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ABSTRACT

We evaluate the efficacy of the Secondary Market Corporate Credit Facility (SMCCF), a program designed to stabilize the corporate bond market in the wake of the Covid-19 shock. The Fed announced the SMCCF on March 23 and expanded the program on April 9. Regression discontinuity estimates imply that these announcements reduced credit spreads on bonds eligible for purchase 70 basis points. We refine this analysis by constructing a sample of bonds—issued by the same set of companies—which differ in their SMCCF eligibility. A diff-in-diff analysis shows that both announcements had large effects on credit spreads, narrowing spreads 20 basis points on eligible bonds relative to their ineligible counterparts within the same set of issuers across the two announcement periods. The March 23 announcement also reduced bid-ask spreads ten basis points within ten days of the announcement. By lowering credit spreads and improving liquidity, the April 9 announcement had an especially pronounced effect on "fallen angels." The actual purchases lowered credit spreads by an additional five basis points and bid-ask spreads by two basis points. These results confirm that the SMCCF made it easier for companies to borrow in the corporate bond market.

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1 Introduction

Confronted with a severe turmoil in financial markets, major central banks were in the front trenches of the policy response to the Covid-19 pandemic. In concert with fiscal authorities, they took prompt and forceful actions to prevent a potential collapse of the global financial system from further damaging the real economy. Given the singular nature of the Covid-19 shock—fundamentally a real shock arising from measures to address a public health emergency—central banks' responses were broad-based and tailored to country-specific financial system features. The overriding principle behind the extraordinary array of tools employed was to preserve the effectiveness of the monetary transmission mechanism, maintain stability of the financial system, and support the flow of credit to businesses and households (see Bank for International Settlements, 2020).

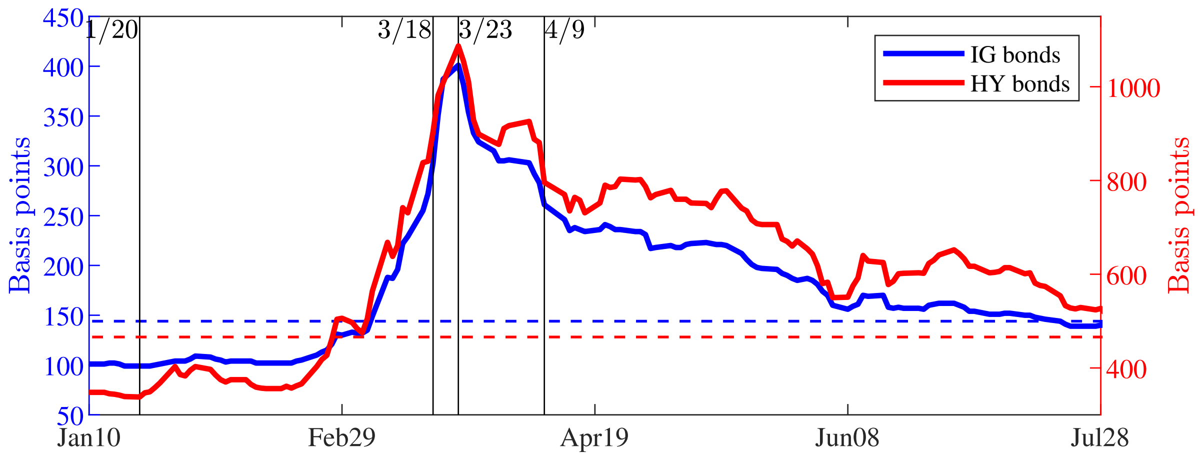
In the United States, the money market mutual fund industry came under acute pressure during the early stages of the Covid-19 crisis, resulting in large redemptions from prime money market funds in early March. In a dynamic eerily similar to that during the 2008-09 financial crisis, these strains had significant knock-on effects on other short-term funding markets—particularly on the commercial paper market—where prime money market funds are key investors. The Fed reacted swiftly and on March 17 announced the establishment of the Commercial Paper Funding Facility (CPFF), whose mandate was to purchase highly rated, short-term unsecured and asset-backed paper from a wide set of eligible issuers. To further shore up the critical short-term funding markets, the Fed announced on March 18 the establishment of the Money Market Mutual Fund Liquidity Facility (MMLF), whose purpose was to make loans to eligible financial institutions to facilitate purchases of high-quality assets from eligible money market mutual funds, thereby enhancing overall market functioning and the provision of credit to the broader economy.

Although these (and other) actions stemmed redemptions and averted a wider market meltdown, liquidity dried up and credit spreads continued to surge amid a global flight to safety. As shown in Figure 1, the benchmark spread for investment-grade U.S. corporate bonds widened nearly 100 basis points—from already elevated levels—over the few days after the two announcements, while the corresponding spread for high-yield bonds jumped 180 basis points over the same period. 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).[1]

Unsurprisingly, 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,

[1]At the same time, the Fed 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. The Fed also 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.

Figure 1: Benchmark Corporate Bond Credit Spreads During the Covid-19 Pandemic



Note: The solid blue line shows the benchmark option-adjusted credit spread for investment-grade (IG) U.S. corporate bonds, while the solid red line shows the corresponding credit spread for high-yield (HY) U.S. corporate bonds. The dashed blue and red horizontal lines represent the respective 2005–present median credit spreads. Vertical lines: (1) January 20, 2020: Chinese officials acknowledge that Covid-19 might be transmissible between humans; (2) March 18, 2020: the Fed announces the establishment of the Commercial Paper Funding Facility (CPFF); (3) March 23, 2020: the Fed announces the establishment of the Primary Market Corporate Credit Facility (PMCCF) and the Secondary Market Corporate Credit Facility (SMCCF); and (4) April 9, 2020: the Fed expands the PMCCF and SMCCF to include corporate debt that was rated investment grade as of March 22 but was subsequently downgraded.
Source: ICE BofA/ML indexes; Board of Governors of the Federal Reserve System.

while high-yield spreads fell 30 basis points. Despite a further narrowing of credit spreads over the remainder of that week, 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—the so-called fallen angels—an additional bold move intended to unfreeze the corporate credit markets.[2]

In this paper, we evaluate the efficacy of the SMCCF using a variety of identification strategies. We focus on the SMCCF because of its historic importance—the first time that the Fed supported the corporate bond market through direct purchases of outstanding securities, in effect taking a material amount of credit risk on its balance sheet. At the same time, evaluating the impact of the SMCCF on market liquidity and credit spreads is complicated by the fact that the SMCCF was announced, expanded, and, as of the date of this draft, is operating in conjunction with a number of other emergency measures. In addition to the CPFF, MMLF, and PMCCF, these include open-ended large-scale purchases of Treasury and agency mortgage-backed securities (LSAPs), the

[2]The objective of the PMCCF was to support credit to businesses through the issuance of bonds and loans; this facility was initially open to investment-grade U.S. companies The SMCCF, by contrast, was established to provide liquidity to the market for outstanding corporate bonds. Initially, the SMCCF was only allowed to purchase in the secondary market corporate bonds issued by investment-grade U.S. companies. As discussed more fully below, the Fed expanded the eligibility for the two facilities on April 9 to include certain U.S. companies that were investment grade as of March 22 but were subsequently downgraded to junk status.

Primary Dealer Credit Facility (PDCF), the Term Asset-Backed Securities Loan Facility (TALF), the Municipal Liquidity Facility, the Paycheck Protection Program Liquidity Facility (PPPLF), and the Main Street Lending Program, an extraordinary set of programs aimed at stabilizing the financial system, cushioning the adjustment for firms and households, and restoring investor confidence.

Given the simultaneous announcement of these various programs, it is important to focus on identification strategies that isolate the direct effect of the SMCCF. A natural way to do this is to analyze the effect of the Fed's corporate bond-buying program on bonds that are eligible for purchase relative to bonds that are not eligible for purchase by the facility. To the extent that there are positive spillovers between these two categories of bonds—or through macroeconomic effects in general—such estimates should be viewed as lower bounds on the likely overall impact of the SMCCF on the corporate bond market.

We begin our analysis by exploiting a natural regression discontinuity, which arises when comparing the effect of the SMCCF on bonds eligible for purchase under the announced program relative to bonds that are ineligible for the purchase by the facility. As discussed more fully below, the SMCCF's two key eligibility requirements are (*i*) bonds must be rated as investment grade; and (*ii*) they must have remaining maturity of less than or equal to five years. The five-year maturity cutoff, therefore, represents a natural regression discontinuity. Moreover, it only applies to investment-grade bonds.

Our regression discontinuity estimates confirm this intuition. Investment-grade bonds below the five-year maturity cutoff experience a drop in credit spreads of 70 basis points, relative to investment-grade bonds above the five-year maturity cutoff, during the post-announcement period. Moreover, these effects occur relatively quickly—within 14 days of the April 9 announcement—and are long lasting. We find no evidence of such discontinuities in the pre-announcement windows before March 23, nor in an otherwise similar sample of high-yield bonds. These results imply that the announcement of the SMCCF program had broad and long-lasting effects on credit spreads of eligible bonds compared with their ineligible counterparts.

It is, however, possible that companies that have issued the SMCCF-eligible bonds differ in systematic ways from companies with ineligible bonds. We therefore consider a refinement of this strategy, whereby we construct a matched sample of eligible vs. ineligible bonds that have been issued by the same company. This effectively 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.

Using this matched sample, we use difference in differences methods to document that the March 23 announcement reduced credit spreads on eligible bonds relative to ineligible bonds issued by the *same* company by ten basis points within a 10-day window. We obtain a similar estimate for the April 9 announcement. Because these are non-overlapping windows, the total effect of the program announcement lowered credit spreads on eligible bonds by 20 basis points relative to ineligible bonds for an average issuer of both types of bonds.

We perform the same analysis on bid-ask spreads and find that bid-ask spreads declined by ten basis points within a 10-day window bracketing the March 23 announcement. This result implies that the Fed's extraordinary actions significantly improved liquidity in the U.S. corporate bond market. Consistent with the notion that the April 9 announcement primarily reflected the shift in the Fed's policy towards greater tolerance of credit risk on its balance sheet, we find no effect of this announcement on market liquidity as measured by our proxies for bid-ask spreads.

The finding that credit spreads narrowed for eligible bonds within the same set of issuers is therefore attributable to two broad mechanisms: An improvement in market liquidity and a reduction in near-term default risk, relative to overall default risk (i.e., bonds with remaining maturity of less than or equal to five years relative to bonds with remaining maturity greater than five years). Prior to the announcement, near-term default risk increased sharply as evidenced by the compression in the dispersion of credit spreads across the maturity spectrum. Our analysis, therefore, suggests that the announcement of the SMCCF helped restore the upward-sloping term structure of credit risk.

