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How new Fed corporate bond programs cushioned the Covid-19 recession

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A B S T R A C T
In the financial crisis and recession induced by the Covid-19 pandemic, many investment-grade firms became unable to borrow from securities markets. In response, the Fed not only reopened its commercial paper funding facility but also announced it would purchase newly issued and seasoned corporate bonds rated as investment grade before the Covid pandemic. We assess the effectiveness of this program using long sample periods, spanning the Great Depression through the Great and Covid Recessions. Findings indicate that the announcement of corporate bond backstop facilities helped stop risk premia from rising further than they had by late-March 2020. In doing so, these backstop facilities limited the role of external finance premia in amplifying the macroeconomic impact of the Covid pandemic. Nevertheless, the corporate bond programs blend the roles of the Federal Reserve in conducting monetary policy via its balance sheet, acting as a lender of last resort, and pursuing credit policies.

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In the financial crisis and recession induced by the Covid-19 pandemic, the ability of firms and municipal governments to borrow from securities markets dried up, as did access by small and mid-sized firms to bank loans. The massive credit squeeze risked seriously damaging the real economy via a financial accelerator mechanism. This credit crunch was manifest in a spike in the corporate Baa-10-year Treasury bond yield spread, a longstanding measure of systemic risk (see Fig. 1). In response, the Fed not only reemployed all the new tools it created during the Great Recession, but also greatly expanded its credit-easing and lender of last resort role in several ways.

This study focuses on the Fed’s announcement that it would buy exchange traded funds (ETFs) of seasoned bonds and newly issued bonds of corporations rated as investment grade before the Covid pandemic. It did so with the explicit backing of the Treasury, which covered any default losses from such purchases. This novel policy was not used in 2008 since without Treasury indemnification against losses, the Fed believed that the riskiness of corporate bonds implied that it did not have the requisite authority. In addition, the Fed in 2008 did not foresee the magnitude and impact of the severe widening of the corporate–Treasury bond spread, whose peak reached highs not seen since 1935 (Duca, 2017). As Fig. 1 illustrates, the spread between yields on Baa-rated corporate and 10-year Treasury bonds (BaaTr) in the recent crisis rose in line with the weekly insured unemployment rate until the Fed announced its corporate bond program in March 2020.

A careful splicing of different unemployment rate series enables us to assess the effectiveness of recent Fed corporate bond

Abbreviations: GFC, Global Financial Crisis; PMCCF, Primary Market Corporate Credit Facility; SMCCF, Secondary Market Corporate Credit Facility; CCF, Corporate Credit Facilities; ETF, Exchange Traded Fund; CFMA, Commodity Futures Modernization Act; TALF, Term Asset-Backed Securities Loan Facility; QE, Quantitative Easing; FG, Forward Guidance; FRBUs, Federal Reserve Board model of the U.S. economy.

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interventions over a long sample that spans the Great Depression through the Great and Covid-19 Recessions. Findings indicate that the announcements of corporate bond backstop facilities prevented corporate bond risk premiums from rising further above pre-GFC averages than they did by late-March 2020. By doing so, these programs limited the role of external finance premia in amplifying the macroeconomic impact of the pandemic and the risk that a panic-induced wave of corporate bankruptcies could worsen the downturn and prolong the recovery from it. Thus, the corporate bond facilities can be seen as a new means by which the Fed pursues its full employment and price stability objectives rather than as an expansion of its mandate. As shown in Fig. 2, a motivation for this new tool is the rise of corporate bonds and the fall of depository loans as sources of external debt for nonfinancial corporations.

Our study is organized as follows. Section 2 discusses the evolution of the Fed’s response to cushion the economy from financial shocks. Section 3 provides details on the Fed’s corporate bond facilities and Section 4 reviews how our paper contributes to the emerging literature on them. Section 5 presents our models of corporate bond premia and Section 6, our data and variables, some of which are novel and extend to 1929. Section 7 presents regression and simulation results. Section 8 discusses how the corporate bond programs differed from other policy actions and presents some robustness checks. The conclusion provides a broader perspective on our findings.

2. The Baa-Treasury spread, fed policy in crises, and the financial accelerator

The Baa-Treasury spread has long been used to analyze the macro-economy and as a gauge of financial crises dating back to at least Friedman and Schwartz (1963). Since Bernanke (1983), the spread has been made more popular by the credit and financial frictions literature, including Bernanke et al. (1996, 1999), Bordo (2008), Mishkin (1991), and Mishkin and White (2002).\footnote{Gilchrist and Zakjek (2012) refine the analysis of corporate credit spreads by extracting from them an excess bond premium, which Bordo and Duca (2020) find was lowered by the Fed’s corporate bond programs.}

A major reason is that this spread correlates well with banking panics, severe financial crises, extreme political shocks and other events as shown by Bordo (2008).

The Federal Reserve was founded to provide financial stability by acting as a lender of last resort to prevent the banking panics that plagued the national banking era (1865 to 1914). The Fed was mandated to follow well-established central banking practice (Bordo and Wheelock, 2011) and to lend freely on the basis of sound collateral (eligible banker’s acceptances or commercial paper). A rule of thumb for central banks’ lender of last resort policy, based on British precedent, was Bagehot’s rule (Bagehot, 1873) which stated that in the face of a banking panic a central bank was to lend freely but at a penalty rate to solvent but illiquid financial institutions. Bagehot’s rule also has been interpreted as lending freely to the money market and not to individual banks (Bordo, 2014).

The Fed successfully prevented a banking panic in 1920 (Gorton and Metrick, 2013, Tallman and White, 2020) and the New York Fed successfully provided liquidity to the New York money center banks during the October 1929 Wall Street Crash to prevent a panic (Friedman and Schwartz, 1963). However, the Fed did not prevent banking panics between 1930 and 1933 which Friedman and Schwartz (1963) argued induced a one-third decline in the money supply that made the Great Contraction 1929–1933 so severe. Bernanke (1983) supported their ‘money hypothesis’ but argued that the banking failures propagated the depression by raising the cost of credit intermediation by severing the link between saving and investment that banks provided.

Bernanke’s focus on credit led to the concept of the ‘financial accelerator’ (Bernanke et al., 1996 and 1999). A large finan-
cial shock leading to a collapse of asset prices reduces the net worth of firms and households, which reduces the collateral available for loans. Commercial banks cut lending which reduces household consumption and business investment. This lowers real output and prices, which in turn reduce net worth and bank lending. This process leads to debt defaults and bankruptcies, spurring bank failures and further credit impairment. In addition, deflation leads to Irving Fisher’s (1933) debt deflation, which further reduces net worth, amplifying the downward spiral. Tightening credit conditions also affect non-bank financial intermediaries and financial markets leading to a general collapse of credit. A key indicator of credit turmoil is the Baa-10-year Treasury bond spread which tracks not only the effects of a credit crunch leading to defaults, but also a shortage of liquidity as occurs in banking panics.

After the Great Contraction, the banking panic problem was greatly reduced by important reforms to the Federal Reserve and the banking system including the creation of the Federal Deposit Insurance Corporation (FDIC) and adding Section 13.3 to the Federal Reserve Act greatly. To overcome the severe restrictions on the Fed’s discount window lending during the Great Contraction (Bordo and Wheelock, 2011), section 13.3 allowed the Federal Reserve to lend to non-member banks and other institutions on sound collateral in “unusual and exigent circumstances.” Although there were several banking crises from the 1970s to the Global Financial Crisis (GFC) these were not classic liquidity driven panics but rather solvency crises (Bordo, 2014). They were addressed by fiscal bailouts and not by lender of last resort actions (Bordo and Meissner, 2016).

The GFC, which began with a collapse in house prices and was centered in the shadow banking system, involved a massive credit crunch amplified by fears of counterparty holdings of toxic financial derivatives based on mortgages of varying quality. This fear was manifest in a spike in the Baa-Treasury spread as well as other spreads, such as the TED spread (Libor-Treasury bill), the commercial paper–Treasury bill rate spread, and the gap between the 30-year mortgage and 10-year Treasury interest rates. The Fed initially viewed it as a liquidity panic and greatly expanded its discount window facilities to give many financial institutions access to the discount window.

The credit crunch spread through the plumbing of the financial system to the repo market a critical source of bank funding. This led the Fed to create facilities to unplug the arteries of the financial system. Via the Commercial Paper Funding Facility, the Fed bought newly issued, top-grade paper and helped cap the paper-bill spread (Duca, 2013). The Fed also bought Aaa-rated debt of lenders via the Term Asset-Backed Securities Loan Facility, which helped keep lender funding costs and hence loan interest rates from soaring (Agarwal et al., 2010). Moreover, the tightening of credit set in motion the financial accelerator mechanism that Bernanke (1983, 1995) outlined for the Great Contraction and for which Bernanke and Gertler (1990) provided theoretical underpinnings. Such considerations led the Fed to develop radical new facilities and buy large quantities of mortgage-backed securities (MBS) to keep credit flowing through the system.

It later became apparent that more important than a liquidity shortage was the potential insolvency of the investment and universal banks that held the toxic derivatives in off-balance sheet special investment vehicles (SIVs). This problem was finally solved by recapitalizing banks with TARP funds following a series of stress tests, both of which allayed counterparty risk.

The March 2020 Covid-19 crisis had elements of both a liquidity crunch and a credit crunch reminiscent of the GFC, as households cut work hours and consumption and as firms cut investment and payrolls with negative effects magnified by government-mandated lockdowns. The panic was reflected in a spike in the Baa-Treasury bond spread. It became quickly apparent to the Fed that massive liquidity injections were needed to prevent not only widespread defaults, but also a collapse of credit networks and financial accelerator effects that would amplify the downturn.

Fig. 2. The rising role of bonds in debt finance for nonfinancial corporations (Sources: Financial Accounts of the U.S. and authors’ calculations).
The Fed reestablished its discount window and other financial “plumbing” facilities developed in the GFC. The latter includes resuming the Commercial Paper Funding Facility and the TALF, as well as again buying large quantities of MBS. The Fed also engaged in new activities, specifically to prevent business defaults. Hence, it began to support the corporate bond market through creating two new facilities. Other novel facilities (backstopped by the Treasury) supported the municipal bond market (Municipal Liquidity Facility) and bank loans to medium size companies bought or backed by the Fed’s new Main Street Lending Facilities. These actions likely mitigated and delayed a wave of business defaults that the bankruptcy court and financial systems were ill prepared to address. As shown later, the programs supporting the corporate bond market—the focus of this study—prevented a further spike in the Baa–Treasury bond spread, which had previously risen with the unemployment rate much as it did in the GFC. Thus, although different impulses triggered these two recessions and supply was more constrained in the Covid Recession, a common amplification was in play that the Fed’s new programs curtailed in the Covid Recession.

3. An overview of the Fed’s new corporate bond facilities

Fed corporate bond facilities bought newly issued investment-grade bonds with maturities up to four years by its Primary Market Corporate Credit Facility (PMCCF) or exchange-traded funds (ETFs) invested in seasoned investment-grade bonds with remaining maturities under five years by its Secondary Market Corporate Credit Facility (SMCCF). Eligible debt was limited to that of U.S. firms with at least 95 percent of proceeds supporting U.S. operations and was limited to nonbanks and firms not receiving other federal aid under the CARES Act of 2020.

