Febru-

[23] In related work, Flanagan and Purnanandam (2020) examine which bond and issuer characteristics as of June 2020—that is, characteristics observed after the March 23 and April 9 announcements—were informative of the likelihood of having had eligible securities purchased by the SMCCF over the subsequent weeks. They document that the facility purchased bonds that became highly information sensitive during the pandemic, bonds used as collateral in the repo market by primary dealers, and bonds held by corporate bond mutual funds. According to their results, the facility did not purchase eligible bonds issued by companies that were especially hard hit by the pandemic or those issued by firms with a large employee base.

[24] Alternatively, we could use $\hat{P}_i$ in place of $\mathbb{1}[i = P]$ in the regression. This approach, however, would create a generated-regressor problem, complicating the associated statistical inference. Using $\hat{P}_i$ as an instrument avoids such complications and implies that the 2SLS estimation of equation (4) will yield correct standard errors.

Table 7: Ex Ante Determinants of Having Eligible Bonds Purchased by the SMCCF

Explanatory Variables	(1)	(2)	(3)	(4)	(5)
FREQ_i	0.18***				0.15***
	(0.01)				(0.01)
$\ln \text{PAR}_i$		0.40***			0.11***
		(0.03)			(0.03)
$\ln \text{TVOL}_i$			0.15***		0.07***
			(0.01)		(0.01)
MTY_i				0.01*	−0.02***
				(0.00)	(0.00)
Pseudo R^2	0.30	0.18	0.13	0.01	0.39

Note: Sample: 574 firms. The dependent variable in all cross-sectional logit specification is $\mathbb{1}[i = P]$, a 0/1-indicator that equals one if issuer i had eligible bonds purchased by the SMCCF and zero otherwise. The entries in the table denote the estimates of the marginal effects on the specified explanatory variable: FREQ_i = average trading frequency of issuer i's outstanding bonds; PAR_i = average par value of issuer i's outstanding bonds; TVOL_i = average trading volume of issuer i's outstanding bonds; and MTY_i = average remaining maturity of issuer i's outstanding bonds. All issuer-specific characteristics are based on averages of daily data over the Jan-1 – Feb-28, 2020, period. All specifications include a constant (not reported) and are estimated by maximum likelihood. Robust asymptotic standard errors are reported in parentheses: * $p < .10$; ** $p < .05$; and *** $p < .01$.

ary 28, 2020. These pre-pandemic (time-invariant) characteristics include the average par value of issuer i's traded bonds (PAR_i); the average frequency at which issuer i's bonds traded over this period (FREQ_i); the total transaction volume of bonds that were traded during this period (TVOL_i); and the average remaining maturity of the traded bonds (MTY_i).[25]

Table 7 contains the estimation results from a cross-sectional logit regression, using the 0/1-indicator $\mathbb{1}[i = P]$ as the dependent variable. In columns (1)–(4), we report the estimated marginal effects for specifications in which each explanatory variable enters separately. According to these estimates, the probability of having had eligible bonds purchased by the SMCCF is increasing in the average par value of bonds that were traded in the secondary market before the pandemic (column 1), as well as in the average trading frequency and the total volume of those transactions (columns 2–3).

Judging by the pseudo R^2, the average pre-pandemic trading frequency of the issuer's bonds is most informative of the likelihood of having had bonds purchased by the facility; this is followed by the average size of the outstanding issues and the total trading volume. Interestingly, the average remaining maturity of the issuer's outstanding bonds before the pandemic has an economically small and imprecisely estimated effect on this probability (column 4), despite the fact that the

[25] We considered additional issuer characteristics to predict the likelihood of having had eligible securities purchased by the SMCCF. Interestingly, variables such as an indicator for whether a firm is publicly listed, the issuer's average pre-pandemic credit rating, the average pre-pandemic credit and bid-ask spreads did not add predictive value. Moreover, within a subsample of publicly listed firms, we can also considered firm size (measured by the firm's total assets) and its riskiness (measured by the firm's average pre-pandemic distance-to-default); again, these variable did not contain any marginal predictive power for the likelihood that the firm's eligible bonds were ultimately purchased by the facility.

facility—when announced—targeted bonds with a remaining maturity of five years or less; moreover, the explanatory power of this explanatory variable is very low. Together, these results suggest that the pre-pandemic maturity structure of the issuer's outstanding bonds was not an important determinant of whether the facility ultimately purchased the issuer's eligible securities.

When considered jointly (column 5), these pre-pandemic issuer characteristics are highly informative of the likelihood that the issuer had their eligible bonds purchased by the SMCCF. In our IV approach, we use the fitted values from this specification as an instrument for $\mathbb{1}[i = P]$, an indicator of whether issuer i's eligible bonds were actually purchased by the facility.

Table 8 contains the results from the 2SLS estimation of regression (4) using credit spreads as the dependent variable. In Panel A, we report results from a specification that omits the maturity interaction term, making these IV estimates of the announcement effects directly comparable to their corresponding OLS estimates shown in Panel A of Table 4. According to these results, our IV approach—which imposes a stricter identifying assumption that bonds be both eligible and were issued by companies whose bonds were eventually purchased, as opposed to using only the maturity-eligibility indicator—produce, on balance, somewhat larger (in absolute terms) estimates of the announcement effects on the credit spreads of the SMCCF-eligible bonds. For example, the sum of the announcement effects based on the ten-day window implies a cumulative reduction of 48 basis points in credit spreads for eligible bonds, compared with a reduction of 44 basis points based on the estimates reported in Panel A of Table 4.