To further highlight the Fed's role in reducing credit risk, we also consider the potential effect of the two announcements on fallen angels. To do so, we consider all bonds issued by companies that were rated as investment grade before March 23 but were downgraded to a notch below investment grade during the subsequent 10 days and hence became SMCCF eligible with the April 9 announcement. We again consider a matched sample and exploit the fact that these fallen angels have outstanding bonds that remain ineligible—owing to the five-year maturity cutoff—following the April 9 announcement.

When compared to the matched sample of ineligible bonds, fallen angels' eligible bonds experienced a 340 basis point increase in credit spreads during the 10-day period following the March 23 announcement. This rise in credit spreads is partly due to an increase in near-term default risk relative to longer-term risk, as these companies were downgraded to junk status sometime during these ten days. It may also be due to the fact that these bonds become ineligible for purchase by the SMCCF during this same 10-day window. We then show that the April 9 announcement reversed much of this run-up. In particular, credit spreads on newly eligible bonds issued by fallen angels fall 250 basis points in the ten days following the April 9 announcement. We view this results as strong evidence that the announcement of the SMCCF influenced credit spreads by significantly reducing near-term default risk.

Lastly, we consider the effect of the facility's implementation on credit and bid-ask spreads. Using intra-day transactions data that exactly identify the Fed's purchases of individual corporate bonds, we document that credit spreads decline by five basis points upon purchase, while bid-ask spreads narrow by two basis points. In summary, our evidence based on both regression discontinuity analysis of bonds eligible for purchase and a difference in differences analysis of a matched sample of bonds issued by the same set of companies confirm that the announcement and subsequent implementation of the SMCCF were very effective at reducing credit risk and improving liquidity in the U.S. corporate bond market.

Our paper is related to the large empirical literature aimed at evaluating and quantifying the effects of unconventional policy measures on financial asset prices that emerged during the 2008–09 global financial crisis. For the U.S., much of this research has focused on whether the Fed's purchases of large quantities of Treasuries, agency MBS and agency debt, as well as various forms of forward guidance have lowered longer-term U.S. benchmark yields and the associated private interest rates (see Krishnamurthy and Vissing-Jorgensen, 2011; Gilchrist and Zakrajšek, 2013; Gilchrist et al., 2015; Hanson and Stein, 2015). While employing a variety of empirical approaches, a common finding that emerges from these studies is that the unconventional policy measures employed by the Fed between the end of 2008 and the end of 2015 have led to a significant reduction in U.S. Treasury yields and that this broad-based reduction in longer-term interest rates has been passed fully to lower borrowing costs for businesses and households.

In this paper, we study the effects of the extraordinary measures employed by the Fed to stabilize the corporate debt markets in response to the Covid-19 pandemic. Specifically, we analyze the impact of the Fed's March 23 announcement, which established its unprecedented corporate bond-buying programs, and the April 9 follow-up announcement that extended the Fed's corporate bond purchases to certain junk-rated firms. A growing number of recent papers address related questions. D'Amico et al. (2020) quantify the effects of the announcements associated with the PMCCF on the corporate bond exchange-traded funds (ETFs) and CDX indexes. They document that these announcements had a significant positive effect on the directly eligible ETFs, as well as on the ETFs holding eligible bonds and their close substitutes, as evidenced by a discrete drop in the perceived credit risk of eligible bonds, especially following the April 9 announcement.

In a similar vein, Nozawa and Qiu (2020) also document that the Fed's announcements of the corporate credit facilities reduced credit risk but find only mixed evidence for the liquidity channel. In contrast, Kargar et al. (2020) show that liquidity conditions in the corporate bond market improved notably for both bonds that were eligible for the Fed's purchase programs as well as for bonds that were ineligible. Finally, Haddad et al. (2020) examine the discrepancy between the corporate bond market and its related credit derivatives (CDS) market during the Covid-19-induced period of market turmoil, using the Fed's announcements to evaluate the potential channels of transmission.

The road map for the remainder of the paper is as follows. Section 2 provides a brief overview of the SMCCF facility. In Section 3, we describe our data sources, the construction of micro-level credit spreads and bid-ask spreads. In Section 4, we take the first cut at our data, using a regression discontinuity design framework, which exploits the five-year maturity cutoff for the SMCCF-eligible bonds. Section 5 presents our main results, which rely on both the issuer- and bond-level difference in differences approach to estimate 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 6. Section 7 offers a brief conclusion.

2 A Brief Introduction to the SMCCF

As noted 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.[3]

The stated objective of the SMCCF, the main focus of this paper, was to provide liquidity to the market for outstanding corporate bonds through direct purchases of individual corporate securities and ETFs, whose primary investment objective is exposure to the broad U.S. corporate bond market. Eligible bonds are required to have been issued by U.S. companies and have a remaining maturity of five years or less. The maximum amount of bonds that the SMCCF will purchase in the secondary market of any eligible issuer is 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 BBB-/Baa3 as of March 22, 2020, and are rated at least BB-/Ba3 as of the date on which the SMCCF purchases their bonds. The SMCCF started buying corporate bond ETFs on May 12, and individual corporate bonds on June 16.[4] 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.

The term sheet of the SMCCF stipulates 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, a set of corporate bonds eligible for purchase by the SMCCF.[5] To get a sense of what credits the SMCCF is targeting, we report in Table 1

[3]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.

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

[5]The Federal Reserve Bank of New York publishes an updated Broad Market Listing roughly

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.

the composition of the initial Broad Market Listing. This first listing of eligible bonds, which was effective as of 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. The second Broad Market Listing announced on August 10 and effective as of June 25 had essentially the same sectoral composition.

3 Data Sources and Methods

The key data used in our analysis come from the Trade Reporting and Compliance Engine (TRACE) database, which contains 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 either the Fixed Income Securities Database (FISD) or Bloomberg to obtain bond characteristics, such as bond type, coupon frequency, date and amount of issuance, maturity date, and credit rating.

We restrict our TRACE sample to transactions that took place between 9:00 a.m. and 4:00 p.m. (EST) on business days since January 1, 2020. From this sample, we drop all transactions involving

once a month; see https://www.newyorkfed.org/markets/secondary-market-corporate-credit-facility/secondary-market-corporate-credit-facility-broad-market-index.

bonds with variable coupons and bonds with a remaining maturity of less that six months or more than 30 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. Moreover, as shown below, a vast majority of bonds purchased by the SMCCF had fixed coupon; restricting our sample to fixed-coupon bonds thus facilitates comparisons with the sample of bonds purchased by the SMCCF.

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.[6] 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 Treasury yields, as estimated on that day by Gürkaynak et al. (2007).

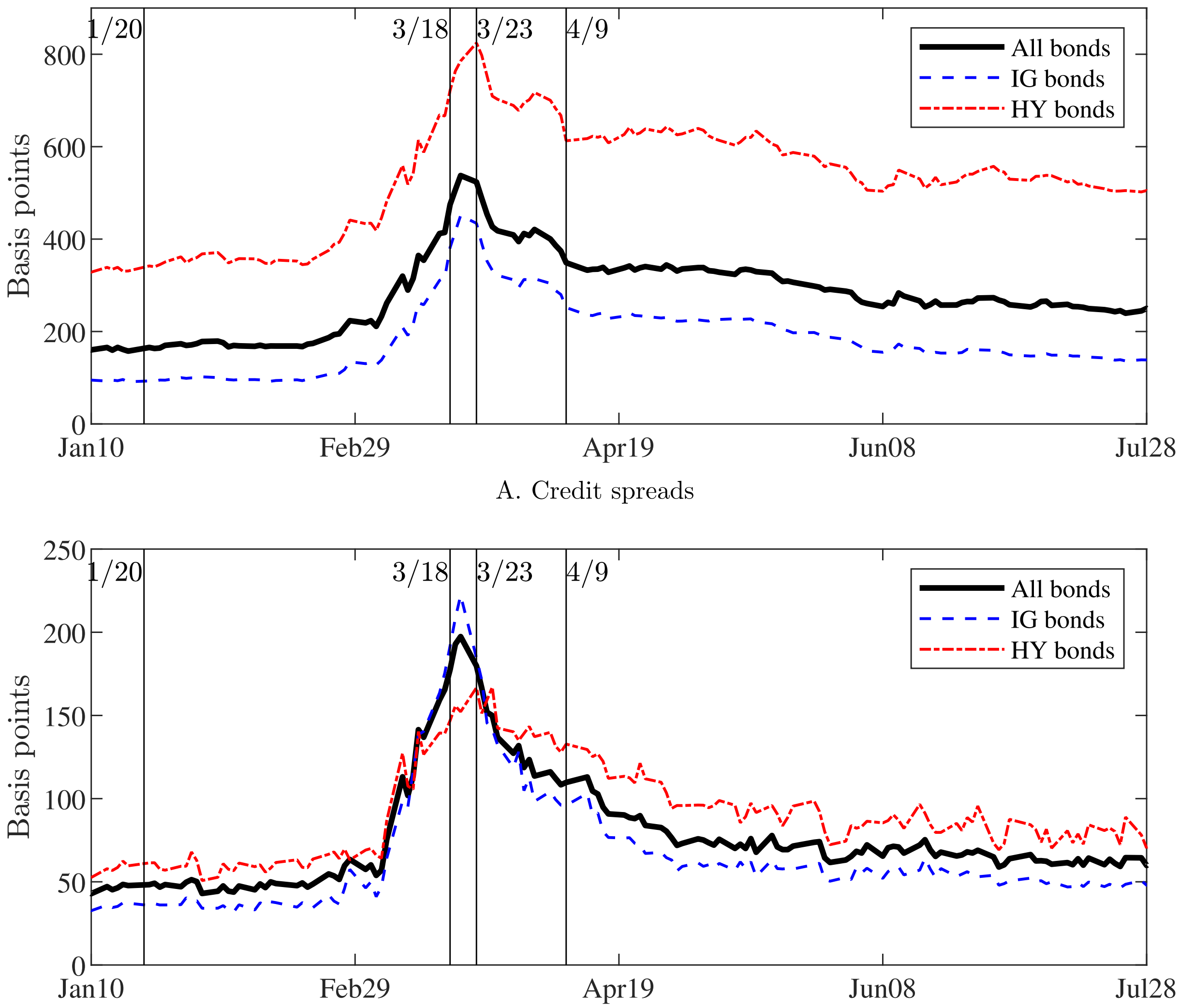
Using these micro-level data, we calculate the daily transaction volume weighted average credit spreads across all bonds in our sample and the corresponding weighted average spreads for the investment-grade and high-yield subsamples.[7] In Panel A of Figure 2, we plot these three series since the beginning of the year. Note that the investment-grade and high-yield credit spreads constructed from the micro-level TRACE data are very similar to their respective benchmark indexes shown in Figure 1. In fact, the correlation in levels is 0.99 for both investment-grade and high-yield credit spreads, while in daily changes, the correlations for investment-grade and high-yield credit spreads are 0.91 and 0.82, respectively. All told, our TRACE sample of corporate bonds appears to be representative of the broad U.S. corporate bond market since the beginning of the year.

