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Business Credit Programs in the Pandemic Era

ABSTRACT We develop a pair of models that speak to the goals and design of the sort of business lending and corporate bond purchase programs that have been introduced by governments in response to the ongoing COVID-19 pandemic. An overarching theme is that, in contrast to the classic lender-of-last-resort thinking that underpinned much of the response to the 2007–2009 global financial crisis, an effective policy response to the pandemic will require the government to accept the prospect of significant losses on credit extended to private sector firms.

Governments around the world have responded to the COVID-19 pandemic with a range of business lending and corporate bond purchase programs to provide credit to nonfinancial firms. In this paper, we try to provide some conceptual grounding for thinking about the goals and design of these business credit programs. For concreteness, we draw motivation from two programs introduced by the US Treasury and the Federal Reserve—the suite of Main Street business lending facilities and the corporate bond purchase facilities known as the Primary Market Corporate Credit Facility (PMCCF) and Secondary Market Corporate Credit Facility

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(SMCCF). However, we believe that the main messages of our analysis apply more broadly and may be useful to other countries that are developing similar business credit programs.

We develop two distinct models. The first model, built with the Main Street and PMCCF facilities in mind, pinpoints the primitive market failures that might justify direct government lending to nonfinancial firms. Using this model, we explore how the market failures arising from today's pandemic-induced recession differ from those in garden-variety recessions as well as those experienced in the 2007–2009 global financial crisis. Thus, the model helps us understand why many governments have taken the extraordinary step of lending directly to nonfinancial businesses in recent months.

We highlight two features of the current COVID-19-induced recession that differentiate it from previous recessions. First, due to the pandemic and associated public health interventions, the relationship between a firm's current cash flows—and hence its ability to service its debts and other fixed obligations—and its long-run post-pandemic viability is likely to be much weaker than in a typical recession. A large number of firms, including many that are likely to be viable in the long run, have suffered precipitous revenue declines in recent months. In the presence of credit market frictions that prevent these firms from borrowing against the full value of their future cash flows, they will not be able to survive the pandemic without government support.

A second distinguishing feature of the current recession is extreme macroeconomic uncertainty due to our lack of knowledge about the path of the pandemic itself. We show that the combination of this high level of uncertainty with aggregate demand externalities means that there is social option value in keeping firms alive. If a surviving firm exerts positive spillovers on other surviving firms, then government support for firms essentially preserves society's option to capture such spillovers if macroeconomic uncertainty resolves favorably (e.g., if a vaccine is developed relatively quickly). These rationales are quite different from the ones that motivated government intervention in the global financial crisis, suggesting that policies should also be designed differently this time around; we flesh out this logic in what follows.

Our second model looks at corporate bond purchase programs such as the SMCCF, where the government announces its intention to buy securities that carry credit risk on the secondary market. As the US case illustrates, even the announcement of such a purchase program can have powerful effects on market prices and primary issuance activity, before the government actually purchases any risky securities. While undeniably

helpful in providing short-run stability to markets, we ask what potential risks might be associated with these strong announcement effects. In particular, we allow for the possibility that investors misperceive the implicit commitment that the Federal Reserve is making when it unveils its purchase programs—that is, that investors fail to properly anticipate the states of the world in which the Federal Reserve will actually step in and buy risky bonds. We show that such misalignments of expectations can help stabilize markets in the short run but also create the risk of sharp unwinds and fire sales further down the road. Of course, the costs and benefits of trading near-term stability for potential future instability depend on how actively firms, financial institutions, and households use the tranquil period to increase their financial buffers and prepare for a downturn. Nonetheless, the potential for the market to misinterpret the Federal Reserve's intentions means that how it communicates its intentions about future security purchases and how it adjusts its purchases in light of economic and financial developments have the potential to become key policy challenges going forward.

Although our two models are quite different, there is an overarching common theme. A classic framework for thinking about government interventions in financial markets is one in which there are important coordination problems between private market actors that raise the prospect of multiple equilibria. In these settings, the mere promise of decisive action by the government can eliminate the bad, Pareto-inferior equilibrium, leaving only the good, Pareto-superior equilibrium. In the good equilibrium, the economy is sufficiently healthy that the government never actually loses any money on its lending programs, so the government is really just committing resources in an out-of-equilibrium sense. Indeed, the more aggressive the government's commitments in such a multiple-equilibrium setting, the less it may stand to lose, and the better the overall economy may perform. In other words, a forceful and broadly encompassing promise of government support can be a "free lunch" proposition. Diamond and Dybvig's (1983) seminal paper—in which a sufficiently committed lender of last resort can eliminate bank-run equilibria—is one example of this kind of logic and has helped shape a generation of crisis management policy thinking, including the dominant thinking in the global financial crisis. As former Treasury secretary Timothy Geithner argues, "it is also true for financial policymakers that once war is unavoidable, you need to commit to overwhelming force" (Geithner 2014, 519).