In other words, our IV estimates also imply an economically and statistically significant narrowing of credit spreads on the SMCCF-eligible bonds, relative to their ineligible counterparts, in response to both announcements. It is also worth noting that our IV approach does not suffer from a "weak instruments" problem, as evidenced by the uniformly high first-stage F-statistics across all specifications.

Although our refinement does not substantially alter the estimated coefficients on treated bonds, it does reveal an unexpected aspect of the announced program. In particular, the March 23 announcement had a significant impact on the credit spreads of *all* bonds issued by companies whose eligible securities were ultimately purchased by the facility, an effect captured by the coefficient β_4 on the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[i = P]$. Note that the ten-day post-announcement effect (column 3) implies an *increase* of 132 basis points in the average credit spread, a tightening of broad financial conditions that is puzzling given the market's initial perception of the scale and scope of the Fed's intervention. However, for bonds issued by companies whose eligible securities were ultimately purchased by the SMCCF, there is an off-setting decline of 85 basis points within that window. This implies that the run-up in credit spreads following the March 23 announcement was due almost entirely to a spike in spreads on bonds—irrespective of their SMCCF eligibility—issued by companies that investors thought were unlikely to be covered by the program.

Panel B of Table 8 contains the IV estimation results that allow for a post-announcement shift in the slope of the credit curve (these estimates should be compared to their corresponding OLS estimates reported in Panel A of Table 6). Once the maturity interaction term is included in the

TABLE 8: The Impact of the SMCCF Announcements on Credit Spreads – IV Estimates

	Mar-23 Announcement			Apr-9 Announcement		
	2-day	5-day	10-day	2-day	5-day	10-day
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
A. Baseline specification						
$\mathbb{1}[t \geq t^*]$	−0.23	0.43**	1.32***	−0.53***	−0.85***	−0.74***
	(0.22)	(0.20)	(0.25)	(0.13)	(0.14)	(0.10)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[i = P]$	−0.06	−0.43	−0.85***	0.04	0.19	0.04
	(0.24)	(0.22)	(0.29)	(0.15)	(0.16)	(0.13)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E] \times \mathbb{1}[i = P]$	−0.48***	−0.37***	−0.19***	−0.09***	−0.20***	−0.29***
	(0.05)	(0.05)	(0.05)	(0.03)	(0.03)	(0.03)
First-stage F-statistic	65.74	50.06	48.41	150.60	171.62	168.65
B. Controlling for Maturity						
$\mathbb{1}[t \geq t^*]$	−0.77***	−0.06	1.14***	−0.55***	−0.98***	−0.95***
	(0.27)	(0.20)	(0.25)	(0.11)	(0.13)	(0.10)
$\mathbb{1}[t \geq t^*] \times \tau_{i,j,t}$	0.10***	0.10***	0.04***	0.00	0.03***	0.04***
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[i = P]$	−0.30	−0.68***	−0.95***	0.04	0.13	−0.07
	(0.23)	(0.23)	(0.30)	(0.16)	(0.17)	(0.13)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E] \times \mathbb{1}[i = P]$	0.00	0.08	−0.02	−0.08	−0.08	−0.08
	(0.11)	(0.07)	(0.07)	(0.05)	(0.05)	(0.05)
First-stage F-statistic	62.14	45.68	43.79	143.05	158.61	156.65
			Panel Dimensions			
No. of firms	492	539	552	509	546	560
No. of bonds	2,597	2,879	3,061	2,647	2,858	3,049
Observations	9,679	21,002	40,014	9,938	21,930	41,827

NOTE: The dependent variable in Panels A and B is $\text{CS}_{i,j,t}$, the credit spread of bond j (issued by firm i) on business day t. The entries in the table denote the 2SLS estimates of coefficients associated with the specified explanatory variable: $\mathbb{1}[t \geq t^*] = 0/1$-indicator variable that equals one if date t is greater than or equal to the specified announcement date t^* and zero otherwise; $\mathbb{1}[j = E] = 0/1$-indicator variable that equals one if bond j was eligible for purchase by the SMCCF as of March 22 and zero otherwise; $\mathbb{1}[i = P] = 0/1$-indicator variable that equals one if eligible bonds of issuer i were purchased by the SMCCF and zero otherwise; and $\tau_{i,j,t}$ = bond j's remaining maturity. The interaction terms involving $\mathbb{1}[i = P]$ are instrumented with the corresponding interaction terms in which $\mathbb{1}[i = P]$ is replaced with $\hat{P}_i$, the fitted probability that issuer i had eligible bonds purchased by the SMCCF, based on the pre-pandemic issuer-specific characteristics (see Table 7 and the text for details). All specifications include a vector of bond-specific controls (not reported) and issuer fixed effects. Asymptotic standard errors reported in parentheses are clustered at the issuer level: * $p < .10$; ** $p < .05$; and *** $p < .01$.

specification, the estimates of β_5, the coefficient on the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E] \times \mathbb{1}[i = P]$ that captures the effect of the announcements on eligible bonds, become economically and statistically insignificant in all estimation windows. The estimates of β_3, the coefficient on the maturity interaction term $\mathbb{1}[t \geq t^*] \times \tau_{i,j,t}$, are again positive, economically large, and statistically significant. Moreover, they imply very similar estimates of the slope of the credit curve to what is shown in Figure 5. These results again highlight the fact that the overall effect of the two announcements was to undo the pandemic-induced inversion of the credit curve, rather than to compress credit spreads of the SMCCF-eligible bonds relative to those of their ineligible counterparts.