To shield the Fed from losses both facilities were structured as special purpose vehicles, funded by Treasury equity stakes of up to $50 billion for the PMCCF and $25 billion for the SMCCF. Debt held by the Fed funded the remainder using up to 10:1 leverage for buying investment grade bonds or syndicated loans that are investment grade when purchased. Portfolio exposure to any one firm was limited to 10% of an issuer’s maximum historical outstanding bonds and to 1.5 percent of combined PMCCF and SMCCF assets. There was a combined size limit of $750 billion on the PMCCF and SMCCF, with both initially expiring on September 30, 2020, but later extended to yearend 2020. The PMCCF could buy newly issued eligible bonds at spreads over comparable maturity Treasuries in a range based on credit rating and prevailing spreads over comparably rated bonds at the time of PMCCF purchase plus one percentage point for a facility fee. While the pricing guidelines for the SMCCF are less explicit, that facility bought investment grade ETFs when the corporate Baa-Treasury spread exceeded 300 basis points. This was about 100 basis points above the average from 1970 up until the global financial crisis of 2007–08.

Quite notably the Baa-Treasury spreads stopped rising on March 23, 2020, when the Fed announced that it would set up the PMCCF and SMCCF. Furthermore, the subsequent purchases by the Fed were under 50 billion by the early July 2020—far below the limits on the size of the facilities (see Table 1)—with the vast bulk being purchases of ETFs by the SMCCF. Instead of reflecting a balance sheet effect (as with QE), this pattern reflects a strong “backstop” effect from announcing the facility by a central bank having a great ability to expand its balance sheet, with an announcement effect evident seven weeks ahead of the Fed’s initial corporate bond purchase.

4. Literature review

The Fed’s corporate bond interventions have spurred new research that generally takes one of two approaches. The first assesses how a wave of redemptions by household investors triggered large fire sales of corporate and municipal bonds by mutual funds that fueled a liquidity crisis in the corporate bond (see Falato et al. (2020) and Haddad et al. (2020)) and municipal bond (Li et al., 2020) markets. Falato et al. (2020) show that bond mutual outflows were greater for funds that invested in more Covid sensitive firms, and that the Fed announcements of the creation and expansion of the PMCCF and SMCCF spurred larger reversals of flows back into funds more exposed to bonds that were eligible for purchase by the new Fed facilities. Haddad et al. (2020) find that the announcements of the creation of the two corporate bond programs disproportionately reversed how much corporate-Treasury bond spreads had risen relative to expected default risk (as tracked by CDS spreads) in the early spring. In particular, the reversals were greater for bonds that were eligible for purchase by the facilities.

The second strand of literature tests whether the transactions costs or yields on bonds that were eligible for purchase fell more than those for ineligible bonds after the program announcements. O’Hara and Zhou (2021) show that trading costs for securities dealers rose and dealer inventories of corporate bonds fell early in the pandemic. Using a diff-in-diff approach, they find that dealer transactions costs fell for newly issued bonds eligible for the PMCCF versus those that were ineligible. Analogously, they find that transactions costs for previously issued bonds fell for those that were eligible for purchase by the SMCCF relative to those that were ineligible.

Three other papers apply a diff-in-diff or regression discontinuity approach to bond yields and spreads. Boyarchenko et al. (2020), D’Amico, Kurakula, and Lee (2020), and Gilchrist, et al. (2020) identify how the Fed’s announcements of bond facilities for investment-grade debt and the extension of eligibility to some downgraded “fallen angel” firms lowered bond yield spreads and returns more for eligible versus ineligible bonds. Boyarchenko et al. (2020) find that improved functioning of secondary markets lowered benchmark yields off which primary securities are priced, thereby lowering yields on new issued.

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Table 1

| Table 1 | The Fed’s balance sheet on July 8, 2020 (Source: Federal Reserve Board, week average of daily figures). |
|---|---|
| Credit and Liquidity Programs | FRS Assets (bil.) | Max. Size |
| New Post-Covid Programs | | |
| Corporate Bond | 164 |  |
| Municipal Liquidity | 42 | 750 |
| Paycheck Protection Program | 16 | 500 |
| Main Street Lending | 68 | Unlimited |
| Reopened Pre-Covid Programs | | |
| Term Asset Backed Securities | 9 | 100 |
| Commercial Paper Funding | 13 | Unlimited |
| Money Market Mutual Fund Liquidity | 20 | Unlimited |
| Primary Dealer Credit | 2 | Unlimited |
| Major Asset Categories | | |
| Total Securities Held Outright | 6134 |  |
| Treasuries | 4221 |  |
| MBS | 1911 |  |
| Other Securities | 309 |  |
| Primary and secondary discount lending | 5 |  |
| New and reopened credit & liquidity programs | 207 |  |
| Central bank swaps & other Reserve Bank assets | 218 |  |
| Memo: Total Reserve Bank Credit | 6915 |  |
| Other Assets Supplying Reserve Funds | 88 |  |
| Total Assets Supplying Reserve Funds | 6969 |  |

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3 Also eligible were bonds from firms one notch below investment grade that were investment grade in March 2020. 
eligible bonds and by making dealers more willing to place issues. D’Amico, et al. (2020) and Gilchrist et al. (2020) find larger effects for debt with maturities closer to those bought by the two bond facilities than for longer maturities.4

Another relevant finding is that much of the rise in yields on investment grade corporate bonds during the spring of 2020 owed not to rises in expected default risk, but rather to greater risk aversion or liquidity premiums. Haddad, et al. (2020) stress how corporate-Treasury bond spreads rose relative to CDS spreads, while Gilchrist, et al. (2020) analyze corporate bond yields controlling for default risk among other variables. Both studies find that these widenings reversed more for bonds eligible for purchase by the facilities when the facilities were announced.

Together, these studies provide evidence of a notable backstop effect of the new Fed corporate bond programs. Nevertheless, these studies may understate the impact of the programs by focusing on differential effects on eligible versus ineligible bonds, thereby missing some of the indirect effects on yields on ineligible bonds, and also how the worsening economic conditions would have likely raised risk premia even higher absent the Fed intervention. In addition, data limitations prevent these studies from drawing information from prior business and financial cycles. Because background conditions can shift over time, cross-section results from one episode may not fully apply to other episodes. Our study complements these papers by analyzing bond spreads across several business cycles, which can help guide counterfactual estimates of how high the spreads would have risen absent the new facilities. Although our time series findings are consistent with many of these micro/cross section studies, our focus is not on establishing causality from the programs to bond yields, but rather on gauging their effects on limiting the amplification of the recession by limiting the nascent surge in spreads that was underway in early March 2020.

5. A model of the Baa-Treasury spread

The main corporate spread investigated is the gap between yields on Baa-rated corporate bonds (Moody’s) and on long-term U.S. government bonds.

5.1. Modeling the baa-treasury spread over 1929–2021

Baa and Aaa corporate yields are available monthly since 1919. Of these, the Baa is more relevant because few firms are rated Aaa (only two in 2020) and because the impact of financial frictions on firm activity tends to be greater for firms that are less resilient than Aaa-rated firms. The 10-year Treasury yield series follows Duca (2017) in splicing three series on long-term Treasury yields. This spread (BaaTr) widens in recessions, especially in the Great Depression, Great Recession, and the Covid Recession (Fig. 3). The Baa spread also tends to be coincident with the business cycle (Duca, 1999), in line with evidence that a consistently measured monthly unemployment rate (UR, Section 6.1) has moved with the BaaTR spread since the late 1920s.

Before the Fed announced the corporate bond facilities, the Baa-Treasury spread mainly reflected not only measurable cyclical and secular risks for corporate debt and shifts in monetary policy, but also hard-to-forecast shocks to liquidity, default risk, and risk aversion. Time series measures for each factor are limited by data availability and endogeneity.5 Tracking the cyclicality of spreads over long periods requires consistent measures of the depth of cycles for which the unemployment rate, output gap, and capacity utilization are available monthly, and the insured unemployment rate, weekly. The correlation of the BaaTR spread is stronger with the square of the unemployment rate than with the level, while the spread’s correlation with the output gap and capacity utilization is stronger in their levels.6 While monthly results are similar using the latter two variables, we mainly proxy cyclical risks with the square of the unemployment rate (UR2), which is expected to be positively correlated with BaaTR and is available monthly and weekly.

That correlation, however, is affected by a major shift following the failure of Penn Central in April 1970 (PennCentral = 1 since then, 0 before), which Jaffee (1975) also found significant. This failure plausibly affected investor’s assessment of the cyclical risk of investment-grade bonds because between 1941 and Penn-Central’s failure, there were no investment-grade defaults (Jaffee, 1975, p. 310), and (Moody’s, 2007, p. 15), but there were 16 in the next 20 years. Furthermore, the “quiet” period between 1951 and June 1970 saw only 17 defaults by speculative-rated corporations followed by 342 defaults in the next 20 years. The period since Penn-Central’s default is marked less by an upward level shift in the spread and more by a greater amplitude of swings—i.e., increased sensitivity to the business cycle. While the swings in the spread are correlated with defaults, it is unclear how much they reflect liquidity versus solvency risk.

Secular shifts in corporate debt risk can be tracked by either major shifts in regulations and the conduct of monetary policy, or by time trends. The latter provides little insight and coefficient estimates on time trends can reflect omitted variable bias from not controlling for other factors. With respect to the former, we found two significant upshifts in the Baa corporate spread after WWII. The first concerns the conduct of monetary policy associated with the Treasury-Fed Accord of 1951. From the start of our sample up to the Accord, the long Treasury yield was constrained by 0 from below in the Great Depression era or by the pegging of the long-Treasury yield from 1942 to March 1951. As a result, there was less counter-cyclical monetary policy implying higher default risk before the Accord. Indeed, we find that a monetary policy regime shift dummy (PreAccord = 1 before March 1951, 0 otherwise) is associated with a higher range of the spread, i.e., an upward shift in the constant in a model of the spread. We tested for other shifts related to monetary policy, but limits to the length of samples—such as the short period of the Gold Standard Convertibility (April 1929-December 1933) or money supply targeting (October 1979-October 1982)—hindered our ability to detect level shifts in BaaTR or shifts in its sensitivity to the unemployment rate. We did, however, find a large negative effect of the suspension of gold convertibility and the devaluation of the dollar in December 1933 on the change in BaaTR.

4 Boparchenko, Kover, and Shachar (2020) find that the corporate bond markets functioned better, lower expected defaults and increased bond issuance. D’Amico, Kurakula, and Lee (2020) analyze the returns on exchange traded funds invested in bonds having versus not having characteristics making them eligible for the PMCCF and SMCCF.

5 Fed interventions prevent using the commercial paper bill spread (Friedman and Kuttner) after 2007 or corporate spreads in modeling commercial paper (Duca, 2013) or municipal-Treasury spreads after February 2020. Endogeneity prevent using the yield curve as long-term Treasury yields affect its slope and the base off which corporate and muni spreads are measured. Also, QE affects the consistency of the yield curve over time. The post-2007 Fed balance sheet also limits using the TED spread as high excess reserves the spread’s ability to track general market risk premia.