By contrast, we argue that in the current pandemic setting, this multiple-equilibrium free lunch logic is not the right frame. Policy can certainly improve outcomes, but it is better thought of as fiscal policy, in which

government expenditures potentially deliver high returns for society. Given the magnitude of the shock induced by the pandemic, policy cannot hope to fully stem the coming wave of corporate financial distress. A more forceful policy response—in either the Main Street or corporate bond buying programs—therefore requires the government to accept a greater risk of credit losses. Of course, such risk does not imply that a forceful response is inappropriate. Indeed, we argue the opposite: the government needs to embrace the prospect of losing money on its programs if it is to have any hope of mitigating the economic and financial fallout from the pandemic. As it stands, however, the Main Street and PMCCF facilities are designed to take relatively little risk and in our view are therefore unlikely to be as effective as they might otherwise be.

That said, it appears that the Federal Reserve's unprecedented efforts to stabilize financial markets since March have for the time being shut down the potential for a macro-financial doom loop, in which deteriorating financial conditions amplify the initial shock to the real macroeconomy. Thus, our analysis here amounts to a set of suggestions for enhancing the future effectiveness of government interventions. The need for such enhancements may become especially relevant if the recovery that has been under way since May stalls in the coming months.

The remainder of the paper proceeds as follows. In section I, we provide a brief timeline of the US government's interventions in credit markets since the onset of the COVID-19 pandemic in early 2020. Section II develops a model of government intervention in primary credit markets, which both provides rationales for such interventions and suggests how they should be designed. Section III analyzes secondary market bond purchase programs and the potential for investors to misperceive the extent of the government's backstop. Section IV concludes.

I. Business Credit Programs in the United States

We begin by briefly outlining the timeline of the US government's interventions in financial markets—emphasizing its interventions in business credit markets—since the onset of the COVID-19 pandemic in early 2020.

Investors' concerns about the economic and financial impact of the COVID-19 pandemic escalated rapidly beginning in late February 2020, with the US stock market losing roughly 33 percent of its value between February 19 and March 23. Credit markets were also roiled, with credit spreads on high-yield corporate bonds rising by 730 basis points over this same period.

The Federal Reserve responded to these developments with unprecedented speed and force. On March 3, the Fed cut the (upper end of its target range for the) federal funds rate from 1.75 percent to 1.25 percent (Federal Reserve System Board of Governors 2020a). On March 15, it cut the funds rate to 0.25 percent and announced that it would purchase $500 billion in Treasury securities and $200 billion in agency MBS, resuming the large-scale asset purchases that it had undertaken from 2008 to 2014 (Federal Reserve System Board of Governors 2020b). On March 17, the Fed announced a number of measures to support liquidity and functioning in short-term funding markets, including reopening the Primary Dealer Credit Facility, the Commercial Paper Funding Facility, and the Money Market Mutual Fund Liquidity Facility, which were crucial components of its response to the global financial crisis (Federal Reserve System Board of Governors 2020c).[1] Finally, on March 23, the Fed signaled that it would purchase Treasury securities and agency MBS in whatever quantities were needed to hold down long-term Treasury and mortgage rates, which rose significantly in mid-March (Federal Reserve System Board of Governors 2020d).[2] Thus, in less than three weeks, the Fed had cut the short-term policy rate to its effective lower bound and had deployed the full arsenal of nonconventional policy tools that it had developed during the global financial crisis.