At the same time, we see significant spillover effects of the March 23 announcement across all bonds issued by companies whose eligible securities were eventually purchased by the program. In fact, controlling for the announcement-induced shifts in the credit curve yields notably larger spillover effects. Within the five-day window, for example, the estimate of β_4, the coefficient on the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[i = P]$, is -0.68 when the maturity interaction term is included in the specification (column 2 of Panel B), compared with -0.43 when we do not control for the announcement-induced shifts in the credit curve (column 2 of Panel A). The estimates in Panel B imply that while credit spreads, on average, *increased* 114 basis points in the ten days following the March 23 announcement, this widening was largely undone for bonds of issuers whose eligible securities were eventually purchased by the SMCCF.

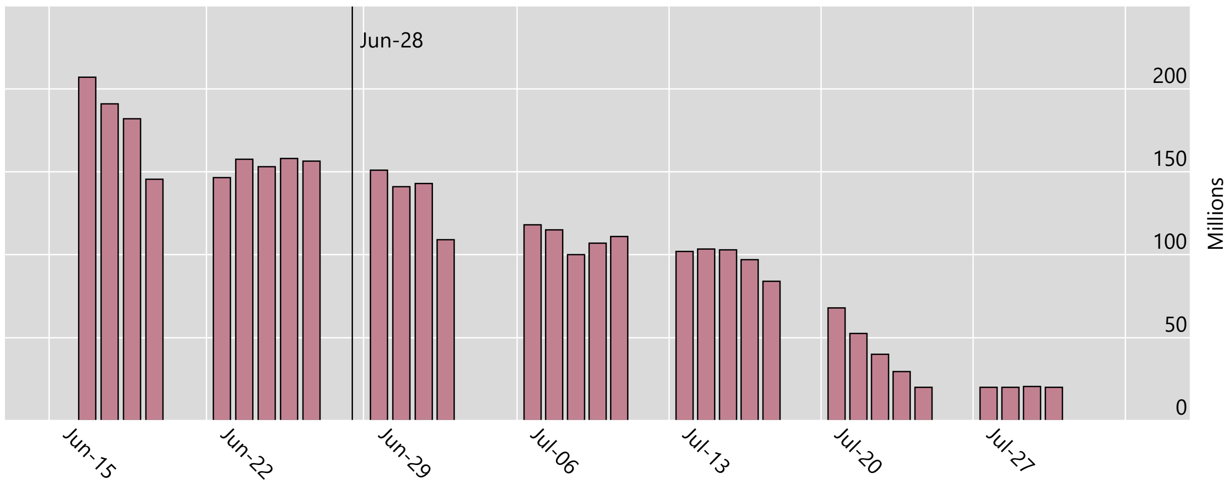
In summary, although the March 23 and April 9 announcements did not lead to a significant difference in the movement of credit spreads on treated bonds relative to those in the control group, as defined by the maturity-eligibility cutoff, they arguably had a much broader impact through their effects on the slope of the investment-grade credit curve. These announcement-induced slope effects were not limited to bonds with a remaining maturity below the five-year maturity cutoff, as they compressed credit spreads across the entire maturity spectrum. Furthermore, the March 23 announcement induced a distinct bifurcation in credit spreads on bonds issued by companies that had their eligible securities ultimately purchased by the facility, relative to spreads on bonds issued by companies that were never included in the program.

4 The SMCCF's Purchase Effects

The previous section has focused on the impact of the two corporate bond-buying program announcements on credit and bid-ask spreads. As noted above, the Fed started to purchase individual corporate bonds on June 16, 2020. Figure 6 shows the dollar amount of corporate bonds purchased by the facility between June 16 and the end of July of 2020. In the latter half of June, the SMCCF purchased about \$150 million of corporate bonds during an average day. The average pace of purchases tapered off to about \$100 million per day during the first half of July and to only \$20 million by the end of July.

To identify the impact of these purchases, we utilize the *intra-day* TRACE transactions between June 16 and July 31 to identify the Fed's purchases of individual bonds. By matching the bond's

Figure 6: SMCCF's Purchases of Corporate Bonds



Note: The vertical bars show the total daily dollar amount of individual corporate bonds purchased by the SMCCF between Jun-15 and Jul-30. The vertical line at Jun-28 indicates the day that the Federal Reserve Bank of New York released the first detailed composition of its purchases.
Source: Authors' calculation using TRACE data and data from the Federal Reserve Bank of New York.

CUSIP, purchase date and time, transaction price and quantity in dealer-to-customer transactions, we are able to identify almost all of the Fed's purchases of individual corporate bonds during this period.[26] Using the exact time of each purchase, we perform a simple intra-day event study, whose major advantage is that we are able to estimate a precise average purchase effect.