6 Swings in output around trend tend to be larger than rises in the unemployment rate, as noted Okun, 1970 who argued that labor market frictions gave firms incentives to adjust employment less than output. This is consistent with our findings that cyclical shifts in corporate risk premia are more correlated with the square of the unemployment rate rather than its level, while levels of the output gap and capacity utilization outperform their quadratic counterparts.
The second major secular shift in BaaTR is an upshift in December 2000, when Congress approved the Commodity Futures Modernization Act (CFMA). As Bolton and Oehmke (2015) and Stout (2011) show, the CFMA exempts derivatives counterparties from the automatic stay in bankruptcy, enabling immediate collection from a defaulted counterparty, giving them a senior claim over most other bankruptcy claimants. The passage of CFMA was quickly followed by a surge in credit default swaps (Duca and Ling, 2020). By giving bankruptcy priority to derivatives (mainly credit default swaps), the CFMA lowered the priority of bond investors and made bonds riskier (see Bolton and Oehmke, 2015). We find that a shift dummy (CFMA = 1 since December 2000, = 0 otherwise) captures an upward level shift in the corporate-Treasury yield spread.7

These considerations imply the following specification for the equilibrium spread:

\[
BaaTR_t = \alpha_0 + \alpha_4 UR_t^2 + \alpha_2 PennCentral_t \times UR_t^2 + \alpha_3 PreAccord_t + \alpha_4 CFMA_t
\]  

(1)

where each coefficient \(\alpha_i\) has an expected positive sign. According to stationarity tests (Appendix A), the levels of BaaTR and UR are not stationary at monthly and weekly frequencies, while their first differences are stationary. Owing to their construction, the same is the case for the two shift variables, PreAccord and CFMA. These tests indicate that the variables in Eq. (1) have unit roots. Accordingly, we estimate Eq. (1) monthly over 1929 to 2021 using a cointegration approach (Johansen’s, 1995) to jointly estimate the long-run level and the short-run change. The latter first difference equation includes an error-correction term (the t-1 gap between the actual and equilibrium spread), lags of first differences of all the variables in the long-run equilibrium relationship and a vector \(X\) of exogenous event shocks. The inclusion of the latter is needed to yield uncorrelated residuals in the first difference model and has little effect on the estimated coefficients of the long-run (equilibrium) relationship. Building off Eq. (1), we thus estimate:

\[
\begin{align*}
BaaTR_t & = \beta_0 + \beta_1 EC_{t-1} + \sum_{i=1}^{n} \beta_2i \Delta BaaTR_{t-i} + \sum_{i=1}^{n} \beta_3i \Delta UR_t^2 \\
& + \sum_{i=1}^{n} \beta_4i \Delta [PennCentral_{t-i} \times UR_t^2] \\
& + \sum_{i=1}^{n} \beta_5i \Delta PreAccord_{t-i} + \sum_{i=1}^{n} \beta_6i \Delta CFMA_t + \Omega X_t,
\end{align*}
\]  

(2a)

\[
\Delta BaaTR_t = \beta_0 + \beta_1 EC_{t-1} + \sum_{i=1}^{n} \beta_2i \Delta BaaTR_{t-i} + \sum_{i=1}^{n} \beta_3i \Delta UR_t^2 \\
+ \sum_{i=1}^{n} \beta_4i \Delta [PennCentral_{t-i} \times UR_t^2] \\
+ \sum_{i=1}^{n} \beta_5i \Delta PreAccord_{t-i} + \sum_{i=1}^{n} \beta_6i \Delta CFMA_t + \Omega X_t
\]  

(2b)

where \(EC_{t-1} = BaaTR_{t-1} - BaaTR_{t-1}\), lag lengths minimize the SIC, \(\Omega\) is a vector of coefficients for the \(X\) vector and the estimation allows for time trends in each variable in the long-run equation but not a trend in the long-run relationship. The coefficient \(\beta_1\) on the error-correction term should be negative so that the spread converges toward its equilibrium, with the absolute magnitude implying the speed of error-correction. Note that the model implicitly imposes an almost instantaneous reaction of the corporate bond yield to the long-term Treasury yield, reflecting the Treasury yield’s role as a benchmark. The speed of error-correction (the speed at which the spread adjusts), reflects lags in how the perceived relative risk and degree of risk aversion for Baa-rated corporate bonds adjust in response to the business cycle and the regime shifts.5

The latter involve the failure of Penn Central, the Treasury-Fed Accord,

---

7 The CFMA era is also marked by greater international portfolio holdings of safe assets, such as long-term Treasuries, that may push down Treasury yields relative to corporate Baa yields.

8 Note that the estimators of these coefficients are super-consistent, implying that standard asymptotic theory will overstate the statistical significance of the variables in the long-run relationships.
and the CFMA-related shift in the bankruptcy priority and the relative risk of Baa-rated corporate versus Treasury bonds.

Eqs. (2a) and (2b) comprise a baseline model of the Baa-Treasury yield spread before the Fed announced its new corporate bond-buying facilities in late March 2020. By preventing the spread from rising further, this intervention broke the normal equilibrium relationship. This can be seen in Figs. 1 and 3. Accordingly for samples extending past February 2020, we adjust the baseline equation to allow for a change in the impact of the unemployment rate on the spread.

5.2. Modeling the corporate-treasury yield spread with higher frequency data 1971–2021

Given the short post-Covid sample, using higher frequency weekly data has the advantage of helping identify the effects of the pandemic and Fed interventions on the corporate bond market, but at the disadvantage of not spanning pre-1971 data. The weekly models have the advantages of using unemployment data that have not been spliced and avoid the need to control for regime shifts other than CFMA. Accordingly, the weekly model for the post-1970 sample simplifies to:

\[
\text{Baa}_{t} = \alpha_{0} + \alpha_{1} (UR_{t}^{T}) + \alpha_{4} \text{CFMA}_{t}
\]

\[
\Delta \text{Baa}_{t} = \beta_{0} + \beta_{1} E_{t-1} + \sum_{i=1}^{n} \beta_{2i} \Delta \text{Baa}_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta \text{CFMA}_{t} + \Omega_{t}
\]

6. Data and variables

This section provides details on the unemployment rate variables, how some models adjustments for Fed corporate bond programs, and on exogenous shock variables.

6.1. Unemployment rate

The main cyclical variables are variants of the monthly civilian unemployment rate and the weekly insured unemployment rate from the initial claims for unemployment report. Monthly unemployment rates are based on data from the Bureau of Labor Statistics (BLS) that the BLS derived from the monthly household survey since 1948 and from other, earlier Census surveys. Readings from 1933 to 1943 are adjusted for time-varying employment in Depression-era federal job-creation programs that were excluded in calculating the unemployment rate. Adjustments use estimates from Darby (1976), who showed that official statistics from this period are not comparable with those from other periods, and notably overstate unemployment in the mid to late-1930s. As discussed in an appendix in Bordo and Duca (2020), monthly readings on unemployment are adjusted based on Darby's estimates and for several breaks in data before 1948. Monthly data from the household survey spanning January 1948–present are spliced with 1940–47 data from an earlier Census survey and with 1929–39 data from the Conference Board.

In weekly models our cyclical variable is based on the weekly, insured unemployment rate from the weekly initial claims report, available since 1971. The raw series has not consistently moved with the monthly unemployment rate (Cleary et al., 2009) because the taxation of, and eligibility for, UI benefits have changed, as have the regional and unionized composition of employment which affect the proclivity of the unemployed to file for benefits and count as unemployed. To address this we multiply the seasonally-adjusted weekly series by the centered, 12-week moving average of the ratio of the weekly unemployment rate to the monthly unemployment rate.\(^9\) While the adjusted and unadjusted weekly unemployment rates are each significantly related to (cointegrated with) the Baa-Treasury spread and the spread significantly corrects toward its equilibrium, the adjusted series yields short-run residuals that are not significantly correlated in contrast to residuals from a model using the unadjusted series.

6.2. Accounting for the impact of the Fed’s corporate bond programs

The Fed’s corporate bond programs were introduced to stem further rises in corporate bond spreads and their announcement on March 23, 2020 rapidly affected expectations and spreads well before the first bond purchases were made in May 2020. Essentially, the Fed’s announced intervention ended further feedback from a worsening economy and investor concerns on corporate bond premiums. We track the former amplification effects—and to some extent other factors affecting risk premia around downturns—using the square of the unemployment rate.\(^10\)

To gauge the impact of the corporate bond program, we create a squared unemployment rate series that equals the squared unemployment rate series \((UR^{2})\) before the program announcements and after the programs ended in December 2020. From the announcement to December 2020, the program-adjusted unemployment rate series \((URCCF)\) is the maximum of the unemployment rate in late March (6.4 percent, the average of the last two weekly adjusted insured unemployment rates), and the weekly insured unemployment rate. This adjustment implies that the program had very large effects on the spread in spring 2020 and large effects in summer 2020, and then faded away by mid-November 2020 and December 2020 on a weekly and monthly basis, respectively. The adjusted unemployment rate series mirrors the capping of spreads by the bond backstop by reflecting that the bond programs had a larger effect at the height of the pandemic and that the backstop effects ebbed in the summer and fall of 2020, before disappearing before the program had ended. In other models, we made analogous adjustments based on the May 12th start of Fed purchases of corporate bond ETFs but the announcement-based models fit notably better.

6.3. Monthly exogenous, shock variables

Five monthly shocks are added to the model. Four occur in the Great Depression and three of these reflect temporary, large effects of bank failures and crises on the Baa spread in an era before deposit insurance and aggressive Fed lender of last resort policies. One shock is the failure of the Bank of the U.S. in December 1931—the largest U.S. bank failure at that time, which triggered a temporary spike in the Baa spread. To control for this outlier, we include a dummy variable, \(UBankFail\), which equals 1 in December 1931, -1 in January 1932 and 0, otherwise.

Another variable, \(QE1932\), equals 1 in April 1932 when the Fed began conducting a quantitative easing-like program of buying long-term Treasuries, which pushed down long-term Treasury rates (Bordo and Sinha, forthcoming), thereby widening the Baa-T spread. Otherwise, \(QE1932\) equals 0, except for equaling -1 in August 1932, just after the Fed announced ending this QE precursor, which let long-term Treasury rates rise, narrowing the spread. The third Great Depression era bank crisis dummy controls for the bank crisis of early 1933 (BkCrisis33), which triggered a jump in the Baa-Treasury spread in March 1933 that did not reverse until May 1933, just after solvent banks were certified during the

\(^{9}\) The smoothing of the adjustment parameter limits noise in the weekly, and to a lesser extent in the monthly series.