On March 23, the Federal Reserve and the Treasury broke new ground and announced their intent to intervene directly in business credit markets, unveiling the PMCCF and SMCCF (Federal Reserve System Board of Governors 2020e). Under the original March 23 PMCCF terms, the Fed would purchase up to $100 billion of newly issued bonds and loans (maturing in less than four years) from investment-grade US firms (i.e., those with credit ratings of at least BBB–/Baa3).[3] To finance these purchases, the PMCCF received an initial $10 billion equity investment from

1. Federal Reserve, Policy Tools, "Primary Dealer Credit Facility," https://www.federalreserve.gov/monetarypolicy/pdcf.htm; Federal Reserve, Policy Tools, "Commercial Paper Funding Facility," https://www.federalreserve.gov/monetarypolicy/cpff.htm; Federal Reserve, Policy Tools, "Money Market Mutual Fund Liquidity Facility," https://www.federalreserve.gov/monetarypolicy/mmlf.htm.

2. On March 23, the Fed and the Treasury also announced they would reestablish a $100 billion Term Asset-Backed Securities Loan Facility, which had been formed during the global financial crisis to support the issuance of asset-backed securities; Federal Reserve, Policy Tools, "Term Asset-Backed Securities Loan Facility," https://www.federalreserve.gov/monetarypolicy/talf.htm.

3. Federal Reserve, Policy Tools, "Primary Market Corporate Credit Facility," https://www.federalreserve.gov/monetarypolicy/pmccf.htm.

the Treasury's Exchange Stabilization Fund (ESF), and the Fed agreed to lend the PMCCF the remaining $90 billion on a secured basis under section 13(3) of the Federal Reserve Act. Under the SMCCF's original terms, the Fed would purchase up to $100 billion of investment-grade corporate bonds (maturing in less than five years) in the secondary market as well as exchange traded funds (ETFs) that provide broad exposure to US investment-grade bonds.[4] The SMCCF would also be financed using a $10 billion equity investment from the ESF, with the Fed providing $90 billion of secured debt financing.

On March 27, the Coronavirus Aid, Relief, and Economic Security (CARES) Act was signed into law.[5] The CARES Act allocated an additional $454 billion to the ESF to enable the Treasury to expand its joint lending facilities with the Fed. In addition, the act established the Small Business Administration's (SBA) Paycheck Protection Program (PPP) to assist small firms—generally defined as those with fewer than 500 employees—in retaining their employees.[6] While firms applied for PPP loans through private banks, these low-interest loans were guaranteed by the SBA. In addition, if most of the loan proceeds were used to cover payroll expenses, PPP loans would be forgiven by the SBA. The CARES Act initially appropriated $349 billion for PPP loans, but an additional appropriation of $320 billion was made on April 24 after demand from small firms exhausted the initial allocation. The SBA stopped accepting applications for PPP loans on August 8.[7]

On April 9, the Federal Reserve and the Treasury significantly expanded the size of the PMCCF and SMCCF from the original $200 billion to a combined $750 billion (Federal Reserve System Board of Governors 2020f). They also expanded the scope of the PMCCF and SMCCF so both facilities could purchase the debts of "fallen angel" firms—that is, firms that had investment-grade credit ratings on March 22 but had been subsequently downgraded to no worse than BB–/Ba3. In addition, they changed the scope

4. Federal Reserve, Policy Tools, "Secondary Market Corporate Credit Facility," https://www.federalreserve.gov/monetarypolicy/smccf.htm.

5. Coronavirus Aid, Relief, and Economic Security (CARES) Act, Pub. L. 116–136, 134 Stat. 281 (March 27, 2020), https://www.congress.gov/116/plaws/publ136/PLAW-116publ136.pdf.

6. Small Business Administration, "Paycheck Protection Program," https://www.sba.gov/funding-programs/loans/coronavirus-relief-options/paycheck-protection-program.

7. Granja and others (2020), Autor and others (2020), Chetty and others (2020), Bartik and others (2020), and Hubbard and Strain (2020) study the effects of the PPP. Congress added an appropriation of $284 billion in December 2020 for a third round of PPP loans.

of the SMCCF, allowing it to buy ETFs that provide broad exposure to the high-yield corporate bond market.[8]

In the same April 9 announcement, the Federal Reserve and the Treasury also established the $600 billion Main Street Lending Program (MSLP) to provide loans to small and medium-sized US firms, with the Treasury making a $75 billion equity investment in the MSLP. Under the terms eventually adopted on July 28, private banks make Main Street loans—which are typically secured—to qualifying firms with the MSLP purchasing 95 percent of the loan and the originating bank retaining the remaining 5 percent.[9] Firms are eligible for the Main Street program if they satisfy size restrictions on the number of employees and revenues and also have relatively low leverage.[10] All loans made under the program have a five-year maturity with principal payments deferred for two years and carry an interest rate of LIBOR plus 300 basis points. Firms are generally prohibited from using Main Street loans to prepay or refinance existing debt. In addition, firms that participate in the MSLP are subject to restrictions on executive compensation, dividends, and repurchases.