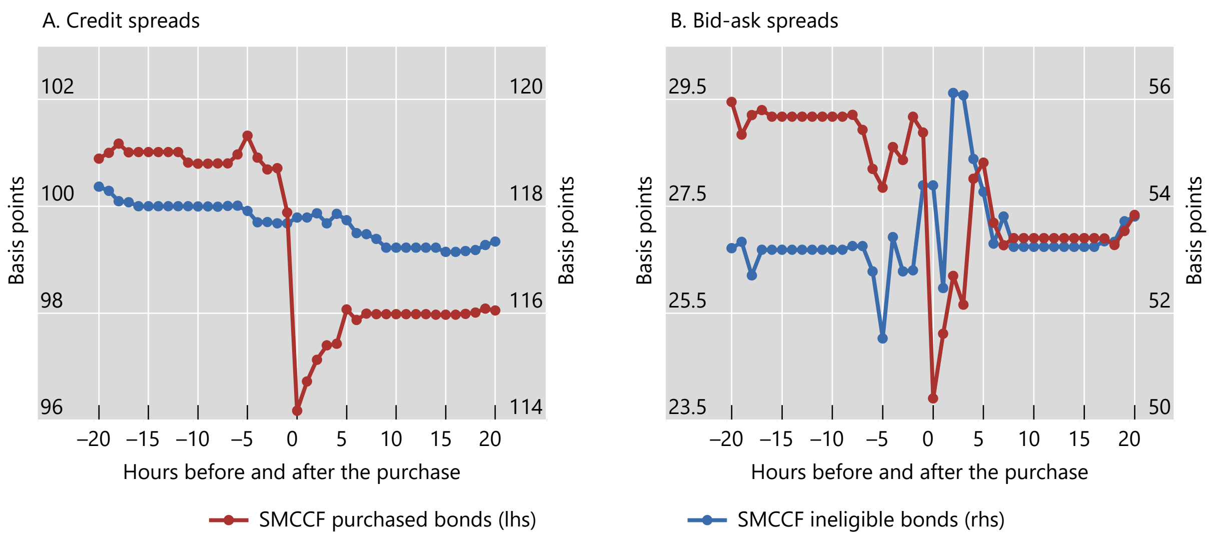
The red line in the left panel of Figure 7 shows the average credit spread on bonds purchased by the SMCCF within the event window that spans 20 hours before and 20 hours after the purchase time, which is normalized to be equal to zero. According to this figure, the credit spread on an average purchased bond declined about five basis points upon the actual purchase. Over the subsequent six hours, the spread edged up about two basis points before stabilizing over the remainder of the event window for a net decline of about three basis points. The blue line shows the corresponding average spread in the control group—that is, bonds issued by the same set of issuers but whose remaining maturity is greater than five years.[27] Interestingly, the actual purchases appear to have also had a delayed effects on the credit spreads of ineligible bonds, though this effect is very small, a mere basis point or so.

The right panel of Figure 7 shows the same event study for the bid-ask spreads. Though

[26]We identify all of the facility's 1,351 purchases, except for a single purchase on June 29; this transaction involved the bond with CUSIP 126650CT5, issued by the CVS Health Corporation, which had two matches at slightly different times: 11:33:39 a.m. and 11:59:12 a.m. We dropped this transaction from the analysis.

[27]As before, we construct the control group by pairing each bond purchased by the SMCCF—the treatment group—with a bond issued by the same company but whose remaining maturity is greater than five years. There are 482 unique issuers in our treatment group. If an issuer has multiple bonds purchased by the SMCCF, we choose the bond with remaining maturity as close to five years as possible. Similarly, if there are multiple bonds that can be paired up with a given bond purchased by the SMCCF, we choose the bond with a remaining maturity as close to five years as possible.

FIGURE 7: The Impact of the SMCCF's Corporate Bond Purchases



NOTE: The red line in Panel A shows the average credit spread on bonds purchased by the SMCCF in a symmetric 20-hour window bracketing their purchases, the times of which are normalized to equal zero; the blue line shows the corresponding average credit spread on the SMCCF-ineligible bonds issued by the same set of issuers. The corresponding lines in Panel B show the average bid-ask spreads for the same two groups of bonds.
SOURCE: Authors' calculations using TRACE date and data from the Federal Reserve Bank of New York.

considerably more noisy, the average bid-ask spread on bonds actually purchased by the SMCCF (the red line) is estimated to have declined about five basis points upon purchase before bouncing back over the subsequent several hours. The average bid-ask spread on bonds in the control group (the blue line), by contrast, shows no discernible pattern around the purchase time. In combination with the results presented above, it is clear that the vast majority of the SMCCF's impact on the corporate bond market is due to the announcement effects, which occurred well before the Fed directly intervened in the market.

5 Conclusion

In this paper, we quantify the effects of the SMCCF on the U.S. corporate bond market. Using a matched sample of program-eligible and ineligible securities trading in the secondary market—with both types of securities issued by the same company—and a DiD methodology, we isolate and estimate the direct effects of the program announcements on corporate bond prices and market liquidity measures. We document that the March 23 and April 9 announcements were very effective in alleviating the pandemic-related strains by significantly reducing credit spreads. Using the same approach, we also document a significant improvement in market liquidity, as measured by the decline in bid-ask spreads, in response to the March 23 announcement. Our results also indicate the announcement-induced narrowing of credit spreads is due almost entirely to a reduction in credit risk premia, rather than to a reduction in the likelihood of default.

The paper also delineates what we consider to be the key impact of the two announcements: the restoration of the normal upward-sloping term structure of credit risk in the investment-grade segment of the market, as opposed to the announcements having a differential effect on the prices of eligible and ineligible securities. We show that the two announcements had a disproportionately large effect on credit spreads of all shorter-maturity bonds—a segment of the market where the pandemic-induced dislocations were especially severe—and on credit spreads of bonds, irrespective of their eligibility, issued by companies that investors ex ante thought were likely going to covered by the program. Consistent with the theoretical framework proposed by Hanson et al. (2020), our results thus imply that the primary effect of the announcements was to restore investor confidence and improve market sentiment, in the process making it substantially easier for companies to borrow in the corporate bond and other debt markets.

An intra-day event study of the actual bond purchases conducted by the Fed from mid-June through the end of July of 2020 shows that credit spreads narrowed, on average, by only five basis points upon purchase; the average decline in bid-ask spreads was even smaller, a mere two basis points. In other words, the vast majority of the SMCCF's impact on the corporate bond market occurred before the Fed actually bought anything.