We also use our TRACE sample of bonds to construct a proxy for bid-ask spreads, a common measure of liquidity in financial markets. In that case, we utilize information about the type of counterparties involved in each recorded transaction. Specifically, on each business day, we define a bond's "bid" price as an average of all prices generated by transactions involving customers selling that bond to a dealer on that day. The bond's corresponding "ask" price, by contrast, is defined as an average of all prices generated by transactions involving dealers selling that same bond to a customer. Lastly, we define the bond's "mid" price as an 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 bid and ask prices, divided by the mid price.

[6] 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.

[7] To mitigate the effects of extreme observations on our results, we winsorize our sample of credit spreads at the 1st and 99th percentiles of their distribution.

Figure 2: TRACE-Based Credit Spreads and Bid-Ask Spreads



A. Credit spreads

B. Bid-ask spreads

Note: In Panel A, the blue line shows the weighted-average credit spread for all corporate bonds in our TRACE sample, while the dashed red lines and the dotted black lines show the corresponding weighted-average credit spreads for the investment-grade (IG) and high-yield (HY) subsamples, respectively. In Panel B, the lines show the average bid-ask spreads for the same market segments. Vertical lines: (1) January 20, 2020: Chinese officials acknowledge that Covid-19 might be transmissible between humans; (2) March 18, 2020: the Fed announces the establishment of the Commercial Paper Funding Facility (CPFF); (3) March 23, 2020: the Fed announces the establishment of the Primary Market Corporate Credit Facility (PMCCF) and the Secondary Market Corporate Credit Facility (SMCCF); and (4) April 9, 2020: the Fed expands the PMCCF and SMCCF to include corporate debt that was rated investment grade as of March 22 but was subsequently downgraded.
Source: Authors' calculations using TRACE data.

Panel B of Figure 2 shows the time series of the average bid-ask spread for all bonds in our sample, as well the corresponding bid-ask spreads for the investment-grade and high-yield segments of the market. As can be seen from the figure, bid-ask spreads started to rise gradually following the acknowledgment by the Chinese officials on January 20, 2020, that Covid-19 might be transmissible between humans. In late February, as the worsening news relating to the Covid-19 outbreak roiled global financial markets, liquidity in the U.S. corporate bond market deteriorated markedly, and bid-ask spreads shot up. The Fed's announcements on March 23 and April 9 led to some improvement in market functioning, though bid-ask spreads remained notably above their pre-pandemic levels through the end of July.

4 The Regression Discontinuity Approach

Our first pass at examining whether the two SMCCF announcements left an imprint in the U.S. corporate bond market exploits the facility's two key eligibility criteria—the bond's time-to-maturity and its credit rating—within the regression discontinuity design (RDD) framework (see DiNardo and Lee, 2004; Card et al., 2008). Recall that the first criterion limits the remaining maturity of eligible bonds to five years or less, while the second requires eligible bonds to have an investment-grade credit rating at the time of a purchase. If the SMCCF announcements had an effect on the corporate bond market, we should observe a discontinuity in credit spreads around the time-to-maturity cutoff of five years in the investment-grade segment of the market after the two announcements. In other words, eligible investment-grade bonds with remaining maturity of five years or less should have, all else equal, lower credit spreads than the eligible investment-grade bonds with remaining maturity of more than five years. At the same time, we should see no, or very little, such discontinuity in the high-yield segment of the market because a vast majority of high-yield bonds is ineligible for purchase by the SMCCF.[8]

Using our TRACE sample of bonds, we implement the RDD as follows. In a sample window of d (business) days strictly before the March 23 announcement (i.e., the interval $[3/22-d, 3/22]$) and in the same-length window strictly after the April 9 announcement (i.e., the interval $[4/10, 4/10+d]$), we select all bonds with the remaining maturity between four and six years, a range narrowly bracketing the SMCCF's time-to-maturity cutoff of five years. Within each d-day window, we sort the resulting sample of bonds into 24 maturity bins of width of one month. Thus, the first bin contains all bonds whose remaining maturity lies in the interval $(4, 4.083]$, the second bin spans the maturity interval $(4.083, 4.166]$, and the last bin covers the maturity interval $(5.917, 6]$. Within each bin, we then calculate the weighted average credit spread using the corresponding transaction volumes as weights.

This binning exercise is performed separately for investment-grade and high-yield samples of bonds on windows of various lengths. To ensure a reasonable number of bonds in each bin, we consider "before" and "after" announcement windows of length $d = 14, 30, 60, 90$ days. For each

[8] Although the investment-grade rating criterion in the March 23 announcement was relaxed somewhat in the subsequent April 9 announcement, the SMCCF still cannot purchase bonds with a rating below BB-/Ba3 at the time of a purchase. Moreover, the actual SMCCF's purchases are overwhelmingly skewed towards investment-grade corporate debt, despite the fact that purchases can include bonds rated just a notch below investment grade.

window, we then estimate the following regression:

$$\text{CS}_b = \alpha + \beta \times \mathbf{1}[\text{TTM}_b \leq 5] + p(\text{TTM}_b; \boldsymbol{\theta}_1) + p(\text{TTM}_b; \boldsymbol{\theta}_2) \times \mathbf{1}[\text{TTM}_b \leq 5] + \epsilon_b, \tag{1}$$

where CS_b denotes the average credit spread in bin b and $\mathbf{1}[\text{TTM}_b \leq 5]$ is a 0/1-indicator function that equals one if the time-to-maturity (TTM) of bin b is less than or equal to five years and zero otherwise. The functions $p(\text{TTM}_b; \boldsymbol{\theta}_1)$ and $p(\text{TTM}_b; \boldsymbol{\theta}_2)$ denote quadratic polynomials—parameterized by vectors $\boldsymbol{\theta}_1$ and $\boldsymbol{\theta}_2$, respectively—in TTM_b, while ϵ_b denotes a mean-zero disturbance term.

The coefficient of interest in the RDD specification (1) is β, which measures the degree of discontinuity in credit spreads around the SMCCF's time-to-maturity cutoff of five years. This discontinuity, if it exists, would reflect the average effect of the March 23 and April 9 SMCCF announcements on credit spreads. We would expect the estimate of β to be negative and statistically different from zero in the after-announcement windows containing investment-grade bonds. At the same time, there should be no such discontinuity—that is, $\beta = 0$—at the five-year maturity in the before-announcement windows and in windows containing high-yield bonds.

The results of this exercise are tabulated in Table 2. Panel A reports the (unweighted) OLS estimates of the regression discontinuity coefficient β, while Panel B reports the corresponding WLS estimates of β, using the bin-specific transaction amounts as weights. According to the entries in the table, we uniformly fail to reject the null hypothesis that $\beta = 0$ in all before-announcement windows for both investment-grade (columns 1–4) and high-yield (columns 5–8) subsamples. This result is robust to using both the OLS and WLS to estimate the regression discontinuity coefficient β.

In the after-announcement windows, by contrast, there is strong evidence of discontinuity in investment-grade credit spreads at the time-to-maturity cutoff of five years. As detailed in columns 1–4 of Panel A, the OLS estimates of β are negative and statistically different from zero at conventional significance levels in the 30-, 60-, and 90-day after-announcement windows containing investment-grade bonds. The corresponding WLS estimates reported in Panel B are of similar magnitudes and are statistically different from zero at conventional significance levels in all four after-announcement windows containing investment-grade bonds. At the same time, the estimates of β are statistically indistinguishable from zero in the after-announcement windows containing high-yield bonds (columns 5–8). The magnitude of discontinuity in investment-grade credit spreads is also economically significant. The range of estimates in the after-announcement windows containing investment-grade bonds indicates that the two SMCCF announcements lowered credit spreads on eligible investment-grade bonds between 60 and 80 basis points, relative to their ineligible counterparts.

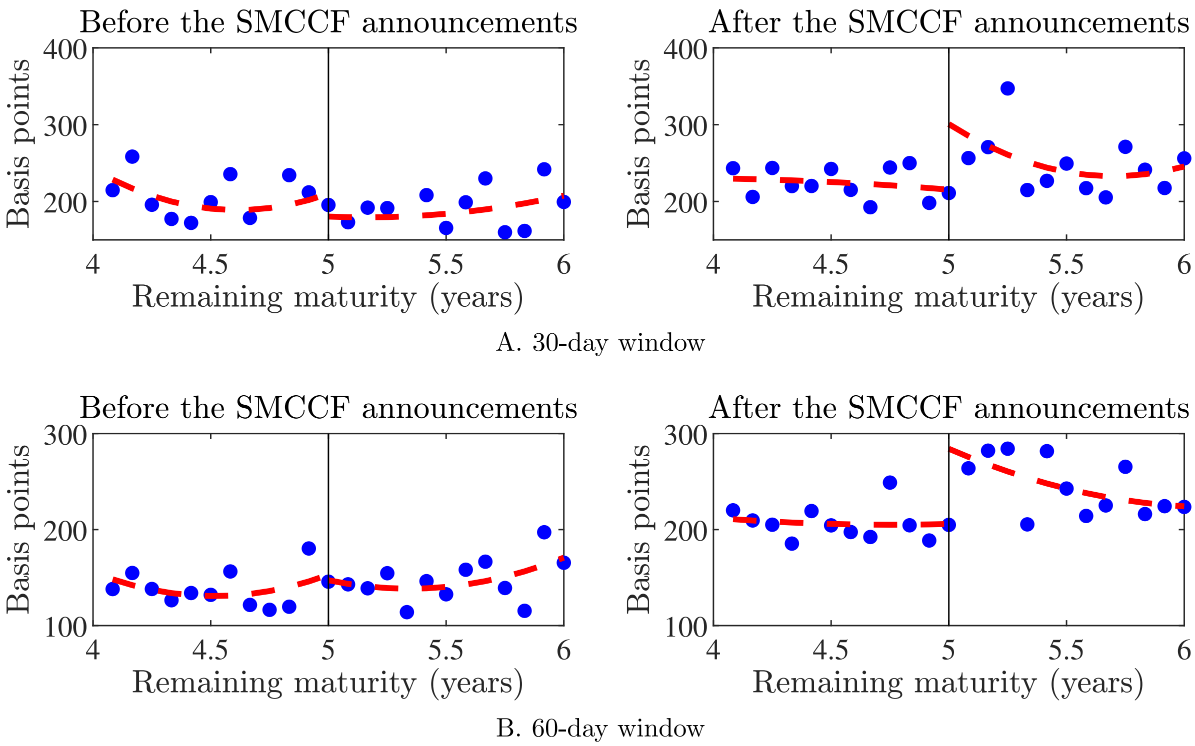
Figure 3 provides a visual confirmation of the discontinuity in investment-grade credit spreads for the 30- and 60-day windows based on the OLS estimates reported in Panel A of Table 2. The discontinuity in credit spreads at the maturity cutoff of five years is clearly evident in the after-announcement windows, especially so in the 60-day window. This window, however, extends beyond June 16 when the Fed commenced with the actual purchases of individual corporate bonds.