\(^{10}\) Other risk premia shocks are tracked by the lagged first differences in the risk premia and long-term variables.
Bank Holiday of 1933. To control for this spike, the dummy variable $BkCrisis33$ is included which equals 1 in March 1933, -1 in May 1933, and zero otherwise. The fourth Great Depression variable controls for the drop in the Baa-Treasury spread in December 1933 ($DGold34 = 1$ in January 1934, 0 otherwise), when the U.S. devalued the dollar, signaling that monetary policy would be less constrained by the gold standard and better able to act countercyclically, thereby reducing corporate bond default risk.\(^\text{11}\) To control for the outsized effect on corporate spreads of Lehman’s failure in late September 2008, we include a fifth and last shock variable—a dummy equal to 1 in October 2008, shortly after, and 0, otherwise.\(^\text{12}\)

### 6.4. Weekly exogenous, shock variables

In parallel with the monthly models, the exogenous variables for the weekly, post-1970 model include a dummy for the failure of Lehman ($DLehman = 1$ for the week of September 19 and 0, otherwise). However, three other short-run controls are needed for the short-run model to avoid having serially correlated errors. Two are dummies for the 1987 stock market crash ($StockCrash87 = 1$ in the week of October 23, 1987 and 0, otherwise) and the September 2001 terrorist attacks ($911 = 1$ in the week of September 13, 2001, and 0, otherwise). The coefficients are expected to be positive reflecting likely increases in default and liquidity risk in these crises. The third shock variable is for Standard and Poor’s’ 2011 downgrading of U.S. Treasury debt from Aaa to Aa ($USDGrade = 1$ in the week of August 12, 2011, and 0, otherwise). Since the unexpected downgrade would likely push up yields on Treasuries relative to corporates, the coefficient on $USDGrade$ is expected to be negative. While omitting the exogenous shocks results in a long-run model yielding a unique and significant cointegrating vector having similar coefficients and a short-run model with a similar estimated and significant speed of error-correction, the errors are serially correlated. To control for Covid effects in the full sample weekly models, we include a level dummy ($Covid$) equal to 1 only since March 13 and time t to t-11 lags of its first difference.

### 7. Estimation results

Models of the corporate Baa-Treasury spread are estimated using monthly data from 1929 to 2021 and weekly data over 1971-2020. The advantage of the long sample is that it spans the Great Depression. The shorter sample, weekly models have more observations to assess the impact the Fed corporate bond programs. In our models, the unemployment rate terms are adjusted during the corporate bond programs to reflect that the announced programs essentially prevented the Baa spread from widening further as the economy deteriorated during the early onset of the pandemic.

#### 7.1. Monthly results

Table 2 reports results from monthly models that include the PennCentral shift in the cyclicality of the spread and the Treasury-Fed Accord and CFMA shift level shift terms in the long-run model, and the set of shock terms in the $X$ vectors described in Section 3.2. The Schwartz Information Criterion selected lag lengths on lagged first differences in the short-run model of 6 for the monthly model (1/2 year). Models 1 and 2 exclude and include the shock variables, respectively. Model 3 estimates Model 1 over a sample including the pandemic (November 1929–March 2021), with the addition of a Covid impact dummy variable equal to 1 in March 2020, and two lags of it (essentially one-time impact or shock variables for April and May 2020). These Covid variables are also included in the other full sample models (Models 4–6). Model 4 replicates Model 3 with one major change to gauge the effects of the new Fed corporate bond programs. In particular, Model 4 replaces the squared unemployment rate terms in Model 3 with the squared unemployment rate series ($URCCF$) which reflects the backstop effects of the announced Fed corporate bond buying programs. Models 5 and 6 parallel Models 3 and 4 except they add the set of exogenous shock variables described earlier. This set of models provides perspective not only on the pre-Covid behavior of corporate spreads and the role of unusual shocks (Models 1 and 2), but also on the potential impact of Fed interventions in the full sample both excluding the controls for unusual shocks (Models 3 and 4) and including the shock terms (Models 5 and 6).

In each model in Table 2, unique and significant long-run relationships are identified in which the long-run coefficients are significant with the expected signs. The positive coefficients on the Pre-Treasury Fed Accord and CFMA long-run effects are notable and imply a need to account for regime shifts. The positive and significant coefficient on the non-interacted, squared unemployment rate reflects the impact of business cycle swings. The coefficient and standard error on the squared unemployment rate interacted with the Penn-Central level shift dummy indicate a statistically and economically significant increase in the cyclicality of the Baa-Treasury spread since the failure of Penn-Central. This supports the view that this bankruptcy spurred a reassessment of the cyclical risk of investment-grade bonds, which had not seen a default in nearly 20 years prior, and that the default was the largest bankruptcy in U.S. history at its time.

Nevertheless, results from modeling changes in the spread reflect the importance of the Fed’s new corporate bond program. In both pre-Covid sample models (Models 1 and 2), the error-correction coefficients ($EC$) are statistically significant and imply plausible annual speeds of adjustment at which the gap between the actual and equilibrium spreads are narrowed (though the model including short-run controls (Model 2) outperforms the model without them (Model 1)). However, when the end-of-sample is extended beyond February 2020, the speeds of adjustments slow (Model 3 and 5), and in the case which omits short-run controls, the error correction term is insignificant and implies an implausibly slow speed of adjustment. In contrast, error correction speeds do not fall in the models in which the Fed corporate bond programs nullify the amplification effects of higher unemployment rates on corporate spreads. This can be seen by comparing the $EC$ coefficients from corresponding pre- and post-Covid sample models lacking short-run controls (Models 1 and 4) or including them (Models 2 and 6). When the speeds of error-correction fall as samples are extended, this can be a sign of omitted variable bias or misspecification that reflects that the long-run relationships are less applicable as sample periods are extended.

In the case of the models that ignore the Fed corporate bond facilities, this is reflected in Fig. 4 which plots the equilibrium relationship from the full sample estimates from Model 6 and a counterfactual which replaces the squared unemployment rate with the squared unemployment rate that is adjusted for the corporate credit facilities (CCF) effect. Before the Covid pandemic hit the U.S., the estimated equilibrium generally trends with the actual spread, with upward spikes during periods of heightened risk that are hard to predict or forecast. Notice how much the equilibrium spread from the model that ignores the CCF effects exceeds the

\(^{11}\) The negative sign on $DGold34$ suggests that this countercyclical factor offset a countervailing positive effect from higher uncertainty about what bonds were worth following the abrogation of gold clauses in debt contracts when the U.S. left the gold standard—this controversy was unresolved until a Supreme Court decision in 1935 (Edwards 2018).

\(^{12}\) Several geo-political shock dummies were insignificant, e.g., for the European start of WWII, the 1940 fall of France, the 1941 Pearl Harbor attack, and the Federal Reserve’s raising of reserve requirements in 1936 and 1937.
Table 2
Nine decade sample models of the Baa-Treasury spread, 1929–2021.

| Model No. | Monthly (1929-11–2020-02) | CCF Adjusted 4th | CCF Adjusted 6th |
|-----------|---------------------------|------------------|------------------|
|           |                           |                  |                  |
| **Long-Run Equilibrium:** $\text{BaaTR}_t = \alpha_0 + \alpha_1 \text{UR}_t + \alpha_2 \text{PennCent}_t \times \text{UR}_t + \alpha_3 \text{PreAccord}_t + \alpha_{CFA}\text{M}_t$ |                  |                  |
| Constant  | 0.9600                    |                  |                  |
| $\text{UR}_t^2$ | 0.0067**                |                  |                  |
| $\text{UR}_t \times \text{PennCent}_t$ | 0.0143**                |                  |                  |
| $\text{PreAccord}_t$ | 0.3697*                 |                  |                  |
| $\text{CFMA}_t$ | 0.8471**                |                  |                  |
| unique coint. & Yes** & Yes** & Yes** & Yes** & Yes** & Yes** |
| vec. # lags | 6 | 6 | 6 | 6 | 6 | 6 |
| trace no vec. | 92.46** | 89.87** | 224.70** | 94.28** | 222.46** | 92.25** |
| trace only 1 | 36.12 | 24.63 | 44.86 | 36.30 | 36.76 | 25.13 |
| **Short-Run:** $\Delta \text{BaaTR}_t = \beta_0 + \beta_1 \text{EC}_{i,t-1} + \Sigma_{i=1}^n \beta_i \Delta \text{BaaTR}_{i,t} + \Sigma_{i=1}^n \beta_i \Delta \text{UR}_{i,t} + \Sigma_{i=1}^n \beta_i \Delta \text{PennCent}_{i,t} \times \text{UR}_{i,t} + \Sigma_{i=1}^n \beta_i \Delta \text{PreAccord}_{i,t} + \Sigma_{i=1}^n \beta_i \Delta \text{CFMA}_{i,t}$ |                  |                  |
| $\text{EC}_{i,t-1}$ | -0.032*                |                  |                  |
| adjust. speed (i) | 32% | 47% | 17% | 32% | 28% | 47% |
| $\Delta \text{BaaTR}_{i,t}$ | 0.212**                |                  |                  |
| $\Delta \text{UR}_{i,t}^2$ | 0.003**                |                  |                  |
| $\Delta \text{UR}_t \times \text{PennCent}_{t-1,i}$ | 0.006                   |                  |                  |
| $\Delta \text{PreAccord}_{i,t}$ | 0.018                  |                  |                  |
| $\Delta \text{CFMA}_{i,t}$ | -0.006                 |                  |                  |
| $\text{QE1932}_t$ | 2.113*                 |                  |                  |
| $\text{USBankFail}_t$ | 1.562**                |                  |                  |
| $\text{BkCrisis33}_{t-1}$ | 0.709**                |                  |                  |
| $\text{DGold34}_t$ | 0.009                  |                  |                  |
| $\text{DLehman}_t$ | 1.444**                |                  |                  |
| $\text{Covid}_{t-1}$ | 1.273**                |                  |                  |
| $\text{Covid}_{t-1}$ | 0.279**                |                  |                  |
| Constant  | -0.001                 |                  |                  |
| $\text{Adj. R}^2$ | 0.100                  |                  |                  |
| S.E.      | 0.200                  |                  |                  |
| VEC Auto (1) | 23.98                 |                  |                  |
| VEC Auto (2) | 23.54                 |                  |                  |
| VEC Auto (4) | 44.45**                |                  |                  |

Notes: Absolute t-statistics are in parentheses and ** (*) denote significant at the 90% (95%) confidence level. (i) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship using a two-equation system with at most one co-integrating vector. (ii) $\text{EC}_{i,t} = \beta_0 + \alpha_1 \text{UR}_t + \alpha_2 \text{PennCent}_t \times \text{UR}_t + \alpha_3 \text{PreAccord}_t + \alpha_{CFA}\text{M}_t$. (iii) First difference terms of elements in the long-run cointegrating vector. (iv) Lag lengths chosen to minimize the AIC criterion. (v) Significance of the trace and VEC Auto statistics reflects lag length. (vi) In models 4 and 6 URCCF replaces $\text{UR}^2$ in level and first difference terms, including interaction terms. (vii) Seasonalized speed of adjustment.

The large disparities between the pre-Covid relationships and spreads in the Covid era imply that the error correction terms

of 2020 is a loose gauge of the effects of the Fed’s announced corporate bond program—measured by the more normal cyclical response of spreads but lacking a gauge or other, more liquidity, effects of the pandemic. Similar results arise using weekly models. The exercise assumes that the pre-Covid patterns would have prevailed absent the Fed corporate bond programs, which is supported by weekly data showing the spread moving in line with the weekly insured unemployment rates until the Fed’s announcement of corporate bond purchases (Fig. 6).
Fig. 4. Equilibrium spreads track actual baa-treasury spreads until March 2020 (NBER recessions are shaded. Sources: BLS, NBER Macro-History Database, Moody's, Federal Reserve, and authors' calculations).