More generally, our findings shed light on the potential transmission channels of such credit easing policies, which in recent years have been implemented by all major central banks. Under one such channel, the so-called portfolio balance channel, the central bank's purchases of corporate bonds replace corporate bond holdings held by the private sector with bank reserves. As long as corporate debt and bank reserves are not perfect substitutes, as would be the case in the preferred habitat framework of Vayanos and Vila (2009), the central bank's actual and expected purchases can lower corporate bond credit spreads by reducing risk premia.

One immediate implication of this transmission channel is that we should see a larger decline in credit spreads on longer-maturity bonds because purchases of longer-maturity bonds, holding everything else constant, remove more duration risk from the market and thus should induce a greater decline in risk premia. This implication, however, is not consistent with our findings, which show that the Fed's announcements had a disproportionately large effect on credit spreads of shorter-maturity bonds. Our findings, therefore, are more consistent with the so-called signalling channel, whereby the Fed's announcement of a corporate bond-buying program, by sending a credible "whatever it takes" message, effectively forestalls fire sales and stabilizes conditions in the market.

References

Adelino, M., M. A. Ferreira, M. Giannetti, and P. Pires (2020): "Trade Credit and the Transmission of Unconventional Monetary Policy," NBER Working Paper No. 27077.

Augustin, P., V. Sokolovski, M. G. Subrahmanyam, and D. Tomio (2021): "In Sickness and in Debt: The COVID-19 Impact on Sovereign Credit Risk," Forthcoming in the *Journal of Financial Economics.* Available at https://doi.org/10.1016/j.jfineco.2021.05.009.

Bahaj, S. and R. Reis (2020): "Central Bank Swap Lines during the Covid-19 Pandemic," Covid Economics 2.

Bharath, S. T. and T. Shumway (2008): "Forecasting Default with the Merton Distance to Default Model," *Review of Financial Studies*, 21, 1339–1369.

Bi, H. and B. W. Marsh (2020): "Flight to Liquidity or Safety? Recent Evidence from the Municipal Bond Market," Federal Reserve Bank of Kansas City Working Paper No. 20-19.

Boyarchenko, N., A. Kovner, and O. Shachar (2020): "It's What You Say and What You Buy: A Holistic Evaluation of the Corporate Credit Facilities," Staff Report No. 935, Federal Reserve Bank of New York.

Brunnermeier, M. and A. Krishnamurthy (2020): "Corporate Debt Overhang and Credit Policy," Forthcoming in the *Brookings Papers on Economic Activity*.

Cameron, A. C., J. B. Gelbach, and D. L. Miller (2011): "Robust Inference with Multi-Way Clustering," *Journal of Business and Economic Statistics*, 29, 238–249.

Cesa-Bianchi, A. and F. Eguren-Martin (2021): "Dash for Dollars," Bank of England Working Paper No. 932.

Clarida, R. H., B. Duygan-Bump, and C. Scotti (2021): "The COVID-19 Crisis and the Federal Reserve's Policy Response," Finance and Economics Discussion Series 2021-035. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2021.035.

Cox, J., D. L. Greenwald, and S. C. Ludvigson (2020): "What Explains the COVID-19 Stock Market?" NBER Working Paper No. 27784.

D'Amico, S., V. Kurakula, and S. Lee (2020): "Impacts of the Fed Corporate Credit Facilities through the Lenses of ETFs and CDX," Federal Reserve Bank of Chicago Working Paper No. 2020-14.

Dick-Nielsen, J. and T. K. Poulsen (2019): "How to Clean Academic TRACE Data," Available at SSRN: https://ssrn.com/abstract=3456082 or http://dx.doi.org/10.2139/ssrn.3456082.

Duffie, D. (2020): "Still the World's Safe Haven? Redesigning the U.S. Treasury Market After the COVID-19 Crisis," Hutchins Center Working Paper No. 62, Brookings Institution.

D'Amico, S. and I. Kaminska (2019): "Credit Easing versus Quantitative Easing: Evidence from Corporate and Government Bond Purchase Programs," Bank of England Working Paper No. 825.

Falato, A., I. Goldstein, and A. Hortaçsu (2021): "Financial Fragility in the COVID-19 Crisis: The Case of Investment Funds in Corporate Bond Markets," Forthcoming in the *Journal of Monetary Economics.* Available at https://www.sciencedirect.com/science/article/pii/S0304393221000751.

Flanagan, T. and A. Purnanandam (2020): "Corporate Bond Purchases After COVID-19: Who Did the Fed Buy and How Did the Markets Respond?" Available at SSRN: https://ssrn.com/abstract=3668342.

Fleming, M. J. and F. Ruela (2020): "Treasury Market Liquidity During the COVID-19 Crisis," Liberty Street Economics 20200417, Federal Reserve Bank of New York.

Gilchrist, S. and E. Zakrajšek (2012): "Credit Spreads and Business Cycle Fluctuations," *American Economic Review*, 102, 1692–1720.

Gormsen, N. and R. S. Koijen (2020): "Coronavirus: Impact on Stock Prices and Growth Expectations," *Review of Asset Pricing Studies*, 10, 574–597.

Grosse-Rueschkamp, B., S. Steffen, and D. Streitz (2019): "A Capital Structure Channel of Monetary Policy," *Journal of Financial Economics*, 133, 357–378.