Table 2: Regression Discontinuity in Credit Spreads
(March 23 and April 9 Announcements)

	Investment-Grade Bonds				High-Yield Bonds			
	14-day	30-day	60-day	90-day	14-day	30-day	60-day	90-day
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Unweighted regression								
Before the SMCCF Announcements								
$\hat{\beta}$	0.182	0.297	0.057	−0.016	−1.364	−0.650	−0.963	−0.301
	[0.34]	[0.73]	[0.22]	[0.09]	[0.73]	[0.55]	[1.39]	[0.55]
R^2	0.28	0.17	0.23	0.34	0.07	0.18	0.38	0.49
After the SMCCF Announcements								
$\hat{\beta}$	−0.531	−0.853**	−0.783**	−0.692***	−0.251	1.336	0.666	0.419
	[1.43]	[2.16]	[2.67]	[4.38]	[0.20]	[0.95]	[0.86]	[0.74]
R^2	0.18	0.28	0.55	0.75	0.24	0.29	0.64	0.76
B. Weighted regression								
Before the SMCCF Announcements								
$\hat{\beta}$	0.101	0.249	0.042	−0.010	−0.842	−0.588	−0.718	0.071
	[0.21]	[0.76]	[0.19]	[0.07]	[0.55]	[0.68]	[1.32]	[0.16]
R^2	0.29	0.19	0.23	0.35	0.14	0.26	0.35	0.46
After the SMCCF Announcements								
$\hat{\beta}$	−0.602**	−0.696**	−0.741***	−0.659***	−0.528	0.624	0.426	0.250
	[2.23]	[2.55]	[3.39]	[4.52]	[0.55]	[0.66]	[0.83]	[0.68]
R^2	0.25	0.36	0.61	0.72	0.39	0.46	0.79	0.86

Note: Observations in each d-day estimation window, $d = 14, 30, 60, 90$, correspond to the 24 maturity bins of width of one month (see the RDD specification 1 and the text for details). The dependent variable in all specifications is the transaction volume weighted average credit spread in each bin. The entries in rows labeled $\hat{\beta}$ denote the estimates of the coefficient β on $\mathbf{1}[\text{TTM}_b \leq 5]$, a 0/1-indicator function that equals one if the time-to-maturity (TTM) of bin b is less than or equal to five years and zero otherwise. Panel A reports the (unweighted) OLS estimates of β, while the corresponding WLS estimates of β, using the bin-specific total transaction volumes as weights, are reported in Panel B. Absolute t-statistics are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

Figure 3: Regression Discontinuity in Investment-Grade Spreads



Note: The two panels provide a visual depiction of the RDD specification (1) for the 30- and 60-day windows reported in Panel B of Table 2; see the text and notes to Table 2 for details.
Source: Authors' calculations using TRACE data.

The fact that the regression discontinuity coefficients based on the 60- and 90-days windows are, in general, estimated more precisely (see Table 2) suggests that the Fed's actual purchases had an additional effect on credit spreads in the investment-grade segment of the market.

In Table 3, we report the results from the analogous RDD analysis of bid-ask spreads. In this case, however, the evidence that the two SMCCF announcements led to a discontinuity in bid-ask spreads is less clear. The OLS estimates of β in the after-announcement windows containing investment-grade bonds, while negative, are estimated less precisely (columns 1–4 in Panel A), and the same is true for their corresponding WLS estimates (columns 1–4 in Panel B). In general, the estimates of the regression discontinuity coefficients are statistically different from zero only in the longer (i.e., 60-day and 90-day) windows. As noted above, this finding may reflect the fact that the 60- and 90-day after-announcement windows extend beyond June 16, when the Fed started its actual purchases of individual corporate bonds, thereby directly affecting liquidity in the market. The absence of discontinuity in bid-ask spreads at the maturity cutoff of five years in shorter (i.e., 14-day and 30-day) after-announcement windows could also reflect the fact that our bid-ask spreads are noisy proxies of the true underlying bid-ask spreads, making it to difficult to identify the regression discontinuity.

TABLE 3: Regression Discontinuity in Bid-Ask Spreads
(March 23 and April 9 Announcements)

	Investment-Grade Bonds				High-Yield Bonds			
	14-day	30-day	60-day	90-day	14-day	30-day	60-day	90-day
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Unweighted regression								
				Before the SMCCF Announcements				
$\hat{\beta}$	−0.157	−0.177	−0.163	−0.203	−0.107	−0.070	−0.011	0.082
	[0.20]	[0.33]	[0.57]	[1.16]	[0.26]	[0.32]	[0.07]	[0.78]
R^2	0.08	0.09	0.15	0.22	0.10	0.11	0.13	0.14
				After the SMCCF Announcements				
$\hat{\beta}$	−0.003	−0.148	−0.177*	−0.202**	−0.293	−0.127	−0.108	−0.027
	[0.01]	[0.96]	[1.97]	[2.82]	[0.96]	[0.62]	[0.68]	[0.22]
R^2	0.253	0.409	0.453	0.461	0.363	0.595	0.630	0.670
B. Weighted regression								
				Before the SMCCF Announcements				
$\hat{\beta}$	−0.210	−0.209	−0.124	−0.138	0.096	−0.039	0.040	0.135
	[0.32]	[0.50]	[0.54]	[0.97]	[0.28]	[0.21]	[0.33]	[1.61]
R^2	0.120	0.157	0.210	0.205	0.089	0.085	0.123	0.211
				After the SMCCF Announcements				
$\hat{\beta}$	−0.034	−0.075	−0.100	−0.131**	−0.129	0.035	0.010	0.058
	[0.20]	[0.74]	[1.48]	[2.25]	[0.53]	[0.23]	[0.09]	[0.71]
R^2	0.425	0.586	0.594	0.584	0.434	0.646	0.702	0.746

NOTE: Observations in each d-day estimation window, $d = 14, 30, 60, 90$, correspond to the 24 maturity bins of width of one month (see the RDD specification 1 and the text for details). The dependent variable in all specifications is the transaction volume weighted average bid-ask spread in each bin. The entries in rows labeled $\hat{\beta}$ denote the estimates of the coefficient β on $\mathbf{1}[\text{TTM}_b \leq 5]$, a 0/1-indicator function that equals one if the time-to-maturity (TTM) of bin b is less than or equal to five years and zero otherwise. Panel A reports OLS estimates of β, while the corresponding WLS estimates of β, using the bin-specific total transaction volumes as weights, are reported in Panel B. Absolute t-statistics are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

5 The Difference in Differences Approach

The RDD results above provide suggestive evidence that the March 23 and April 9 announcements significantly lowered credit spreads on the SMCCF-eligible investment-grade bonds relative to their ineligible counterparts. There are, however, two issues with those results. First, the RDD design does not control for observable bond characteristics that can influence prices in the secondary market. Second, the 60- and 90-day after-announcement windows extend beyond June 16—the start date of the actual purchases—and thus the estimates of regression discontinuity coefficients based on those windows confound the announcement and purchase effects. To address these issues, we consider in this section an alternative approach to identify the two announcement effects on the corporate bond market, an approach based on issuer- and bond-level data and the difference in differences (DiD) methodology.

5.1 Constructing the "Treatment" and "Control" Groups

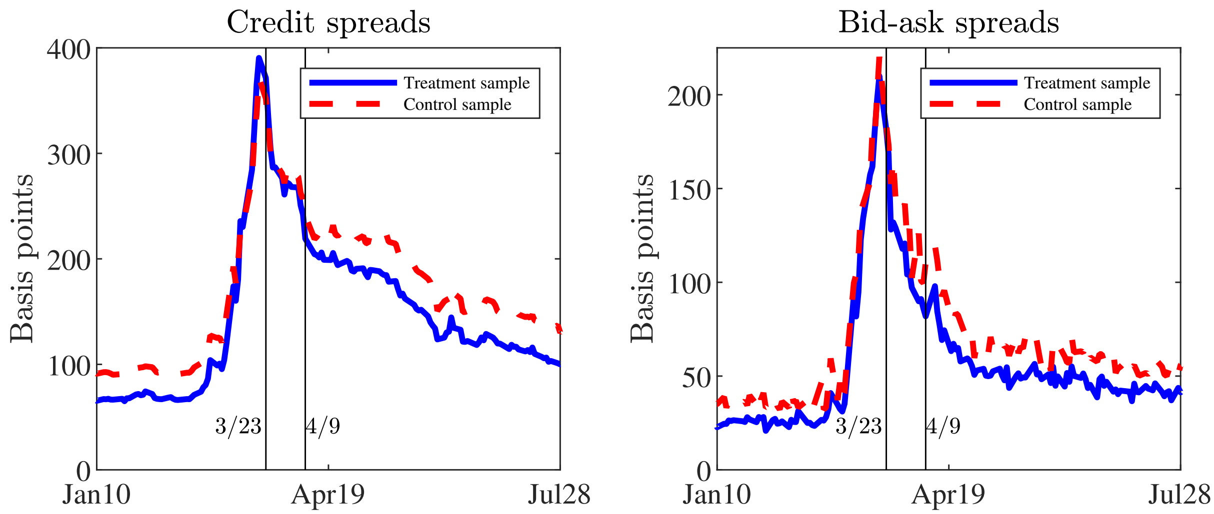
Using our TRACE sample of corporate bonds, we construct the "treatment" and "control" groups as follows. First, we select all bonds whose issuer had an investment-grade rating as of March 22 and whose remaining time-to-maturity as of the March 23 announcement was less than or equal to five years; this 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 is not eligible to be purchased by the SMCCF. To ensure a reasonable degree of maturity concordance between these two samples of bonds, we impose the condition that the remaining maturity of the issuer-paired bonds in the non-eligible sample cannot exceed 10 years. 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 treatment and control groups used in our DiD analysis. To construct the treatment group, we select from issuers with multiple bonds in the eligible sample, bonds with the remaining maturity closest to five years. Analogously, if there are multiple bonds in the non-eligible sample that can be paired with the bond in the treatment group, we keep only the bond with time-to-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 treatment and control groups have the remaining maturity that is as close as possible.[9]

The blue line in the left panel of Figure 4 shows the daily average credit spread of bonds in the treatment group, while the red line shows the corresponding average credit spread in the control group. The blue and red 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 mid-February, the average credit spread in the control group was consistently

[9] This matching process yielded 4,825 pairs of bonds, issued by 1,076 unique companies. The mean (median) difference in the remaining maturity across pairs of bonds is 3.5 (3.3) years, while the 95th percentile is 6.7 years.