Fig. 5. Pre-Covid relationships imply a sharper jump in the corporate-treasury bond yield spread than was seen since March 2020 (NBER recessions are shaded. Sources: BLS, NBER Macro-History Database, Moody's, Federal Reserve, and authors' calculations).
from models ignoring the Fed interventions overstate the extent to which the actual spreads exceed the equilibriums. As a result, and because the error-correction terms have negative signs, the short-run predicted changes from such miss-specified models exceed the actual changes during the pandemic. This will induce a string of negative model residuals and could result in significant serial correlation, which occurs in Models 3 and 5 that ignore the Fed programs. In contrast, the post-Covid models that account for how the Fed programs capped the amplification effects of unemployment (Models 4 and 6) have well behaved residuals, as is the case for the pre-Covid model that includes exogenous shocks (Model 2).

It is important to note how much short-run exogenous shocks account for variation in the short-run changes in the Baa-Treasury spread in Table 2. As expected, the dummies for the failure of the Bank of U.S., the Fed’s short-lived QE experiment in 1932, and Lehman’s demise were positive and significant, while the December 1933 change in the gold standard had a significantly negative effect. Of the models having short-run shock terms (Models 2, 5, and 6), the corrected $R^2$’s for the short-run model portions range between 0.44 and 0.46, which are reasonable for models of the first-difference of a spread. Moreover, these corrected $R^2$’s are 0.33 to 0.34 higher than those from corresponding models without them (Models 2 vs. 1; Models 5 vs. 3, and Models 6 vs. 4).

In addition, the error-correction terms are significant in every model with the expected negative sign and imply sensible speeds at which the Baa-Treasury spread adjusts to its long-run equilibrium. Nevertheless, the annualized speeds of adjustment are also much higher in corresponding models that include the shock terms. For the pre-Covid sample, the estimated annual speeds of correction are 15 percentage points faster in the model with the controls (Model 2) than without them (Model 1). For full sample models that do not control for the impact of the corporate bond programs on unemployment effects, annualized speeds of adjustment are 11 percentage points faster in the model with the controls (Model 5) than without them (Model 3). Finally, for models which account for the new Fed programs, the annual speeds of adjustment are 15 percentage points higher with the controls (Model 6) than without them (Model 4).

7.2. Weekly results for samples using data since 1971

Results from estimating weekly models with post-1970 data are reported in Table 3. Owing to their later sample start, these models omit the short-run Great Depression shock variables and the long-run Treasury-Fed Accord, and PennCentral variables. Models 1 and 2 exclude and include a set of short-run shock variables over a pre-Covid sample, respectively. The set of weekly exogenous dummy shock terms include controls for the stock market crash of 1987 (DStock87), the September 2001 terrorist attack (D911), the failure of Lehman (DLehman), and Standard and Poor’s 2011 debt ceiling-related downgrade of U.S. Treasuries (DUSDGrade). Parallel the monthly models in Table 2, the odd-numbered models in Table 3 omit the shock terms with only Models 4 and 6 adjusting the unemployment rate for the Fed’s announced creation of the corporate bond programs. Similarly, Models 5 and 6 in Table 3 include the Covid shock terms with only Model 6 using the cap-adjusted unemployment rate. The Schwartz Information Criterion selected lag lengths on lagged first differences in the short-run model of 12 for the weekly models.

As with the monthly models, we identify a significant and unique long-run cointegrating relationship in each weekly model, long-run coefficients are significant with the expected signs, and the corresponding short-run models have uncorrelated residuals in the pre-Covid sample. In pre-Covid sample models with short-run controls (Model 2), the long-run unemployment and CFMA coefficients and speeds of error-correction are significant and are not statistically different between the weekly and monthly models (the
latter add in the Penn-Central shift effects:

\[ BaaTR_1 = 1.042 + 0.0195UR_2i^2 + 0.7942CFMA_{t-1}^* \]

**Speed of adjustment : 0.086 per month or approximately 47% per year (Monthly Model 2)**

\[ BaaTR_i = 1.379 + 0.0134UR_2i^2 + 0.7383CFMA_{t-1}^* \]

**Speed of adjustment : 0.072 per month or approximately 61% per year (Weekly Model 2)**

As with results using monthly data back to 1929, in the post-1970 weekly models extended into the Covid era, there is evidence that not controlling for the Fed’s new corporate bond programs results in misspecification. In particular, the residuals from such models (Models 3 and 5 in Table 3) exhibit significant serial correlation according to VECLM statistics, whereas residuals are free from serial correlation in the models that account for the credit programs (Models 4 and 6). Indeed, the models that do not account for how the corporate bond programs attenuated the unemployment-amplifier effect, also suffer from long strings of predictions that overstate short-run changes in the spread (i.e., correlated negative residuals) after the Fed announced the creation of the facilities.

Other short-run results are worth noting. First, the error-correction terms are negative and significant and imply sensible speeds at which the Baa-Treasury spread adjusts to its long-run equilibrium. In particular, the estimated coefficient implies that about 60 percent of the gap is corrected within a year. As expected for the weekly short-run shock terms, the estimated coefficients on DLehman, StockCrash87, and D911 are significant and positive while that for USDGrade are negative and significant. Nevertheless, comparing corresponding models, the improvement in fit from adding
the exogenous shocks to weekly, post-1970 models is smaller than that from doing so to the post-1929 monthly models. This difference may reflect that bond markets were hit by larger shocks in the 1930s than in the last half century when the safety net and automatic stabilizers were also more extensive and important in cushioning the macroeconomy.

7.3. Assessing Covid and Fed Bond Market Intervention effects on the bond spread

Figs. 1–3 strongly suggest that the Fed’s announced interventions notably affected the corporate-Treasury spread, altering the relationship between the unemployment rate and the spread. Adding a Covid level shift or a Fed bond market-intervention term to the long-run relationship is infeasible as the lag length needed to estimate exceeds or nearly exceeds the number of observations since these events. Instead, we gauge the implied counterfactual impact of the programs using coefficient estimates from Model 4 in Tables 2 and 3, which include Covid impact dummies and adjust the unemployment rate channel for the Fed’s announced corporate facilities.

We do this by multiplying the gap between the squared actual unemployment rate and the squared capped unemployment rate by the coefficient on URCCF from Model 4. This provides a counterfactual estimate of how the corporate credit facilities affected the equilibrium spread between corporate Baa and 10-year Treasury yields. Figs. 7 and 8 plot the implied, cyclical equilibrium effect that the announced Fed corporate bond interventions had on the Baa-Treasury spread for the monthly and the weekly models, respectively. From the monthly model, the peak equilibrium effects are in April, reaching 3.4 percent. Estimates from the preferred weekly model (model 6, Table 3) imply a peak effect of 3.7 percent occurring in the last business week in April with the effect tailing off to about 0.9 percent at the end of June 2020. It is unclear, however, how much these estimates track the effects from shifts in liquidity versus solvency risk. With these qualifications in mind, these estimated effects in Figs. 7 and 8 are notable and reasonable—being similar to the 1 percentage point effect on the output gap calculated by Duca and Murphy (2013) for what such a facility could have done in the Great Recession.

The Duca and Murphy (2013) study differs in assuming a counterfactual scenario for 2008–09 in which a corporate bond facility existed but in fact had not, while the current study estimates the counterfactual in which a corporate bond facility did not exist in the COVID-19 Recession. Duca and Murphy (2013) assume that such a facility would be effective whereas the current paper quantifies how much the facility’s announcement had an effect. These scenarios share a similarity. The Duca and Murphy paper examined a hypothetical scenario in which the central bank explicitly capped a bond spread at exactly 100 bps over its average from 1971–GFC (equivalent to capping the spread at no greater than 300 basis points). The late-March 2020 announcement of the primary and secondary corporate bond facilities had the effect of capping the spreads at their mid-March levels, which turned out to be about 100 bps above the spreads average from 1970 to 2007.

7.4. Gauging fed bond market intervention effects on the macroeconomy

To examine the impact of the Fed’s corporate bond programs on the real macro-economy, we use our estimates to adjust bond spreads in forecasts using the recently revised Federal Reserve Board Model of the US. economy (FRBUS) described by LaForte (2018). In the FRBUS model, the equity risk premium is mainly driven by movements in the spread between yields on S&P BB-rated corporate and the 10-year Treasury bond. This spread is equivalent to our Moody’s based Baa-Treasury spread.13 The

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13 The FRBUS system models the bond risk spread mainly as a function of the output gap and random shocks, the former effects being similar to our modeling the Baa-Treasury spread as driven by the unemployment rate.
monthly model estimates plotted in Fig. 7 imply that the announced interventions lowered the Baa-Treasury spread by 1.93 percentage points in 2020:q2, which are similar to what our weekly models imply (figure available upon request).

In the FRBUS model, the spread between yields on investment-grade corporate and 10-year Treasury bonds affects the real economy via three main channels. First, a higher spread depresses stock prices by pushing up the equity risk premium. In addition, a higher spread raises the user cost of capital, thereby depressing business investment, and pushes up spreads of home mortgage over long-term Treasury interest rates, thereby lowering residential investment.

To assess the impact of the corporate bond facilities on real GDP, we ran simulations of the FRBUS model under the assumptions of an inertial Taylor Rule and that the effective zero lower bound on the federal funds rate would be binding throughout the forecast period. Using publicly available inputs, these assumptions yield a baseline. Alternative assumptions for the BBB-10-year Treasury spread are generated by assuming the counterfactual that the Fed corporate bond programs were not implemented. Each of the two estimated models imply different monthly paths for the equilibrium spread, which for simplicity we assume would have immediately affected the actual spread absent the PMCCF and SMCCF. In each case, quarterly averages of the spread would have been higher in 2020:q2 and 2020:q3, and slightly higher in 2020:q4 before wearing off.

This exercise produces somewhat lower paths for real GDP than the baseline that translate into more negative real output gaps (scaled by potential real GDP), which are reported in Table 4. After four quarters (2021:q2), real GDP is 0.7 to 0.8 percentage points lower, with the largest effect in the monthly model. After 8 quarters, the magnitudes grow somewhat, ranging from 1.0 to 1.3 percentage points, and remain similar after 8 quarters. This reflects the fact that the forecast incorporates the limits that the zero lower bound puts on the policy response to a wider output gap.

8. Robustness checks and limitations of the analysis

Pre-COVID recessions were driven by different factors than those driving the COVID recession. In turn, expectations of the persistence of the COVID recession could differ. Coupled with different policy responses, these can limit how much the analysis can attribute differences in the behavior of corporate spreads to the corporate bond programs. Nevertheless, the timing of movements in the unemployment rate and the Baa-Treasury spread were in line that of prior recessions until the corporate bond programs were announced. Even then, because several policy responses were implemented around the start of the COVID recession, our estimates may capture direct effects but not indirect ones and not fully account for general equilibrium effects. To partially address these concerns, this section provides more evidence on identifying corporate bond program effects and the robustness of our results to using other gauges of economic slack.

8.1. Evidence distinguishing corporate bond program effects from those of other policies

Several programs or special policies occurred while the Fed’s corporate bond programs were in effect. This raises the possibility
that our aforementioned results may co-mingle the effects of the PMCCF and SMCCF with those of other policy actions, which fall into three categories.