Gürkaynak, R. S., B. Sack, and J. H. Wright (2007): "The U.S. Treasury Yield Curve: 1961 to the Present," *Journal of Monetary Economics*, 54, 2291–2304.

Haddad, V., A. Moreira, and T. Muir (2021): "When Selling Becomes Viral: Disruptions in Debt Markets in the COVID-19 Crisis and the Fed's Response," Forthcoming in the *Review of Financial Studies.* Available at https://doi.org/10.1093/rfs/hhaa145.

Hanson, S. G., J. C. Stein, A. Sunderam, and E. Zwick (2020): "Business Credit Programs in the Pandemic Era," Forthcoming in the *Brookings Papers on Economic Activity.*

He, Z., S. Nagel, and Z. Song (2021): "Treasury Inconvenience Yields During the COVID-19 Crisis," Forthcoming in the *Journal of Financial Economics.* Available at https://doi.org/10.1016/j.jfineco.2021.05.044.

Kargar, M., B. Lester, D. Lindsay, S. Liu, P.-O. Weill, and D. Zuniga (2021): "Corporate Bond Liquidity During the COVID-19 Crisis," Forthcoming in the *Review of Financial Studies.* Available at https://doi.org/10.1093/rfs/hhab063.

Kruttli, M. S., P. J. Monin, L. Petrasek, and S. W. Watugala (2021): "Hedge Fund Treasury Trading and Funding Fragility: Evidence from the COVID-19 Crisis," Finance and Economics Discussion Series 2021-038. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2021.038.

Li, T. and J. Lu (2020): "Municipal Finance During the COVID-19 Pandemic: Evidence from Government and Federal Reserve," Available at SSRN: https://ssrn.com/abstract=3637636.

Liang, J. N. (2020): "Corporate Bond Market Dysfunction During COVID-19 and Lessons from the Fed's Response," Hutchins Center Working Paper No. 69, Brookings Institution.

Ma, Y., K. Xiao, and Y. Zeng (2020): "Mutual Fund Liquidity Transformation and Reverse Flight to Liquidity," Columbia Business School Working Paper (August 5, 2020).

Merton, R. C. (1974): "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance*, 29, 449–470.

Nozawa, Y. and Y. Qiu (2021): "Corporate Bond Market Reactions to Quantitative Easing During the COVID-19 Pandemic," Forthcoming in the *Journal of Banking and Finance*. Available at SSRN: http://dx.doi.org/10.2139/ssrn.3579346.

O'Hara, M. and X. Zhou (2021): "Anatomy of a Liquidity Crisis: Corporate Bonds in the Covid-19 Crisis," Forthcoming in the *Journal of Financial Economics.* Available at SSRN: https://ssrn.com/abstract=3615155.

Sastry, P. (2018): "The Political Origins of Section 13(3) of the Federal Reserve Act," *Economic Policy Review, Federal Reserve Bank of New York*, 24, 1–33.

Schrimpf, A., H. S. Shin, and V. Sushko (2020): "Leverage and Margin Spirals in Fixed Income Markets During the COVID-19 Crisis," BIS Bulletin No. 2.

Suganuma, K. and Y. Ueno (2018): "The Effects of the Bank of Japan's Corporate and Government Bond Purchases on Credit Spreads," IMES Working Paper 2018-E-4. Bank of Japan, https://www.imes.boj.or.jp.

Todorov, K. (2020): "Quantify the Quantitative Easing: Impact on Bonds and Corporate Debt Issuance," *Journal of Financial Economics*, 135, 340–358.

Vayanos, D. and J. Vila (2009): "A Preferred-Habitat Model of the Term Structure of Interest Rates," NBER Working Paper No. 15487.

Wei, B. and V. Z. Yue (2020): "The Federal Reserve's Liquidity Backstops to the Municipal Bond Market during the COVID-19 Pandemic," Federal Reserve Bank of Atlanta's Policy Hub.

Supplementary Material

This section contains two appendixes. In Appendix A, we use the DiD methodology to quantify the announcement effects on the credit and bid-ask spreads of the so-called fallen angels. In Appendix B, we provide details regarding the construction of the residual credit spreads, that is, our proxy for the credit risk premia.

A Fallen Angels

Unlike the "whatever it takes" message implied by the March 23 announcement, the April 9 announcement primarily clarified a number of key aspects of the Fed's corporate bond-buying program. Most importantly, it extended the facility to certain fallen angels, in effect signaling to the market the Fed's willingness to take on a potentially significant amount of credit on its balance sheet. In this section, we zero in on this aspect of the April 9 announcement and examine its impact on the fallen angels' credit and bid-ask spreads.

To do so, we modify the baseline DiD specification (1) by an additional interaction term involving $\mathbb{1}[i = \text{FA}]$, a 0/1-indicator that equals one if issuer i is an eligible fallen angel and zero otherwise.[28] Specifically, we use our treatment and control groups to estimate

$$\begin{aligned} Y_{i,j,t} = \beta_1 \mathbb{1}[t \geq t^*] + \beta_2\big(\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]\big) + \beta_3\big(\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E] \times \mathbb{1}[i = \text{FA}]\big) \\ + \theta' \mathbf{X}_{i,j,t} + \eta_i + \epsilon_{i,j,t}. \end{aligned} \tag{A-1}$$

Because specification (A-1) includes issuer fixed effects, the indicator variable $\mathbb{1}[i = \text{FA}]$ is not separately identified.