On May 29, Federal Reserve Chair Jerome Powell made remarks at a Princeton University event that underscored the Fed's commitment to market stability, saying:

> The Fed is strongly committed to using our tools to do whatever we can for as long as it takes to provide some relief and some stability now, to support the recovery when it comes, and to try to avoid longer-run damage to people's lives through long spates of unemployment, or to their businesses through unnecessary

8. See Boyarchenko, Kovner, and Shachar (2020) and Gilchrist and others (2020) for analyses of the PMCCF and SMCCF. Falato, Goldstein, and Hortaçsu (2020) and Haddad, Moreira, and Muir (2020) also analyze bond markets in the COVID-19 crisis. On April 9, the Fed and the Treasury introduced a Paycheck Protection Program Liquidity Facility (PPPLF) that would extend credit to banks that had originated PPP loans, taking the PPP loans as collateral at face value; Federal Reserve, Policy Tools, "Paycheck Protection Program Liquidity Facility," https://www.federalreserve.gov/monetarypolicy/ppplf.htm. The Fed and the Treasury also announced the creation of a $500 billion Municipal Liquidity Facility (MLF) that would purchase short-term notes issued by US states as well as eligible counties and cities; Federal Reserve, Policy Tools, "Municipal Liquidity Facility," https://www.federalreserve.gov/monetarypolicy/muni.htm.

9. Federal Reserve, Policy Tools, "Main Street Lending Program," https://www.federalreserve.gov/monetarypolicy/mainstreetlending.htm.

10. To qualify for a Main Street loan, firms and organizations must have fewer than 15,000 employees or 2019 revenues of less than $5 billion. For for-profit firms, the firm's ratio of total debt to 2019 EBITDA is capped at either four or six, depending on the specific Main Street subprogram. Nonprofit organizations must meet a lengthy list of financial conditions.

Table 1. Capacity and Take-up for the US Government's Business Credit Programs

Program	*Total capacity ($ billion)*	*Utilization ($ billion)*
PMCCF and SMCCF	750	12.8
. . . of which is PMCCF		0.0
. . . of which is SMCCF		12.8
Main Street Lending Program	600	1.2
Paycheck Protection Program	659	525

Sources: Federal Reserve H.4.1 Release and the Small Business Administration.
Notes: Lending capacity and take-up as of September 2, 2020.

> insolvencies. . . . We crossed a lot of red lines, that had not been crossed before. . . . This is that situation in which you do that, and then you figure it out afterward. (Jeff Cox 2020, m4:10)

On June 15, the Federal Reserve further amended the terms of the SMCCF, indicating that it would begin buying a portfolio of bonds designed to track a diversified index of corporate bonds that meet the program's eligibility requirements (Federal Reserve System Board of Governors 2020g). This indexing approach was intended to complement the SMCCF's purchases of ETFs. Importantly, in a set of FAQs, the Fed indicated that it expected to slow or suspend its secondary market bond purchases if indicators of market functioning, including credit spreads, were to return "to levels at or near those prevailing prior to the COVID-19 dislocation" and, conversely, that it expected to increase its purchases if market conditions deteriorated.[11]

As shown in table 1, of the numerous credit programs announced by the Federal Reserve and the Treasury in response to the COVID-19 pandemic, only the PPP had seen significant take-up as of September 2, 2020. The PPP closed on August 8 after extending $525 billion of loans to small businesses, compared to a program capacity of $659 billion. By contrast, the PMCCF and SMCCF have a combined program capacity of $750 billion, but the PMCCF had not purchased any newly issued bonds or loans as of September 2, and the SMCCF had purchased only $12.8 billion of bonds and ETFs. Similarly, the Main Street program has the capacity to lend up to $600 billion but had made just $1.2 billion of loans as of September 2.

11. Federal Reserve Bank of New York, "FAQs: Primary Market Corporate Credit Facility and Secondary Market Corporate Credit Facility," https://www.newyorkfed.org/markets/primary-and-secondary-market-faq/corporate-credit-facility-faq.