The first are programs providing liquidity, primarily in money markets. These include the Treasury provision of deposit insurance on money fund accounts, Fed backstop lending programs available to money funds and primary dealers, term discount loans, backstops or purchases of commercial paper (e.g., the Commercial Paper Funding Facility), and the Term Asset Backed Securities program that helped fund support for consumer and small business loans. However, these programs did not entail support for bonds issued by corporations. Furthermore, they were in place during the Great Recession and were revived at the start of the Covid Recession, and yet, the Baa-Treasury spread was very wide during the former episode but not during the latter.

Another liquidity facility created during the Covid pandemic was the Municipal Liquidity Facility (MLF), through which the Fed could buy new issued municipal bonds which backstopped municipal bonds. Note that the behavior of municipal and corporate yield spreads implies that the announcement of the MLF and the corporate bond facilities differently affected spreads in these markets.

This accords with the tendency for the substitutability of different assets to decline in financial crises and induce increases in spreads between yields on different assets and Treasuries.\footnote{Shleifer and Vishny (1997) theoretically show why arbitrage may decline during financial crises. Acharya, et al. (2012) show how higher illiquidity during crisis increases segmentation across corporate bond ratings classes.}

On March 23, 2020, the Fed and Treasury announced the creation of the corporate bond facilities just before Congress passed the CARES Act on March 27, which authorized the Treasury to cover default losses incurred by Fed facilities to support liquidity in the municipal bond market. Despite a further rise in the weekly unemployment rate, the Baa-rated corporate bonds and 10-year Treasury bonds stopped rising that week (Fig. 8), while the yield spread between municipal and Treasury bonds retraced part of its prior widening. Thereafter, the corporate Baa-Treasury spread declined for several straight weeks. In contrast, the mun-Treasury spread rose the week after the CARES Act was passed when the Fed disapponted markets by not announcing the creation of the MLF. Then when the Fed announced the municipal program two weeks after the CARES Act passed, municipal spreads fell. Differ-

| Table 5 | Monthly GDP output gap models of the Baa-Treasury spread, 1960–2021. |
| Model No. | Monthly (1960:03–2020:02) | Monthly (1960:03–2021:03) |
|-----------|--------------------------|--------------------------|
|           | CCF Adjusted 4th | CCF Adjusted 5th | CCF Adjusted 6th |
| **Long-Run Equilibrium:** BaaTR = α0 + α1 GDPGap + α2 PennCent + α3 CFMA, | | |
| Constant  | 1.0670  | 1.0825  | 1.0666  |
| GDPGap,1  | -0.0779\*  | 0.0705\*  | -0.1073\*  |
| PennCent,1| 0.8228**  | 0.8311**  | 0.7777**  |
| CFMA,1    | 0.5993**  | 0.5591**  | 0.6283**  |

| **Adj. R²** | 0.191  | 0.310  | 0.259  |
| S.E.       | 0.171  | 0.154  | 0.164  |
| VEC Auto 1 | 7.920  | 9.320  | 16.13  |
| VEC Auto 2 | 10.97  | 19.37  | 36.54**|

**Notes:** 1. t-statistics are in parentheses and \*\* (\*) denote significant at the 95% (95%) confidence level. (i) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship using a two-equation system with at most one cointegrating vector. (ii) EC_{t-1} = BaaTR_{t-1} + \alpha_0 + \alpha_1 GDPGap,_{t-1} + \alpha_2 PennCent,_{t-1} + \alpha_3 CFMA,_{t-1}. \ (iii) First difference terms of elements in the long-run cointegrating vector. (iv) Lag lengths chosen to minimize the AIC criterion. (v) Significance of the trace and VEC Auto statistics reflects lag length. (vi) In models 5 and 6 GDPGapCF replaces GDPGap in all level and first difference terms, including the interaction terms. (vii) Annualized speed of adjustment.


Table 6
Monthly capacity utilization models of the Baa-Treasury spread, 1960–2021.

| Model No. | Monthly (1953:01–2020:02) | Monthly (1953:01–2021:03) |
|-----------|-----------------------------|-----------------------------|
|           | CCF Adjusted 4t° 5          | CCF Adjusted 6t°            |
| Long-Run Equilibrium: BaaTRt = α0 + α1 CapUtilt + α2 PennCentt + α3 CFMA1 |
| Constant  | 4.8845                      | 4.8979                      |
|           | (2.60)                      | (2.83)                      |
| CapUtilt  | -0.0465**                  | 0.1108**                   |
|           | (-3.24)                     | (6.71)                      |
| PennCentt | 0.84045**                  | 0.65645**                  |
|           | (5.49)                      | (4.63)                      |
| CFMA1     | 0.3833*                    | 0.0907                     |
|           | (2.25)                      | (0.44)                      |
| unique coint. | Yes**                      | Yes**                      |
| vec. # lags | 13                         | 13                          |
| trace no vec. | 61.92**                    | 69.61**                    |
| trace only 1 | 24.47                      | 24.66                      |
|           | 37.36**                     | (72.91)                     |
| Short-Run: ΔBaaTRt = β0 + β1ECt+1 + Σt+1 = β2 ΔBaaTRt+1 + Σt+1 β3 ΔCapUtilt+1 + Σt+1 β4 ΔPennCentt+1 + Σt+1 β5 ΔCFMA1 + μt + μt |
| ECt+1     | -0.0965**                  | -0.1005**                  |
|           | (5.65)                      | (6.22)                      |
| adj. speedd) | 70%                        | 72%                        |
| ΔBaaTRt   | 0.397**                    | 0.391**                    |
|           | (10.62)                     | (10.40)                     |
| Δ CapUtilt | -0.02055                   | -0.02055                   |
|           | (2.22)                      | (2.48)                      |
| ΔPennCentt | 0.202                      | 0.243                      |
|           | (1.23)                      | (1.32)                      |
| ΔCFMA1    | 0.264                      | 0.287                      |
|           | (1.63)                      | (1.80)                      |
| D1ehman   | 1.371                      | 1.371                      |
|           | (8.78)                      | (8.78)                      |
| Covi1     | 1.277**                    | 1.269**                    |
|           | (7.83)                      | (7.87)                      |
| Covi1d    | -0.4755                    | -0.4575                    |
|           | (2.80)                      | (2.70)                      |
| Constant  | -0.0005                    | -0.0005                    |
|           | (0.04)                      | (0.38)                      |
| Adj. R2   | 0.198                      | 0.272                      |
|           | (0.13)                      | (0.27)                      |
| S.E.      | 0.160                      | 0.152                      |
|           | 0.162                      | 0.162                      |
| VEC Auto 1 | 13.01                      | 14.62                      |
| VEC Auto 2 | 18.90                      | 17.66                      |
| VEC Auto 4 | 16.83                      | 20.12                      |

Notes: Absolute t-statistics are in parentheses and ** (* ) denote significant at the 99% (95%) confidence level. (i) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship using a two-equation system with at most one cointegrating vector. (ii) ECt+1 = BaaTRt−1 + α0 + α1 CapUtilt−1 + α2 PennCentt−1 + α3 CFMA1. (iii) First difference terms of elements in the long run cointegrating vector. (iv) Lag lengths chosen to minimize the AIC criterion. (v) Significance of the trace and VEC Auto statistics reflects lag length. (vi) In models 4 and 6 CapUtiltCF replaces CapUtilt in all first difference terms, including the interaction terms. (vii) Annualized speed of adjustment.

ences in the movements of spreads in the corporate and muni markets reflect differences in the timing of liquidity program announcements, which suggests that substitutability across corporate bond investors and investors in municipal bonds declined early in the crisis. The timing of these patterns, coupled with differences in the investor base for muni bonds (household seeking tax-advantages) versus that for corporate bonds (institutional oriented), provide evidence that the corporate bond spreads were primarily affected by the PMCCF and SMCCF, and the muni-Treasury spreads were mainly altered by the MLF (Bordo and Duca, 2021).

The second set of programs were introduced during the Covid-19 Recession to support firms via bolstering bank lending. However, the Paycheck Protection Program supported small firms that did not issue bonds, and the Fed’s MainStreet Lending Program supported bank loans to firms ineligible for PPP loans and for the PMCCF and SMCCF. Hence, the firms directly affected were not issuing bonds whose pricing (spreads) could be plausibly and notably affected.

The third set of interventions comprises the unconventional monetary policy tools of forward guidance (FG) and quantitative easing (QE). FG and often QE are explicitly intended to affect medium- and long-term Treasury (and sometimes mortgage) interest rates (Bernanke, 2021). There are times of turmoil in financial markets, such as in March 2020 when Treasury yields rose because of a scramble for liquidity, and when QE was conducted by the FOMC “to support smooth market functioning and effective transmission of monetary policy to broader financial conditions,” (Board of Governors of the Federal Reserve System, 2020a). However, even in this case, QE lowered long-term interest rates by offsetting troubling liquidity conditions (Visser-Jorgensen, 2021). In its September 2020 release, the FOMC stated it intended its QE purchases to support both market functioning and provide monetary accommodation (Board of Governors of the Federal Reserve System, 2020b), both of which lower Treasury bond and mortgage interest rates.

The effects of QE on the corporate spread are, a priori, unclear. Their use could (a) narrow the corporate spread if they are viewed as notably lowering default risk, (b) have little net effect if the use of these tools mainly affect Treasury rates off which corporates are priced, or (c) widen spreads if they lower Treasury spreads rela-
Table 7
Weekly models of the Baa-Treasury spread controlling for forward guidance, 1971–2021.

| Model No. | 04/09/71–02/28/20 | 04/09/71–03/26/21 | Models Using UR,2 | Models Using URCh,2 |
|-----------|-------------------|-------------------|-------------------|-------------------|
| Pre-Covid |                   |                   |                   |                   |
| 1         |                   |                   |                   |                   |
| 2         |                   |                   |                   |                   |
| 3         |                   |                   |                   |                   |
| 4         |                   |                   |                   |                   |
| 5         |                   |                   |                   |                   |
| 6         |                   |                   |                   |                   |
| **Constant** | 1.3778          | 1.5397          | 1.3181          | 1.4225          |
| ur,2      | 0.0134**         | 0.0097*         | 0.0145**        | 0.0121**        |
| CFMA,4   | 0.7408**         | 0.5999**        | 0.7467**        | 0.6601**        |
| FG,1     | 0.3301 (1.16)    |                  | 0.2051 (0.10)   | 0.3225 (1.14)   |
| unique count. | Yes**           | Yes**           | Yes**           | Yes**           |
| vec. # lags | 12              | 12              | 12              | 12              |
| trace no vec. | 55.28**         | 67.13**         | 63.36**         | 75.23**         |
| trace only 1 | 8.86            | 20.84           | 9.22            | 22.48           |
| **Short-Run:** |               |                   |                   |                   |
| ΔBaaTR,2 | -0.018**         | -0.017**        | -0.018**        | -0.017**        |
| adjust. speed** | 60%            | 55%             | 60%             | 59%             |
| ΔCovid,1 | 0.227**          | 0.227**         | 0.232**         | 0.231**         |
| ΔUR,2     | 0.001            | 0.001           | 0.000           | 0.000           |
| ΔCFMA,4   | 0.020 (0.09)     | 0.009 (0.17)    | -0.006 (0.25)   | -0.006 (0.85)   |
| ΔFG,1     | -0.064 (1.02)    |                  | -0.056 (0.07)   | -0.056 (0.94)   |
| Covids | -0.007 (0.36)    | -0.007 (0.36)   | -0.011 (0.74)   | -0.011 (0.96)   |
| ΔCovids,1 | 0.525**          | 0.525**         | 0.549**         | 0.552**         |
| ΔCovids,2 | 0.665**          | 0.665**         | 0.635**         | 0.697**         |
| ΔCovids,3 | 0.234**          | 0.234**         | 0.208**         | 0.231**         |
| Constant | -0.000 (0.11)    | -0.000 (0.09)   | 0.000 (0.07)    | -0.001 (0.07)   |
| Ad, R2     | 0.075            | 0.074           | 0.117           | 0.116           |
| S.E.       | 0.089            | 0.089           | 0.089           | 0.089           |
| VEC Auto 1 | 3.43             | 9.39            | 24.63**         | 36.34**         |
| VEC Auto 2 | 3.19             | 9.74            | 56.25**         | 65.09**         |
| VEC Auto 4 | 8.63             | 8.31            | 39.99**         | 47.78**         |

Notes: Absolute t-statistics are in parentheses and ** (*) denote significant at the 95% (90%) confidence level. (i) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship using a two-equation system with at most one cointegrating vector. (ii) ECi,1 = BaaTR,1 – [α0 + α1 UR,2 + α2 CFMA,4 + α3 QEGDP,1]. (iii) First difference terms of elements in the long-run cointegrating vector. (iv) Lag lengths chosen to minimize the AIC criterion. (v) Significance of the trace and VEC Auto statistics reflects lag length and if a time trend is included in the long run. (vi) Annualized speed of adjustment.