To gauge the effects of the two announcements on the eligible fallen issuers, we focus on companies rated investment grade as of March 22, but which were downgraded to the eligible fallen angel category between March 23 and April 9. We identified 14 such companies, and they were all downgraded withing a couple of days of the March 23 announcement. To facilitate the comparison of the March 23 and April 9 announcement effects, we thus consider symmetric five-day event windows bracketing each announcement.

The results of this exercise are reported in Table A-1. According to the entries in column (1), the estimate of β_3, the coefficient on the interaction term $\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E] \times \mathbb{1}[i = \text{FA}]$, is positive, economically large, and statistically significant. The point estimate of 3.42 implies that credit spreads on the SMCCF-eligible bonds issued by fallen angels *increased* about 340 basis points relative to their non-eligible counterparts in response to the March 23 announcement.

This large estimated differential increase in credit spreads in response to the March 23 announcement likely reflects the confluence of two factors. First, the actual downgrade to junk status would, all else equal, lead to an increase in credit spreads in both the treatment and control groups. The much larger estimated increase in credit spreads on the fallen angels' treated bonds is likely due to investors' perception that the increase in default risk that led to the downgrade was heavily concentrated in the near term. Second, following the downgrade, the fallen angels' SMCCF-eligible bonds were no longer eligible for purchase by the facility. The loss of program eligibility for bonds in the treatment group would additionally drive up their credit spreads relative to their counterparts in the control group. Both factors—the increase in the near-term risk of default and the loss of bonds' eligibility status—could thus induce a differential effect between the fallen angels' credit spreads in the treatment and control groups.

[28] According to the SMCCF's term sheet, an eligible fallen angel is a U.S. company that had an investment-grade credit rating as of March 22 but was subsequently downgraded to junk. However, the fallen angel's credit rating still had to be at least Ba3/BB- as of the date on which the facility purchased their eligible bonds.

TABLE A-1: The Impact of the SMCCF Announcements on Fallen Angels
(DiD Estimates Based on the Full Sample, Five-Day Window)

	Credit Spreads		Bid-Ask Spreads	
	Mar-23	Apr-9	Mar-23	Apr-9
Explanatory Variables	(1)	(2)	(3)	(4)
$\mathbb{1}[t \geq t^*]$	0.05	-0.69^{***}	-0.25^{***}	-0.20^{***}
	(0.03)	(0.02)	(0.04)	(0.03)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E]$	-0.25^{***}	-0.16^{***}	-0.14^{*}	-0.00
	(0.04)	(0.03)	(0.06)	(0.05)
$\mathbb{1}[t \geq t^*] \times \mathbb{1}[j = E] \times \mathbb{1}[i = \mathrm{FA}]$	3.42^{***}	-1.19^{**}	0.73^{***}	-0.18
	(1.02)	(0.57)	(0.06)	(0.09)
R^2	0.70	0.90	0.12	0.32
Observations	8,656	9,106	4,134	4,904

NOTE: The dependent variable specifications reported in columns (1) and (2) is $\mathrm{CS}_{i,j,t}$, the credit spread of bond j (issued by firm i) on business day t, while in columns (3) and (4), the dependent variables is $\ln \mathrm{BAS}_{i,j,t}$, the log of the corresponding bid-ask spread. The entries in the table denote the OLS estimates of coefficients on the specified explanatory variable: $\mathbb{1}[t \geq t^*]$ = 0/1-indicator variable that equals one if date t is greater than or equal to the specified announcement date t^* and zero otherwise; $\mathbb{1}[j = E]$ = 0/1-indicator variable that equals one if bond j was eligible for purchase by the SMCCF as of March 22 and zero otherwise; and $\mathbb{1}[i = \mathrm{FA}]$ = 0/1-indicator variable that equals one if issuer i became fallen angel within five business days of the March 23 announcement. All specifications include a vector of bond-specific controls (not reported) and issuer fixed effects. Asymptotic standard errors reported in parentheses are clustered at the issuer level: * $p < .10$; ** $p < .05$; and *** $p < .01$.

The estimated effects of the April 9 announcement reported in column (2), by contrast, are as expected. In the five-day window bracketing the announcement, credit spreads on the fallen angels' SMCCF-eligible bonds are estimated to have narrowed about 120 basis points relative to their ineligible counterparts. All told, the April 9 announcement is estimated to have reversed about one-third of the relative increase in credit spreads for fallen angels that occurred in the aftermath of the March 23 announcement.

Columns (3) and (4) contain the corresponding announcement effects for the bid-ask spreads. Consistent with the credit spread results reported in columns (1) and (2), the March 23 announcement is estimated to have boosted bid-ask spreads on the fallen angels' SMCCF-eligible bonds 73 percent—relative to their ineligible counterparts—in the five days following the announcement. This significant deterioration in liquidity, however, was partly reversed by the April 9 announcement, though this effect is estimated relatively imprecisely.

B Credit Spread Residuals

In this appendix, we provide details underlying the construction of credit spread residuals, our proxy for credit risk premia. To avoid any look-ahead bias when constructing credit risk premia, we use daily data between June 2002 and December 2019 to estimate the coefficients of specification (2) in the main text. Using these estimates, we then compute the predicted credit spreads, denoted by $\widehat{\mathrm{CS}}_{i,j,t}$, from January 2020 through the end of July 2020. The credit spread residual for a given bond is thus the difference between the actual credit spread $\mathrm{CS}_{i,j,t}$ and its predicted value $\widehat{\mathrm{CS}}_{i,j,t}$ (see Gilchrist and Zakrajšek, 2012, for details).