FIGURE 4: Credit and Bid-Ask Spreads – Treatment vs. Control Groups



NOTE: The blue line in the left panel shows the daily average credit spreads of bonds in the treatment group (i.e., the SMCCF-eligible sample), while the red line shows the average credit spreads in the control group (i.e., the issuer-matched sample of ineligible bonds). The right panel shows the daily average bid-ask spreads for the same two samples. See the text for details regarding the construction of the treatment and control groups. Vertical lines: (1) March 23, 2020: the Fed announces the establishment of the Primary Market Corporate Credit Facility (PMCCF) and the Secondary Market Corporate Credit Facility (SMCCF); and (2) April 9, 2020: the Fed expands the PMCCF and SMCCF to include corporate debt that was rated investment grade as of March 22 but was subsequently downgraded.
SOURCE: Authors' calculations using TRACE date.

above that in the treatment group. The gap between the credit spreads in the two samples, however, 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 above the average bid-ask spread in the control sample during this period. This indicates that bonds in our treated group were, on average, less liquid than their counterparts in the control group, possibly due to their shorter maturity or other bond characteristics.

In the latter half of February, 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 March. This acute risk-on 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 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 U.S. 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.

5.2 Econometric Methodology

Our first formal pass at quantifying the separate effects of the March 23 and April 9 announcements on credit spreads uses the pairs of bonds in the treatment and control groups to estimate the following *issuer-level* DiD specification:

$$\text{CS}_{i,t}^{treated} - \text{CS}_{i,t}^{control} = \beta \times \mathbf{1}[t > t^*] + \eta_i + \epsilon_{i,t}, \tag{2}$$

where $\text{CS}_{i,t}^{treated}$ is the credit spread on issuer i's bond in the treatment group, and $\text{CS}_{i,t}^{control}$ is the credit spread on issuer i's bond in the control group on the same business day t. The 0/1-indicator variable $\mathbf{1}[t > t^*]$ equals one if the date t is greater than the specified announcement date t^*, either March 23 or April 9. The issuer fixed effect η_i controls for any (time-invariant) unobservable issuer characteristics within each event window. The coefficient β thus quantifies the difference in credit spreads between the SMCCF-eligible and non-eligible bonds of the same issuer and comparable maturity in response to the specified announcement.

We estimate specification (2) by OLS in symmetric 1-, 5-, and 10-day windows bracketing the March 23 and April 9 announcements. The results of this exercise are reported in Table 4, with Panel A containing the March 23 announcement effects and Panel B containing the April 9 announcement effects. The entries in Panel A 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 to their non-eligible counterparts. Within the 1- and 5-day windows bracketing the announcement, the spreads on the SMCCF-eligible bonds are estimated to have declined about 15 basis points relative to spreads on no-eligible bonds issued by the same set of companies. The announcement effect in the 10-day window is estimated to be about ten basis points, suggesting that the initial impact of the March 23 announcement on credit spreads waned somewhat over time.

The estimates of the April 9 announcement effects, reported in Panel B, are smaller in magni-

Table 4: The Impact of the SMCCF Announcements on Credit Spreads
(Issuer-Level Difference in Differences Analysis)

	Event Window		
	1-day	5-day	10-day
Explanatory Variable	(1)	(2)	(3)
A. $t^* =$ March 23			
$\mathbf{1}[t > t^*]$	-0.137^{**}	-0.164^{***}	-0.109^{***}
	[2.69]	[5.75]	[5.22]
R^2	0.56	0.29	0.23
Observations	1,083	4,635	9,144
B. $t^* =$ April 9			
$\mathbf{1}[t > t^*]$	0.023	-0.063^{***}	-0.119^{***}
	[0.78]	[4.00]	[8.51]
R^2	0.63	0.45	0.38
Observations	1,243	5,047	9,768

Note: The dependent variable in all specifications is $\text{CS}_{i,t}^{treated} - \text{CS}_{i,t}^{control}$, the difference between the credit spread on issuer i's bond in the treatment group ($\text{CS}_{i,t}^{treated}$) and the credit spread on issuer i's bond in the control group ($\text{CS}_{i,t}^{control}$) on business day t (see the DiD specification 2 and the text for details). The entries in the table denote the OLS estimates of coefficients on $\mathbf{1}[t > t^*]$, a 0/1-indicator variable that equals one if date t is greater than the specified announcement date t^* and zero otherwise. In Panel A, $t^* =$ March 23, and in Panel B, $t^* =$ April 9. All specifications include issuer fixed effects. Absolute t-statistics based on issuer-clustered standard errors are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

tude, though still economically and statistically significant. Moreover, they increase (in absolute terms) as we widen the event window, rising from about six basis points in the 5-day window to 12 basis points in the 10-day window. This finding suggests that the April 9 announcement had a more persistent—though economically smaller—effect on credit spreads, a finding mirrored in the persistent divergence between the red and blue lines shown in the left panel of Figure 4.

In Table 5, we report the results from the analogous exercise using the difference in bid-ask spreads, $\text{BAS}_{i,t}^{treated} - \text{BAS}_{i,t}^{control}$, as the outcome variable. According to the entries in Panel A, the March 23 announcement had a noticeable effect on the liquidity in the corporate bond market. Within the 5-day window bracketing the announcement, bid-ask spreads on the SMCCF-eligible bonds were estimated to decline about 15 basis points relative to bid-ask spreads on no-eligible bonds issued by the same set of companies, while the corresponding announcement effect within the 10-day window is about nine basis points. The April 9 announcement, in contrast, appears to have had no differential effect on bid-ask spreads, according to the results reported in Panel B. These results are broadly consistent with those based on the RDD approach in Table 3, which showed that the average effect of the two announcements did not induce a clear discontinuity in bid-ask spreads at the five-year maturity cutoff in shorter estimation windows.

TABLE 5: The Impact of the SMCCF Announcements on Bid-Ask Spreads
(Issuer-Level Difference in Differences Analysis)

	Event Window		
	1-day	5-day	10-day
Explanatory Variable	(1)	(2)	(3)
A. $t^* =$ March 23			
$\mathbf{1}[t > t^*]$	−0.062	−0.154**	−0.085**
	[0.51]	[2.43]	[2.16]
R^2	0.50	0.19	0.15
Observations	491	2,090	4,271
B. $t^* =$ April 9			
$\mathbf{1}[t > t^*]$	0.069	−0.043	−0.002
	[0.74]	[1.01]	[0.05]
R^2	0.44	0.21	0.15
Observations	547	2,625	5,109

NOTE: The dependent variable in all specifications is $\text{BAS}_{i,t}^{treated} - \text{BAS}_{i,t}^{control}$, the difference between the bid-ask spread on issuer i's bond in the treatment group ($\text{BAS}_{i,t}^{treated}$) and the credit spread on issuer i's bond in the control group ($\text{BAS}_{i,t}^{control}$) on business day t (see the DiD specification 2 and the text for details). The entries in the table denote the OLS estimates of coefficients on $\mathbf{1}[t > t^*]$, a 0/1-indicator variable that equals one if date t is greater than the specified announcement date t^* and zero otherwise. In Panel A, $t^* =$ March 23, and in Panel B, $t^* =$ April 9. All specifications include issuer fixed effects. Absolute t-statistics based on issuer-clustered standard errors are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

A potential limitation of the DiD analysis at the issuer level is that the pairs of bonds in the treatment and control groups—while having a reasonably comparable maturity—could differ in other characteristics that influence their prices. To take into account these confounding factors, we use the treated and control samples to estimate the following *bond-level* DiD specification:

$$\begin{aligned}\text{CS}_{i,j,t} = \beta \times \big(\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]\big) + \gamma_1 \times \mathbf{1}[j \in \text{SMCCF}] + \gamma_2 \times \mathbf{1}[t > t^*] \\ + \theta' \mathbf{X}_{i,j,t} + \eta_i + \epsilon_{i,j,t},\end{aligned} \tag{3}$$

where i indexes issuers and j indexes their outstanding bonds. In this specification, $\text{CS}_{i,j,t}$ denotes the credit spread on bond j, a liability of issuer i, on business day t. The indicator variable $\mathbf{1}[j \in \text{SMCCF}]$ equals one if bond j was eligible for purchase by the SMCCF as of March 22 and zero otherwise, while the indicator variable $\mathbf{1}[t > t^*]$ is defined as above.

The main coefficient of interest in this DiD specification is β on the interaction term $\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$, which measures the difference in credit spreads between the SMCCF-eligible bonds and their ineligible counterparts that can be attributed to the specified Fed announcement. If the specified announcement in fact eased borrowing conditions in the corporate bond market, we would expect β to be negative and statistically different from zero. To control for the fact that bonds in the treated sample differ in certain dimensions from those in control sample, the specification also includes a vector of pre-determined covariates—denoted by $\mathbf{X}_{i,j,t}$—comprising of the bond's remaining days-to-maturity, its age (i.e., the number of days since it was issued), coupon rate, and the logarithm of the par amount issued.