To assess the impact of QE and FG on the Baa-Treasury spread we add controls for their short and long effects on Treasury bonds in a parsimonious way to limit the size of cointegrating vectors, which helps identify unique vectors. We added two long-term variables to the long-run models of the weekly spread and their first differences to the short-run equation of changes in the spread. One is the variable QEGDP, which is the ratio of seasonally adjusted weekly Federal Reserve assets to nominal potential GDP (quarterly CBO data are smooth and are interpolated into weekly readings). Adding the level of the ratio to the long-run equilibrium vector of the Baa spread controls for portfolio balance effects of QE, while adding the first differences to the equation of the change in the corporate spread controls for the pace of QE purchases. To parsimoniously control for forward guidance, the shift variable FG equals 1 in periods for which the Fed previously indicated that it would not change the federal funds rate (Yardeni, 2021). These include the long stretch from December 16, 2008 until October 28, 2015 when it removed forward guidance, as well as the period since March 15, 2020. In addition, FG equals 1 during the period starting August 12, 2003, when the Fed announced that it anticipated maintaining its then low 1 percent federal funds rate target for a “considerable period,” and stating, until May 4, 2004, that it could be “patient” about when to begin raising the federal funds rate. Markets interpreted “considerable period” and “patient” as a commitment not to raise rates for a while (Carlstrom and Fuerst, 2005). In practice, the Fed nearly simultaneously employed QE and FG in the last two decades. As a result, the measures of them, FG and QEGDP, are highly collinear making it difficult to obtain sensible long-run relationships and unique long-run relationships (cointegrating vectors) if both are added. To avoid these problems, we added each separately to weekly models from Table 3, with Tables 7 and 8 reporting results adding FG and QEGDP, respectively. In each of the latter two tables, models 1 and 2 repeat the pre-Covid Model 1 from Table 3 except that Model 2
### Table 8

Weekly models of the Baa-Treasury spread controlling for quantitative easing, 1971–2021.

| Model No. | 04/09/71–02/28/20 | 04/09/71–03/26/21 |
|-----------|-------------------|-------------------|
|           | Pre-Covid Models  | Models Using UR,1  | Models Using UR,2 |
|           | 3                 | 4                 | 5                 |
|           | 6                 |                   |                   |
| **Long-Run Equilibrium:** BaaTR,1 = α0 + α1 UR,1 + α2 CFMA,1 + α3 QEGDP,1 | | | |
| Constant | 1.3778            | 1.5271            | 1.3181            | 1.4360            | 1.3884            | 1.5528            |
| UR,1     | 0.0134**          | 0.0089**          | 0.0145**          | 0.0070**          | 0.0132**          | 0.0082**          |
| (4.17)   | (2.90)            | (4.82)            | (3.35)            | (4.10)            | (2.70)            |                   |
| CFMA,1   | 0.7408**          | 0.3864**          | 0.7467**          | 0.4053**          | 0.7472**          | 0.3688**          |
| (5.22)   | (2.09)            | (5.49)            | (2.32)            | (5.27)            | (1.99)            |                   |
| QEGDP,1  | 2.0777 (1.44)     |                   | 2.0231 (1.49)     |                   | 2.1422 (1.49)     |                   |
| **unique coint.** | Yes**        | Yes**            | Yes**             | Yes**             | Yes**             | Yes**             |
| vec. # lags | 12               | 12               | 12                | 12                | 12                | 12                |
| trace no vec. | 55.28** | 78.39**          | 63.36**          | 87.84**          | 56.27**          | 87.84**          |
| trace only 1 | 8.86             | 23.11            | 9.22              | 22.24            | 9.14              | 22.24            |

**Short-Run:** \( \Delta \text{BaaTR,1} = \beta_0 + \beta_1 \Delta \text{EC,1} + \sum_{i=1}^2 \beta_i \Delta \text{BaaTR,1} + \sum_{i=1}^3 \beta_i \Delta \text{UR,1} + \sum_{i=1}^4 \beta_i \Delta \text{CFMA,1} + \Omega_X + \mu_1 \)

- \( \beta_1 = -0.018** 
- \( \beta_1 = -0.019** 
- \( \beta_1 = -0.018** 
- \( \beta_1 = -0.019** 
- \( \beta_1 = -0.017** 
- \( \beta_1 = -0.019** 

- \( \beta_1 = -0.106 ** 
- \( \beta_1 = -0.107 ** 
- \( \beta_1 = -0.108 ** 
- \( \beta_1 = -0.109 ** 
- \( \beta_1 = -0.110 ** 
- \( \beta_1 = -0.111 ** 

Notes: Absolute t-statistics are in parentheses and ** (∗) denote significant at the 99% (95%) confidence level. (i) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship using a two-equation system with at most one cointegrating vector. (ii) \( \text{EC,1} = \Delta \text{BaaTR,1} = \alpha_0 + \alpha_1 \Delta \text{EC,1} + \alpha_2 \Delta \text{BaaTR,1} + \Omega_X + \mu_1 \). (iii) First difference terms of elements in the long-run cointegrating vector. (iv) Lag lengths chosen to minimize the AIC criterion. (v) Significance of the trace and VEC Auto statistics reflects lag length and if a time trend is included in the long run. (vi) Annualized speed of adjustment.

includes one of measures of the two unconventional monetary tools. In Table 6, Models 3 and 4 rerun Models 1 and 2 over a full sample ending in late March 2021 without adjustments for the Fed’s corporate bond programs. In contrast, Models 5 and 6 rerun Models 1 and 2 over the full sample with adjustments to the squared unemployment rate for the Fed’s corporate bond programs.

As reported in Tables 7 and 8, in each case—especially the models using a pre-Covid sample—the FC and QE variables are insignificant and do not affect the qualitative results regarding the need to adjust the models for the corporate bond programs. In models estimated through the full sample, the models that account for the corporate bond programs by capping the unemployment rate continue to have clean residuals and better model fits than the corresponding models that are not adjusted for the backstop effects of the Fed corporate bond programs.

We also ran a placebo-test by replacing the Baa-Treasury spread with the 10-year Treasury yield. As shown in Appendix Table B, there was no substantial difference between corresponding placebo models that capped or did not cap the unemployment rate, whether in terms of finding a long-run relationship, estimates of long-run coefficients, and speeds of error-correction, nor in the fit or degree of serial correlation in the residuals of the short-run models. This is consistent with the view that Treasury yields and the provision of liquidity in that market were not the main channel through which policy actions limited the rise of corporate spreads in the COVID recession.

### 8.2. Alternative measures of economic slack

As a robustness check, we reviewed alternative measures of slack of which two are available at a monthly but not weekly frequency and are available over a long sample. Monthly models of the Baa-Treasury spread were run using the GDP output gap or manufacturing capacity utilization to replace the squared unemployment rate as a gauge of slack. One advantage of the GDP output gap is that it more comprehensively measures economic slack.
and the risk it poses to companies and their debt holders than the unemployment rate. In addition, provided that the estimates of potential GDP are accurate, GDP output gaps better implicitly control for capacity than actual unemployment rates. A major disadvantage is that the quarterly frequency of standard GDP output gaps severely limits degrees of freedom to assess the Fed’s corporate bond program.

To address this, we model the monthly Baa-Treasury spread using monthly nominal GDP output gaps to replace monthly unemployment rates. IHS Markit Economics constructs a nominal monthly GDP series starting in 1992 that applies techniques to monthly input data mimicking those of the Bureau of Economic Analysis. To these, we spliced monthly nominal GDP estimates from Stock and Watson that span 1959:01 - 2010:06.\(^{15}\) CBO quarterly estimates of potential nominal GDP are interpolated into monthly readings and the monthly GDP gap (GDGap) is the difference between actual and potential GDP as a percent of potential. Using this 1959:01-2021:03 sample, we estimate the following specification of the level and the first difference of the Baa spread:

\[
\begin{align*}
BaaTR_t &= \alpha_0 + \alpha_1 GDPGap_t + \alpha_2 PennCentral_t + \alpha_3 CFMA_t \\
\Delta BaaTR_t &= \beta_0 + \beta_1 EC_{t-1} + \sum_{i=1}^{n} \beta_{2i} \Delta BaaTR_{t-i} \\
&+ \sum_{i=1}^{n} \beta_{3i} \Delta GDPGap_{t-i} + \sum_{i=1}^{n} \beta_{4i} \Delta PennCentral_{t-i} \\
&+ \sum_{i=1}^{n} \beta_{5i} \Delta CFMA_{t-i} + \Omega X_t.
\end{align*}
\]

(6a)

(6b)

which omit Accord and short-run Great-Depression shock variables that predate the sample.

Because it is positive when output exceeds potential, GDPGap is expected to have a negative effect, while the PennCentral and CFMA regime shift dummies are expected to have positive estimated effects. Eqs. (6a) and (6b) were also rerun replacing the GDPGap with the Federal Reserve’s measure of capacity utilization in manufacturing (CapUtil) which starts in 1949.

The long-run model in Eq. (6a) slightly modifies Eq. (2a) by using the level of the GDP gap rather than the level multiplied by its absolute value and by not interactiong the Penn-Central bankruptcy level shift dummy with the measure of slack. These changes yield better fitting models and reflect the different nature of the slack variables. For full sample, the GDP gap is used without adjustment in some models that ignore the Fed corporate bond program. For models accounting for these programs which capped the spread after late March 2020, we limit the absolute magnitude of the negative readings on the output gap over March-December 2020 to either the size of that month’s negative gap (4.11 percent) or the actual gap. This adjusted GDP gap (GDGapCCF) reflects that the programs effectively capped spreads from April to July 2020. Similarly, for capacity utilization, the program-adjusted series uses the March 2020 value of CapUtil as a minimum from April to December 2020, which was binding from April to August 2020.