For each publicly listed firm in our sample, we measure its default risk by the standard "distance-to-default" (DD) framework developed in the seminal work of Merton (1974). Specifically, the daily firm-specific distance-to-default over the horizon of τ years is given by

$$\mathrm{DD}^{\tau} = \frac{\ln(V/D) + \left(\mu_V - 0.5\sigma_V^2\right)\tau}{\sigma_V\sqrt{\tau}}, \tag{B-1}$$

where V is the market value of the firm's assets, D is the face value of its debt—the so-called default point—and μ_V and σ_V denote the expected growth rate and the volatility of the firm's value, respectively. Following standard practice, we calibrate the default point D to the firm's current liabilities plus one-half of its long-term liabilities.

For each firm on each day, we infer V, μ_V, and σ_V using an iterative procedure proposed by Bharath and Shumway (2008). First, we initialize the procedure by letting $\sigma_V = \sigma_E\left[D/(E+D)\right]$, where E denotes the market value of the firm's equity and σ_E denotes the volatility of its equity. We estimate σ_E from historical daily stock returns using a 250-day moving window. Using this initial value of σ_V, we infer the market value of the firm for every day of the 250-day moving window based on the following equation for the value of the firm's equity implied by the Merton model:

$$E = V\Phi(\delta_1) - e^{-r\tau}D\Phi(\delta_2), \tag{B-2}$$

where r denotes the instantaneous risk-free interest rate (one-year U.S. Treasury yield), $\Phi(\cdot)$ is the cumulative standard normal distribution function, and

$$\delta_1 = \frac{\ln(V/D) + \left(r + 0.5\sigma_V^2\right)\tau}{\sigma_V\sqrt{\tau}} \quad \text{and} \quad \delta_2 = \delta_1 - \sigma_V\sqrt{\tau}.$$

Second, we calculate the implied daily log-return on assets (i.e., $\Delta \ln V$) and use the resulting series to generate new estimates of σ_V and μ_V. We then iterate on σ_V until convergence.

Table B-1: Credit Spreads and the Distance-to-Default

Explanatory Variables	*Coeff.*	*Std. Err.*
$-DD^{\tau}_{i,t}$	0.042***	0.003
$\ln \mathrm{DUR}_{i,j,t}$	0.005	0.015
$\ln \mathrm{PAR}_{i,j}$	−0.068***	0.015
$\ln \mathrm{COUP}_{i,j}$	1.113***	0.029
$\ln \mathrm{AGE}_{i,j,t}$	−0.073***	0.007
R^2	0.43	
No. of firms	1,648	
No. of bonds	18,730	
Observations	10,217,485	

Note: Sample period: daily data from June 1, 2002 to December 31, 2019. The dependent variable is $\ln \mathrm{CS}_{i,j,t}$, the log of the credit spread on bond j (issued by firm i) on day t. Asymptotic standard errors are clustered in both the firm (i) and time (t) dimensions, according to Cameron et al. (2011).

In addition to this firm-specific market-based measure of default risk ($DD^{\tau}_{i,t}$), the bond-level credit-spread pricing regression (2) in the main text also includes the following bond-specific characteristics as controls: the bond's duration ($\mathrm{DUR}_{i,j,t}$), the par amount ($\mathrm{PAR}_{i,j}$), the bond's (fixed) coupon rate ($\text{COUP}_{i,j}$), and the age of the issue ($\text{AGE}_{i,j,t}$). As shown in Table B-1, the distance-to-default is a highly significant predictor of the (log) credit spreads: a decrease of one standard deviation in the distance-to-default DD^{τ}_{it} leads to a widening of credit spreads of about 9 basis points. Moreover, this market-based indicator of default risk, together with other observable bond characteristics, explains a considerable portion of the variation in the log credit spreads.

Previous volumes in this series

962 August 2021	Global lending conditions and international coordination of financial regulation policies	Enisse Kharroubi
961 August 2021	Private equity buyouts and firm exports: evidence from UK firms	Paul Lavery, Jose-Maria Serena, Marina-Eliza Spaliara and Serafeim Tsoukas
960 August 2021	Is window dressing by banks systemically important?	Luis Garcia, Ulf Lewrick,and Taja Sečnik
959 August 2021	Macroeconomic effects of Covid-19: a mid-term review	Phurichai Rungcharoenkitkul
958 August 2021	Sharing asymmetric tail risk: Smoothing, asset pricing and terms of trade	Giancarlo Corsetti, Anna Lipińska and Giovanni Lombardo
957 August 2021	Ripple effects of monetary policy	Frederic Boissay, Emilia Garcia-Appendini, and Steven Ongena
956 August 2021	Are households indifferent to monetary policy announcements?	Fiorella De Fiore, Marco Lombardi and Johannes Schuffels
955 August 2021	Quantifying the high-frequency trading "arms race"	Matteo Aquilina, Eric Budish and Peter O'Neill
954 July 2021	Fiscal and monetary policy interactions in a low interest rate world	Boris Hofmann, Marco J Lombardi, Benoît Mojon and Athanasios Orphanides
953 July 2021	Limits of stress-test based bank regulation	Isha Agarwal and Tirupam Goel
952 July 2021	Passive funds affect prices: Evidence from the most ETF-dominated asset classes	Karamfil Todorov
951 July 2021	Distrust or speculation? The socioeconomic drivers of US cryptocurrency investments	Raphael Auer and David Tercero-Lucas
950 June 2021	Fiscal regimes and the exchange rate	Enrique Alberola, Carlos Cantú, Paolo Cavallino and Nikola Mirkov
949 June 2021	The natural interest rate in China	Sun Guofeng and Daniel M Rees

All volumes are available on our website www.bis.org.