As before, we estimate specification (3) by OLS in symmetric 1-, 5-, and 10-day windows bracketing the March 23 and April 9 announcements. The results of this exercise are reported in Table 6, with Panel A containing the March 23 announcement effects and Panel B containing the April 9 announcement effects. The results from the baseline DiD specifications are reported in columns 1–3 of each panel. As a robustness check, we report in columns 4–6 estimates of the corresponding coefficients based on the DiD specifications that also include time fixed effects, which capture common shocks affecting the spreads on bonds in both the treatment and control groups; in the latter case, the coefficient on the indicator variable $\mathbf{1}[t > t^*]$ is not separately identified.

The results reported in both panels of Table 6 are remarkably similar to those reported in Table 4. Our baseline estimates of β—the coefficient on the interaction term $\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$—based on the bond-level data indicate that the March 23 announcement led to a relative decline in credit spreads of 11, 15, and nine basis points in the 1-, 5-, and 10-days windows, respectively (columns 1–3 in Panel A). These magnitudes are very similar to the corresponding announcement effects implied by the issuer-level analysis reported in Table 4. Furthermore, the estimated March 23 announcement effects based on bond-level data are fully robust to the inclusion of time fixed effects (columns 4–6 in Panel A).

The April 9 announcement had, on balance, a somewhat smaller effect on credit spreads. Our estimates of β indicate no discernible effect within the very narrow 1-day window bracketing the April 9 announcement but point to relative declines of about seven and 13 basis points in the 5- and 10-day windows, respectively (columns 1–3 in Panel B). The size of these announcement effects is very similar to those based on the issuer-level analysis, and the estimates of the April 9 announcement effects are essentially the same as those from the DiD specification that includes time fixed effects (columns 4–6 in Panel B).

In Table 7, we report the results from the analogous bond-level analysis of bid-ask spreads. This analysis indicates that the March 23 announcement improved liquidity in the corporate bond market, lowering the bid-ask spreads on the SMCCF-eligible bonds 14 and 10 basis points within the 5- and 10-day windows bracketing the announcement, respectively (columns 1–3 in Panel A); as in the case of credit spreads, the inclusion of time fixed effects has no effect on the estimated announcement effects. The April 9 announcement, in contrast, had no discernible effect on bid-ask spreads in any event window. Again, all of these results are fully consistent with those based on the issuer-level analysis reported in Table 5.

In sum, the DiD analysis presented above provides strong evidence that the Fed's March 23 announcement of the corporate bond-buying program significantly eased strains in the U.S. corporate bond market. In response to this announcement, credit spreads on the SMCCF-eligible bonds are estimated to have narrowed about ten basis points, relative to their ineligible counterparts.

Table 6: The Impact of the SMCCF Announcements on Credit Spreads
(Bond-Level Difference in Differences Analysis)

	Event Window			Event Window		
	1-day	5-day	10-day	1-day	5-day	10-day
Explanatory Variable	(1)	(2)	(3)	(4)	(5)	(6)
A. $t^* =$ March 23						
$\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$	−0.111**	−0.148***	−0.087***	−0.110**	−0.148***	−0.086***
	[2.20]	[5.42]	[4.26]	[2.20]	[5.42]	[4.24]
$\mathbf{1}[j \in \text{SMCCF}]$	0.125**	0.085**	0.059**	0.127**	0.092**	0.041
	[1.97]	[2.25]	[2.17]	[1.99]	[2.48]	[1.59]
$\mathbf{1}[t > t^*]$	−0.404***	−0.247***	−0.272***	.	.	
	[11.90]	[11.47]	[13.07]			
R^2	0.69	0.59	0.50	0.70	0.71	0.75
Observations	2,432	9,399	18,402	2,432	9,399	18,402
Time FE	N	N	N	Y	Y	Y
B. $t^* =$ April 9						
$\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$	0.028	−0.073***	−0.128***	0.028	−0.073***	−0.128***
	[0.97]	[4.42]	[8.63]	[0.98]	[4.43]	[8.63]
$\mathbf{1}[j \in \text{SMCCF}]$	−0.067*	−0.019	0.003	−0.067*	−0.018	0.004
	[1.93]	[0.76]	[0.14]	[1.94]	[0.70]	[0.19]
$\mathbf{1}[t > t^*]$	−0.365***	−0.571***	−0.625***	.	.	.
	[22.01]	[48.07]	[50.26]			
R^2	0.91	0.89	0.87	0.92	0.90	0.89
Observations	2,728	10,219	19,634	2,728	10,219	19,634
Time FE	N	N	N	Y	Y	Y

Note: The dependent variable in all specifications is $\text{CS}_{i,j,t}$, the credit spread of bond j (issued by firm i) on business day t. (see the DiD specification 3 and the text for details). The entries in the table denote the OLS estimates of coefficients on the specified explanatory variable: $\mathbf{1}[j \in \text{SMCCF}] =$ 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 $\mathbf{1}[t > t^*] =$ 0/1-indicator variable that equals one if date t is greater than the specified announcement date t^* and zero otherwise. In Panel A, $t^* =$ March 23, and in Panel B, $t^* =$ April 9. All specifications include issuer fixed effects and the bond's remaining maturity, age, coupon rate, and the logarithm of the par amount issued as controls (not reported). Absolute t-statistics based on issuer-clustered standard errors are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

Table 7: The Impact of the SMCCF Announcements on Bid-Ask Spreads
(Bond-Level Difference in Differences Analysis)

	Event Window			Event Window		
	1-day	5-day	10-day	1-day	5-day	10-day
Explanatory Variable	(1)	(2)	(3)	(4)	(5)	(6)
A. $t^* =$ March 23						
$\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$	0.004	−0.142**	−0.105***	0.003	−0.142**	−0.105***
	[0.03]	[2.32]	[2.69]	[0.03]	[2.32]	[2.68]
$\mathbf{1}[j \in \text{SMCCF}]$	0.001	−0.015	−0.000	0.002	−0.020	−0.001
	[0.00]	[0.22]	[0.00]	[0.01]	[0.30]	[0.02]
$\mathbf{1}[t > t^*]$	−0.342***	−0.387***	−0.221***	.	.	.
	[3.61]	[7.47]	[6.18]			
R^2	0.33	0.24	0.20	0.34	0.26	0.29
Observations	1,192	4,364	8,712	1,192	4,364	8,712
Time FE	N	N	N	Y	Y	Y
B. $t^* =$ April 9						
$\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$	−0.035	−0.044	−0.007	−0.035	−0.045	−0.007
	[0.40]	[1.09]	[0.21]	[0.40]	[1.10]	[0.23]
$\mathbf{1}[j \in \text{SMCCF}]$	−0.076	−0.069	−0.080**	−0.075	−0.062	−0.067*
	[0.91]	[1.48]	[2.11]	[0.90]	[1.32]	[1.78]
$\mathbf{1}[t > t^*]$	0.118*	−0.131***	−0.388***	.	.	.
	[1.70]	[4.24]	[15.33]			
R^2	0.46	0.39	0.37	0.46	0.40	0.40
Observations	1,352	5,396	10,384	1,352	5,396	10,384
Time FE	N	N	N	Y	Y	Y

Note: The dependent variable in all specifications is $\text{BAS}_{i,j,t}$, the bid-ask spread of bond j (issued by firm i) on business day t (see the DiD specification 3 and the text for details). The entries in the table denote the OLS estimates of coefficients on the specified explanatory variable: $\mathbf{1}[j \in \text{SMCCF}] =$ 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 $\mathbf{1}[t > t^*] =$ 0/1-indicator variable that equals one if date t is greater than the specified announcement date t^* and zero otherwise. In Panel A, $t^* =$ March 23, and in Panel B, $t^* =$ April 9. All specifications include issuer fixed effects and the bond's remaining maturity, age, coupon rate, and the logarithm of the par amount issued as controls (not reported). Absolute t-statistics based on issuer-clustered standard errors are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

In addition to lowering credit spreads, the announcement also improved liquidity by reducing relative bid-ask spreads between ten and 15 basis points, depending on the event window. The follow-up April 9 announcement had a more muted effect. Credit spreads on the SMCCF-eligible bonds are estimated to have narrowed by an additional seven to 13 basis points, depending on the event window, while bid-ask spreads on those bonds did not react to the announcement.

5.3 Fallen Angels

The finding that the April 9 announcement had, on balance, less of an effect on the U.S. corporate bond market is not that surprising. 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. It did, however, modify an important aspect of the program by extending 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 issuer-level DiD specification (2) by an additional interaction level using the 0/1-indicator variable $\mathbf{1}[i = \text{Fallen Angel}]$, which equals one if issuer i is an eligible fallen angel and zero otherwise.[10] Specifically, we use our treatment and control groups to estimate

$$\text{CS}_{i,t}^{treated} - \text{CS}_{i,t}^{control} = \beta \times \big(\mathbf{1}[i = \text{Fallen Angel}] \times \mathbf{1}[t > t^*]\big) + \gamma \times \mathbf{1}[t > t^*] + \eta_i + \epsilon_{i,t}. \qquad (4)$$

Because specification (4) includes issuer fixed effects, the indicator variable $\mathbf{1}[i = \text{Fallen Angel}]$ is not separately identified.

According to the entries in shown in Panel A of Table 8, the effects of the March 23 announcement on credit spreads of fallen angels are evident only in the 10-day window. This delayed effect is not surprising because not all the rating downgrades occurred in the immediate aftermath of the announcement. In the 10-day window, the estimate of β, the coefficient on the interaction term $\mathbf{1}[i = \text{Fallen Angel}] \times \mathbf{1}[t > t^*]$, is positive, economically large, and statistically significant. The point estimate of 3.425 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 announcement.

This large estimated differential increase in credit spreads 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 downgrade-induced

[10] 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 BB-/Ba3 as of the date on which the SMCCF purchased their bonds. For the purpose of our analysis, the downgrade had to occur after March 23 but before April 9. There are 18 companies in our sample that meet this fallen angel criterion.