Results in Table 5 use the monthly GDGap specifications in Eqs. (6a) and (6b), and parallel those using the unemployment rate. Models 1, 3, and 4 omit the short-run dummy for Lehman’s collapse, which is in Models 2, 5, and 6. Models 1 and 2 are pre-Covid models estimated through March 2020, while the others are estimated through 2021:03 and include two monthly dummies for the onset of Covid in April and May 2020. Models 3 and 5 use the unadjusted GDGap series, while models 4 and 6 use the CCF-adjusted series. Corresponding models using monthly capacity utilization are presented in Table 6, with the sample starting in January 1953.\(^{16}\)

Unique and significant cointegrating vectors are found for all models in Table 5 with significant coefficients on the long-term variables with a negative sign on the output gap variables and positive signs on PennCentral and CFMA. In Table 6, using capacity utilization, unique and significant vectors are found for the two pre-Covid models and for full sample models adjusted for the corporate bond programs, while unique equilibrium relationships were not found in full sample models (3 and 5) that ignore the programs. Paralleling the output gap models, the long-term variables in Table 6 are significant with a negative sign on capacity utilization variables and positive signs on PennCentral and CFMA. In both tables, residuals are well-behaved in the two pre-Covid era models and the two full sample models that account for the Fed corporate bond programs, whereas residuals are plagued by serial correlation in the two full sample models (3 and 5) that ignore the programs. Consistent with Figs. 5 and 6, the equilibrium spreads implied by the pre-Covid models in Tables 5 and 6 overpredict spreads in months when the Fed’s programs effectively backstopped spreads (April through mid-summer 2020). Overall, the qualitative findings are robust to replacing the unemployment rate with the alternative slack measures.

9. Conclusion

The Covid-19 induced financial crisis and recession created unprecedented challenges for the Fed. The pandemic-induced declines in consumption, investment and labor hours were magnified by government mandated lockdowns in spring 2020. Key to the amplification of negative shocks in an earlier dramatic crisis and depression, 1929–33, was the financial accelerator which followed the financial collapse associated with serious banking panics. The consequent decline in net worth and collateral led to defaults, bankruptcies, and a collapse in credit. Early in the pandemic a similar dynamic occurred as firms were hit by a collapse in sales, orders and a disrupted supply chain. This stress is evident in a spike in the Baa-10-year Treasury bond spread.

In response to the crisis, the Fed restarted facilities developed in the GFC of 2007–2008 to restore the plumbing of the financial system and to bolster the banking system. In the recent crisis the Fed added new facilities to shore up the corporate, municipal government, and small to medium business sectors. It was able to do this because of explicit Treasury guarantees against credit losses, which were not made in the GFC. Key to the effort was the creation of the primary and secondary corporate credit facilities that were intended to support the issuance of, and trading in, corporate bonds, respectively, and at non-crisis spreads over Treasury

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\(^{15}\) Over the 1992-2012 period of overlap, Stock and Watson series was 2.7 to 3.2 percent below the IHS Markit estimates and 2.7 to 3.0 below the latter in 1992. We used the 2.8 percent January 1992 difference to multiplicatively scale the series. These differences owe to benchmark revisions of real GDP and its price deflator. Splicing earlier Stock and Watson monthly real GDP ($2005) with current IHS Markit real estimates ($2012) entails more judgment as the combination of shifts in the base year and other revisions create less consistent differences in the overlap period.

\(^{16}\) The regressions start in 1953 to avoid the need to control for the pre-Treasury-Fed Accord era of pegged interest rates that would have affected the short sub-sample March 1950-December 1952.
yields. The announcement of these facilities halted a rapid rise in the Baa-Treasury bond spread that was in-train in March 2020 at the height of the crisis—and seven weeks before the first Fed purchase of corporate bond ETFs. As a result, rather than continuing to surge, this and other investment-grade corporate spreads peaked at levels seen in more normal recessions, and the spreads have subsequently ebbed.

This paper models the corporate Baa-Treasury spread using monthly data back to 1929 and weekly data since 1971, accounting for the major historical credit market shocks. Movements in the spread are highly correlated with the business cycles, as proxyied by the square of the unemployment rate, but also by the GDP output gap and capacity utilization. These effects do not appear to stem from other policy actions, as indicated by our review of program timing or firm eligibility, and by evidence that the effects do not owe to QE or Fed forward guidance.

Our models show that the announced Fed intervention largely capped the spike of the spread in March 2020. We also find based on the estimated effects on bond spreads, that the Fed’s corporate debt intervention prevented a further 1 to 1 –¼ percentage point decline real GDP. The announced corporate facility seems to have been successful in mitigating the corporate bond market amplification of the downturn that was so damaging in the GFC and the Great Depression.

The Fed’s corporate debt interventions supplemented the Fed’s other liquidity support policies and its expansionary monetary policy actions. However, this new facility—along with the new municipal bond and business loan programs—marks a major departure from earlier Fed practice which only provided support to the banking system and, since 2007, other financial institutions and markets in crises. Moreover, the program could induce the non-financial sector to depend on Fed support in future crises. In other words, despite providing upfront benefits, together the new corporate facilities are not exactly a free-lunch, and their true costs and hence net benefit will depend on how well they are unwound and the extent of the moral hazard effects they induce. Partly on such concerns and given the success of the bond programs in quelling the nascent financial crisis of spring 2020, the Treasury terminated the programs at yearend 2020. Nevertheless, it may take the passage of time to assess to what extent the costs of possibly inducing more risk taking by firms exceed the benefits of the corporate bond program in muting the rise of corporate bond spreads during the Covid Recessions.

### Appendix A

**KPSS stationarity tests.**

| Monthly (May 1929–March 2021)          | Stationarity (bandwidth) | Stationarity (bandwidth) |
|----------------------------------------|--------------------------|--------------------------|
| BaaTR                                  | 0.7261**                 | (11.3)                   | 0.0174                 | (12.40) |
| UR                                     | 0.4758**                 | (11.4)                   | 0.0466                 | (6.86)  |
| UR′                                    | 0.4449**                 | (11.4)                   | 0.0302                 | (7.67)  |

| Monthly (January 1959–March 2021)      | Stationarity (bandwidth) | Stationarity (bandwidth) |
|----------------------------------------|--------------------------|--------------------------|
| BaaTR                                  | 2.5216                   | (10.4)                   | 0.0175                 | (4.75)  |
| GDPGap                                 | 0.5635*                  | (10.4)                   | 0.0199                 | (5.50)  |
| CapUtil                                | 2.7835*                  | (10.7)                   | 0.0144                 | (6.59)  |

| Weekly (January 1971–March 2021)       | Stationarity (bandwidth) | Stationarity (bandwidth) |
|----------------------------------------|--------------------------|--------------------------|
| BaaTR                                  | 0.2398**                 | (15.9)                   | 0.0142                 | (8.86)  |
| UR                                     | 0.3992**                 | (15.9)                   | 0.0147                 | (5.82)  |
| UR′                                    | 0.3834**                 | (15.8)                   | 0.0093                 | (7.75)  |
| QEGDP                                  | 2.5138**                 | (16.0)                   | 0.0714                 | (13.50) |

Notes: * and ** denote 95% and 99% significance levels, respectively. Lag lengths for the KPSS stationarity tests are based on the Newey-West bandwidth selector using a Quadratic Spectral kernel for the spectral estimation method (see Hobijn et al., 2004). The combination of a significant KPSS stationary test statistic on the level of a variable (rejecting that it is stationary) and a significant test statistic on its first difference (accepting it is stationary) is evidence against trend stationarity. Unit root tests include a time trend for the unemployment rate variable combinations reflecting that there could be moving trends in the natural rate of unemployment. Tests omit a time trend for the output gap models which account for trends in potential output. The sample used for CapUtil is 1951:01–2021:03 reflecting the longer sample period and lagged first difference terms used in Table 6.

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17 From its inception through the mid-1930s, the Fed conducted open market operations in bankers’ acceptances. Later, in the GFC, it intervened in commercial paper. In both cases, its actions were confined to the money market, consistent with the traditional central bank objective of maintaining adequate liquidity to prevent and ameliorate financial panics. The recent corporate bond market interventions go beyond that traditional lender of last resort role.
Appendix B
Placebo tests on Long-Term Treasury Yields.

| Model No. | Weekly (1929:11–2020:02) | Monthly (1929:11–2021:03) |
|-----------|--------------------------|---------------------------|
|            | CCF Adjusted 2*          | CCF Adjusted 4*          |
| **Long-Run:** TR₁ = α₀ + α₁ UR₁ + α₂ PennCent₁ + α₃ PreAccord₁ + α₄ CFMA₁ (monthly) | TR²₁ = α₀ + α₁ UR₁ + α₂ CFMA₁ (weekly) |
| Constant  | 5.5288                   | 3.4903                    |
|           | 0.0016**                 | 0.0041                    |
| UR₁        | (2.86)                   | (1.38)                    |
| UR₁/²PennCent₁ | (0.0837)**               | (0.1018)**                |
| UR₁/PennCent₁, in 4 | (0.844)                 | (0.854)                   |
| PreAccord₁ | -1.3447                  | -1.2736                   |
| CFMA₁      | -4.8120**                | -3.5850**                 |
|           | (4.96)                   | (5.53)                    |
| unique count. | No                      | Yes**                     |
| vec. # lags | 15                      | 6                         |
| trace no vec. | 21.28                    | 85.28**                   |
| trace only 1 vector | 5.43                    | 8.095                     |

**Short-Run:** ΔTR₁ = β₀ + β₁EC₁,₁ + β₂ Δlags Δ-long-run variables + ΔX₁ + μ₁

|                | ΔEC₁,₁ | ΔTR₁,₁ |
|----------------|--------|--------|
| Adj. R²        | -0.0017| -0.0012|
| S.E.           | (1.23) | (0.87) |
| VEC Auto (1)   | 0.2740**| 0.2716**|
| VEC Auto (2)   | 8.10   | 8.75   |
| VEC Auto (4)   | 8.97   | 9.70   |
| VEC Auto (4)   | 3.88   | 7.41   |

Notes: Absolute t-statistics are in parentheses and ** (*) denoted significant at the 99% (95%) confidence level. (i) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship using a two-equation system with at most one cointegrating vector. (ii) Impact dummies and first difference terms of elements in the long-run cointegrating vector omitted to conserve space. (iii) Models 1 and 2 (3 and 4) correspond to models 5 and 6 in Table 2 (Table 4) with the modification that the lag length and number of weekly COVID impact dummies lengthened to 15 in models 1 and 2, which resolved serial correlation in the residuals for both models. (iv) Lag lengths chosen to minimize the AIC criterion. (v) Significance of the trace and VEC Auto statistics reflects lag length. (vi) In models 2 and 4 URCCF replaces UR² in all level and first difference terms, including the interaction terms. (vii) Corresponding placebo models with and without CCF adjustments did not significantly differ in terms of long-term and error-correction coefficients, cointegration, and degree of serial correlation in model residuals.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jbankfin.2022.106413.

Credit authorship contribution statement

**Michael D. Bordo:** Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **John V. Duca:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing.

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