Table 8: The Impact of the SMCCF Announcements on Fallen Angels' Credit Spreads (Issuer-Level Difference in Differences Analysis)

	Event Window		
	1-day	5-day	10-day
Explanatory Variable	(1)	(2)	(3)
A. $t^* =$ March 23			
$\mathbf{1}[i = \text{Fallen Angel}] \times \mathbf{1}[t > t^*]$	0.513	0.876	3.425**
	[0.58]	[0.87]	[2.30]
$\mathbf{1}[t > t^*]$	−0.137***	−0.164***	−0.109***
	[2.69]	[5.75]	[5.22]
R^2	0.66	0.38	0.39
Observations	1,097	4,691	9,252
B. $t^* =$ April 9			
$\mathbf{1}[i = \text{Fallen Angel}] \times \mathbf{1}[t > t^*]$	−0.275	−1.233*	−2.206**
	[0.56]	[1.82]	[2.20]
$\mathbf{1}[t > t^*]$	0.023	−0.064***	−0.120***
	[0.76]	[4.02]	[8.52]
R^2	0.67	0.50	0.51
Observations	1,258	5,106	9,889

Note: The dependent variable in all specifications is $\text{CS}_{i,t}^{treated} - \text{CS}_{i,t}^{control}$, the difference between the credit spread on issuer i's bond in the treatment group ($\text{CS}_{i,t}^{treated}$) and the credit spread on issuer i's bond in the control group ($\text{CS}_{i,t}^{control}$) on business day t (see the DiD specification 4 and the text for details). The entries in the table denote the OLS estimates of coefficients on the specified explanatory variable: $\mathbf{1}[i = \text{Fallen Angel}]$ = 0/1-indicator variable that equals one if issuer i is an eligible fallen angel and zero otherwise; and $\mathbf{1}[t > t^*]$ = 0/1-indicator variable that equals one if date t is greater than the specified announcement date t^* and zero otherwise. In Panel A, $t^* =$ March 23, and in Panel B, $t^* =$ April 9. All specifications include issuer fixed effects. Absolute t-statistics based on issuer-clustered standard errors are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

increase in default risk was heavily concentrated in the near term, leading to an inversion in the term structure of credit risk for these companies. Second, following the downgrade, the fallen angel's SMCCF-eligible bonds were no longer eligible for purchase by the facility. Losing eligibility for bonds in the treatment group could additionally drive up their credit spreads relative to their counterparts in the control group. Both factors—the rising near-term credit risk and the loss of eligibility status—may thus induce a differential effect between credit spreads in the treatment and control groups.

The estimated effects of the April 9 announcement reported in Panel B, by contrast, are as expected. In the 5-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, while in the 10-day window, the estimated announcement effect rises to 220 basis points. All told, the Fed's April 9 announcement is estimated to have reversed about

Table 9: The Impact of the SMCCF Announcements on Fallen Angels' Bid-Ask Spreads (Issuer-Level Difference in Differences Analysis)

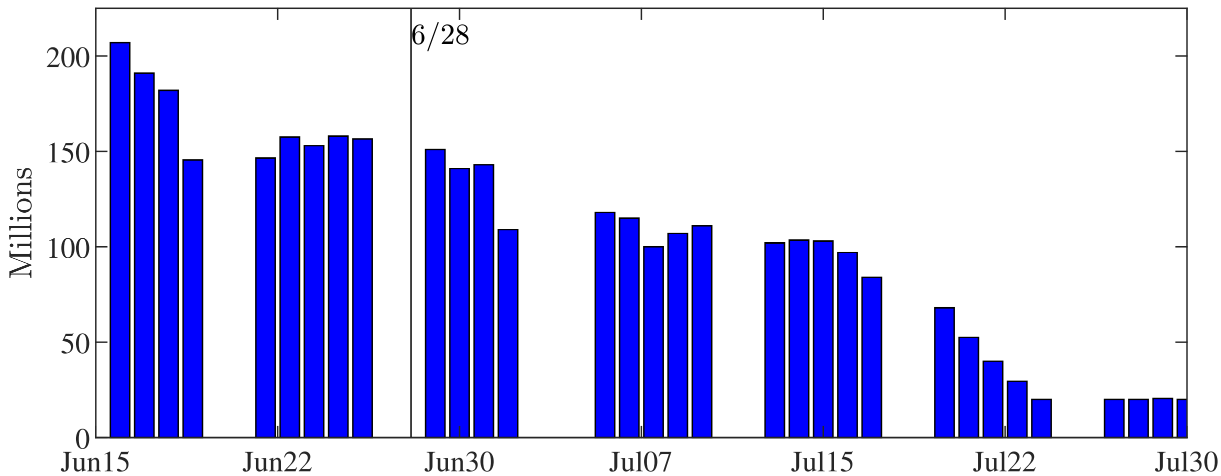
	Event Window		
	1-day	5-day	10-day
Explanatory Variable	(1)	(2)	(3)
A. $t^* =$ March 23			
$\mathbf{1}[i = \text{Fallen Angel}] \times \mathbf{1}[t > t^*]$	5.224**	−1.334	1.941***
	[2.09]	[1.18]	[3.46]
$\mathbf{1}[t > t^*]$	−0.062	−0.149**	−0.083**
	[0.51]	[2.36]	[2.12]
R^2	0.50	0.20	0.15
Observations	497	2,109	4,296
B. $t^* =$ April 9			
$\mathbf{1}[i = \text{Fallen Angel}] \times \mathbf{1}[t > t^*]$	−3.571*	−2.903***	−1.765**
	[1.75]	[6.55]	[2.13]
$\mathbf{1}[t > t^*]$	0.060	−0.033	0.006
	[0.64]	[0.78]	[0.17]
R^2	0.63	0.23	0.15
Observations	550	2,629	5,121

Note: The dependent variable in all specifications is $\text{BAS}_{i,t}^{treated} - \text{BAS}_{i,t}^{control}$, the difference between the bid-ask spread on issuer i's bond in the treatment group ($\text{BAS}_{i,t}^{treated}$) and the credit spread on issuer i's bond in the control group ($\text{BAS}_{i,t}^{control}$) on business day t (see the DiD specification 4 and the text for details). The entries in the table denote the OLS estimates of coefficients on the specified explanatory variable: $\mathbf{1}[i = \text{Fallen Angel}]$ = 0/1-indicator variable that equals one if issuer i is an eligible fallen angel and zero otherwise; and $\mathbf{1}[t > t^*]$ = 0/1-indicator variable that equals one if date t is greater than the specified announcement date t^* and zero otherwise. In Panel A, $t^* =$ March 23, and in Panel B, $t^* =$ April 9. All specifications include issuer fixed effects. Absolute t-statistics based on issuer-clustered standard errors are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

two-thirds of the relative increase in credit spreads for fallen angels that occurred in the aftermath of the March 23 announcement.

Table 9 contains the corresponding announcement effects for bid-ask spreads. Consistent with the credit spread results discussed above, the March 23 announcement is estimated to have boosted bid-ask spreads on the fallen angels' SMCCF-eligible bonds almost 200 basis points—relative to their ineligible counterparts—within the 10-day window bracketing the announcement. This significant deterioration in liquidity, however, was nearly fully reversed by the April 9 announcement, which is estimated to have lowered the fallen angels' SMCCF-eligible bonds about 175 basis points relative to their ineligible counterparts within the same-length window. Indeed, the Fed's April 9 announcement significantly improved liquidity of the SMCCF-eligible bonds issued by fallen angels, inducing declines ranging from 175 to almost 360 basis points depending on the event window.

Figure 5: The SMCCF's Purchases of Individual Corporate Bonds



Note: The vertical blue bars show the total dollar amount (in millions) of individual corporate bonds purchased by the SMCCF between June 16 and July 31, 2020. The vertical line at June 26 indicates the last business day of purchases before the Fed released the detailed composition of its purchases on June 28.
Source: Authors' calculations using TRACE date.

6 The SMCCF's Purchase Effects

Our analysis thus far 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 5 shows the dollar amount of corporate bonds purchased by the facility between June 16 and the end of July of this year. In the latter half of June, the SMCCF purchased about 150 million dollars 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.

Table 10 provides the selected summary statistics of corporate bonds purchased by the facility during this six-week period, based on the information available as of August 10. According to the entries in the table, the SMCCF purchased 1,351 individual corporate bonds, issued by 482 unique companies. A total of 919 unique bonds were purchased between June 16 and July 30, with the total par value of almost \$3.4 billion. The average time-to-maturity across all purchased bonds was about three years, and the average bond in the SMCCF's portfolio was issued nearly four years ago. In terms of their payout characteristics, a vast majority of purchased bonds had a fixed coupon schedule, and the average coupon rate across all purchased bonds was 3.4 percent.

We now examine whether these purchases had an effect on credit and bid-ask spreads in the corporate bond market. We estimate the actual purchase effects using the bond-level DiD framework (see specification 3), where we modify the announcement date t^*. Specifically, in this exercise, t^* equals June 15, a day before the facility commenced with the actual purchases of individual corporate bonds, or June 28 when the Fed revealed the composition of its purchases to the broader

Table 10: Characteristics of Corporate Bond Purchases

Variable	Value
No. of bonds purchased	1,351
No. of unique issuers	482
No. of unique bonds	919
– No. of fixed-coupon bonds	910
– No. of floating-coupon bonds	9
Average time-to-maturity (years)	3.1
Average age (years)	3.9
Average coupon (%)	3.4

Note: This table reports the select characteristics of corporate bonds purchased by the SMCCF between June 16 and July 30, 2020.
Source: Authors' calculations using TRACE data and data from the Federal Reserve Bank of New York.

public. As before, we consider 1-, 5-, and 10-day symmetric windows bracketing the two dates. In this context, it is important to remember that although it was public knowledge that the facility will begin buying individual corporate bonds on June 16, the Fed revealed details of its purchases only on Monday June 28; in other words, from June 16 through June 26, the Fed conducted "stealth" purchases, in the sense that market participants were unaware which corporate bonds were being purchased by the facility.

Table 11 contains the results of this exercise for credit spreads, while Table 12 shows the corresponding results for the bid-ask spreads. In both tables, Panel A reports the estimated purchase effects induced by the actual purchases that started on June 16, while Panel B reports the effects following the release of the detailed information on purchases-to-date to the broader public on June 28.

As shown in Panel A of Table 11, the Fed's "stealth" purchases of corporate bonds had no material effect on credit spreads of the bonds purchased. The estimates of the coefficient β on the interaction term $\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > \text{June 15}]$, while positive, are economically trivial (between one and two basis points) and barely significant at conventional levels. The corresponding estimates of β in Panel B, while at least negative, are also negligible in economic terms and significant at the 5 percent level only in the 10-day window. The results using bid-ask spreads detailed in Table 11 paint the same picture—the Fed's actual purchases of corporate bonds or its announcement of what it had purchased had no effect on the bid-ask spreads in the corporate bond market. Overall, these results would suggest that virtually the entire impact of the Fed's corporate bond-buying program on credit and bid-ask spreads can be attributed to the March 23 and April 9 announcements, rather than to the actual purchases of corporate bonds.

While certainly not implausible, this interpretation relies on evidence from event windows of 1-, 5-, and 10-days bracketing June 15 and June 28. It is entirely possible that the Fed's purchases did have an effect on prices of the SMCCF-eligible bonds, but the effect was very transient. To test this hypothesis, we utilize the *intra-day* transactions data in our TRACE data set to identify

Table 11: The Impact of the SMCCF's Actual Purchases on Credit Spreads
(Bond-Level Difference in Differences Analysis)

	Event Window			Event Window		
	1-day	5-day	10-day	1-day	5-day	10-day
Explanatory Variable	(1)	(2)	(3)	(4)	(5)	(6)
A. $t^* =$ June 15						
$\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$	0.015	0.019*	0.015*	0.015	0.019*	0.015*
	[0.81]	[1.96]	[1.82]	[0.81]	[1.96]	[1.82]
$\mathbf{1}[j \in \text{SMCCF}]$	0.003	−0.020	−0.021	0.003	−0.020	−0.021
	[0.11]	[1.09]	[1.27]	[0.13]	[1.07]	[1.32]
$\mathbf{1}[t > t^*]$	−1.161***	−0.119***	−0.125***	.	.	
	[15.07]	[17.35]	[16.71]			
R^2	0.95	0.94	0.93	0.95	0.94	0.94
Observations	2,668	9,980	19,164	2,668	9,980	19,164
Time FE	N	N	N	Y	Y	Y
A. $t^* =$ June 28						
$\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$	−0.016	−0.003	−0.017**	−0.016	−0.003	−0.017**
	[0.74]	[0.31]	[2.18]	[0.74]	[0.30]	[2.18]
$\mathbf{1}[j \in \text{SMCCF}]$	−0.057*	−0.025	−0.012	−0.057*	−0.025	−0.013
	[1.70]	[1.33]	[0.68]	[1.70]	[1.36]	[0.70]
$\mathbf{1}[t > t^*]$	−0.010	−0.034***	−0.041***	.	.	.
	[0.77]	[5.64]	[6.72]			
R^2	0.95	0.94	0.94	0.95	0.94	0.94
Observations	1,744	8,986	17,878	1,744	8,986	17,878
Time FE	N	N	N	Y	Y	Y

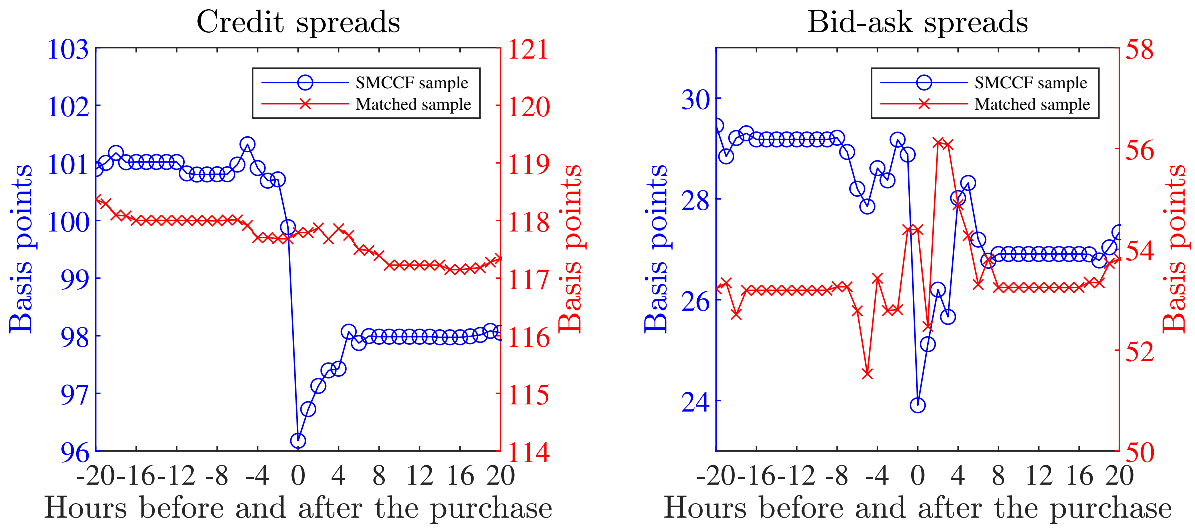
Note: The dependent variable in all specifications is $\text{CS}_{i,j,t}$, the credit spread of bond j (issued by firm i) on business day t (see the DiD specification 3 and the text for details). The entries in the table denote the OLS estimates of coefficients on the specified explanatory variable: $\mathbf{1}[j \in \text{SMCCF}] =$ 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 $\mathbf{1}[t > t^*] =$ 0/1-indicator variable that equals one if date t is greater than the specified date t^* and zero otherwise. In Panel A, $t^* =$ June 16, and in Panel B, $t^* =$ June 28. All specifications include issuer fixed effects and the bond's remaining maturity, age, coupon rate, and the logarithm of the par amount issued as controls (not reported). Absolute t-statistics based on issuer-clustered standard errors are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

TABLE 12: The Impact of the SMCCF's Actual Purchases on Bid-Ask Spreads
(Bond-Level Difference in Differences Analysis)

	Event Window			Event Window		
	1-day	5-day	10-day	1-day	5-day	10-day
Explanatory Variable	(1)	(2)	(3)	(4)	(5)	(6)
A. $t^* =$ June 15						
$\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$	0.011	−0.028	−0.022	0.011	−0.028	−0.022
	[0.20]	[1.06]	[1.13]	[0.20]	[1.06]	[1.13]
$\mathbf{1}[j \in \text{SMCCF}]$	0.031	−0.012	−0.014	0.031	−0.012	−0.014
	[0.55]	[0.41]	[0.57]	[0.55]	[0.41]	[0.56]
$\mathbf{1}[t > t^*]$	−0.021	−0.015	−0.017	.	.	.
	[0.50]	[0.77]	[1.02]			
R^2	0.53	0.46	0.42	0.53	0.46	0.42
Observations	1,334	5,016	9,662	1,334	5,016	9,662
Time FE	N	N	N	Y	Y	Y
A. $t^* =$ June 28						
$\mathbf{1}[j \in \text{SMCCF}] \times \mathbf{1}[t > t^*]$	−0.089	−0.012	0.008	−0.089	−0.012	0.008
	[1.31]	[0.41]	[0.37]	[1.31]	[0.41]	[0.37]
$\mathbf{1}[j \in \text{SMCCF}]$	0.042	−0.041	−0.032	0.042	−0.041	−0.032
	[0.59]	[1.20]	[1.18]	[0.59]	[1.19]	[1.20]
$\mathbf{1}[t > t^*]$	0.054	−0.023	−0.048	.	.	.
	[0.97]	[0.99]	[2.86]			
R^2	0.54	0.47	0.44	0.54	0.47	0.44
Observations	864	4,456	8,870	864	4,456	8,870
Time FE	N	N	N	Y	Y	Y

NOTE: The dependent variable in all specifications is $\text{BAS}_{i,j,t}$, the bid-ask spread of bond j (issued by firm i) on business day t (see the DiD specification 3 and the text for details). The entries in the table denote the OLS estimates of coefficients on the specified explanatory variable: $\mathbf{1}[j \in \text{SMCCF}] =$ 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 $\mathbf{1}[t > t^*] =$ 0/1-indicator variable that equals one if date t is greater than the specified date t^* and zero otherwise. In Panel A, $t^* =$ June 16, and in Panel B, $t^* =$ June 28. All specifications include issuer fixed effects and the bond's remaining maturity, age, coupon rate, and the logarithm of the par amount issued as controls (not reported). Absolute t-statistics based on issuer-clustered standard errors are reported in brackets: * $p < .10$; ** $p < .05$; and *** $p < .01$.

Figure 6: Credit and Bid-Ask Spreads Around the SMCCF's Actual Purchases



Note: The blue line in the left panel shows the daily average credit spreads of bonds in the treatment group (i.e., the SMCCF-eligible sample), while the red line shows the average credit spreads in the control group (i.e., the issuer-matched sample of ineligible bonds). The right panel shows the daily average bid-ask spreads for the same two samples. See the text for details regarding the construction of the treatment and control groups. Vertical lines: (1) March 23, 2020: the Fed announces the establishment of the Primary Market Corporate Credit Facility (PMCCF) and the Secondary Market Corporate Credit Facility (SMCCF); and (2) April 9, 2020: the Fed expands the PMCCF and SMCCF to include corporate debt that was rated investment grade as of March 22 but was subsequently downgraded.
Source: Authors' calculations using TRACE date.

the Fed's purchases of individual bonds. By matching the bond's CUSIP, purchase date and time, transaction price and quantity in dealer-to-customer transactions, we are able to uniquely identify almost all of the Fed's purchases.[11] Using the exact time of each purchase, we perform a simple intra-day event study, whose major advantage is that we are able to identify much more short-lived purchase effects.

The blue line in the left panel of Figure 6 shows the average spread on bonds actually 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 red 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.[12] Interestingly, the actual purchases ap-

[11]Specifically, we uniquely 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 drop this transaction from our analysis.

[12]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 issuer but whose time-to-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

pear 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 6 shows the same event study for bid-ask spreads. Though considerably more noisy, the average bid-ask spread on bonds actually purchased by the SMCCF, the blue 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 our control group, by contrast, shows no discernible pattern around the purchase time.

7 Conclusion

In this paper, we identify the effects of the SMCCF on the U.S. corporate bond market using a variety of identification strategies. We find that the Fed's March 23 and April 9 announcements both had economically large and statistically significant effects on credit spreads, in combination narrowing spreads by 20 basis points on eligible bonds relative to their ineligible counterparts within the same set of issuers across the two announcement periods. The March 23 announcement also significantly improved market liquidity by lowering bid-ask spreads. The April 9 announcement, by narrowing both credit and bid-ask spreads, had an especially pronounced effect on the SMCCF-eligible bonds issued by the qualified fallen angels.

The actual bond purchases conducted by the Fed from mid-June through the end of July are estimated to have narrowed credit spreads by an additional five basis points and bid-ask spreads by two basis points. These findings are intuitive in the sense that the announcements were interpreted by market participants as a credible signal of the Fed's willingness to take a material amount of credit risk on its balance sheet to support the corporate credit markets. Overall, we find strong evidence for both announcement and purchase effects of the SMCCF, and our quantitative assessment of those effects indicates that the facility made it substantially easier for companies to borrow in the corporate bond market.

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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 only the bond with time-to-maturity as close to 5 years as possible.

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