II. A Model of Government Intervention in Business Credit Markets

We start our analysis by developing a model that provides a rationale for government support to private firms during the COVID-19 pandemic. A key goal is to highlight how the current pandemic-induced recession differs from both garden-variety recessions and the global financial crisis and why these differences provide a motive for direct intervention in credit markets today.

In the model, there are two key frictions that drive a wedge between the private market outcome and the social planner's solution. First, credit market frictions can prevent firms from borrowing to survive the pandemic, even if continuation would be value maximizing in the absence of these financing frictions. Second, aggregate demand externalities exist: the benefits to society if a given firm survives can exceed the private value of survival.

While these frictions provide broad rationales for government intervention that could apply in any recession, we use the model to highlight how pandemic-specific conditions turbocharge these rationales. First, in the presence of credit market frictions, the government finds it attractive to provide firms with a bridge through a recession to preserve the value those firms can create in the subsequent recovery. This rationale is strongest in recessions where firm cash flows are very low in the short run but are expected to recover in the long run, and when credit market frictions are more severe. While credit market frictions are always potentially present, the COVID-19 recession differs from typical recessions in that a decline in firm cash flows today is less informative about long-run firm viability than in an ordinary recession. Normally, one might argue that government support for firms in financial distress amounts to keeping alive a set of economically nonviable "zombies." Our point is that in the current pandemic-induced recession this zombie argument loses much of its normal force.

Aggregate demand externalities can also provide a general rationale for government action. However, we focus on the interplay between aggregate demand externalities and the heightened macroeconomic uncertainty created by the pandemic. In the model, the aggregate demand externality from keeping alive an additional firm is larger if the economy recovers quickly than if the economy stagnates in a protracted recession. Thus, by keeping alive firms that the private market would allow to fail, the government preserves the option to have a large, positive aggregate demand externality if the health emergency subsides quickly. In other words, there is social option value for the government in providing short-term aid to firms. Of

course, in the private market equilibrium, there is also some option value for individual firms in delaying their exit decisions—some firms are willing to operate with negative cash flows, in case the economy recovers. However, as we show below, aggregate demand externalities create additional social option value, which makes preserving the option to exit later even more attractive to the planner than to private firms. Thus, unusually high macroeconomic uncertainty of the sort that exists today strengthens the case for government intervention.

II.A. Model Setting

The model has three periods—which we label $t = 1$, $t = 2$, and $t = \infty$—and a continuum of firms $f \in [0, 1]$ that differ solely in their exposure to a negative shock that first hits the economy at $t = 1$. Specifically, we assume the economy enters the initial stages of a recession at $t = 1$, which leads to a larger decline in cash flows for more highly exposed firms. There is also aggregate uncertainty at $t = 1$: the recession will be mild or severe at $t = 2$. Finally, at $t = \infty$, the economy arrives at a new steady state. This steady state depends on the severity of the recession realized at $t = 2$, meaning that the recession may have a permanent scarring effect on firms' cash flows even in the long run.

All agents in the economy are risk neutral with a constant time discount factor given by $\delta \in (0, 1)$. We use F_{S_t} to denote the mass of firms that are operating in state S_t at time t. It will turn out that all firms $f \in [0, F_{S_t}]$ will operate in state S_t at time t.

Each firm can be shut down at any date t. If a firm is shut down, it generates zero cash flow in that period and all future periods. If a firm operates in a given period, it generates some cash flow. If this cash flow is positive, some portion of it can be paid to the firm's outside investors. If the cash flow is negative, it represents an investment that the firm's investors must make to keep it alive.

If firm f operates at $t = 1$, it generates the following cash flow:

$$X_1(f, R_1) = \mu + \gamma - R_1 - \Delta \times f. \tag{1}$$

Here $R_1 > 0$ parameterizes the impact of the recession on firm cash flows at $t = 1$, while f captures cross-sectional heterogeneity in firms' exposure to the recession, with higher f representing greater exposure. In the current pandemic, high-f firms might represent firms in nonessential industries that rely on close physical proximity, for example, firms in the hospitality and leisure sector.

All uncertainty is resolved at $t = 2$, and there are two possible states at $t = 2$: $S_2 \in \{B_2, G_2\}$. With probability p the recession will be severe, denoted $S_2 = B_2$, and with probability $(1 - p)$ the recession will be mild, denoted $S_2 = G_2$. If firm f operates in state S_2 at $t = 2$ it generates cash flow:

$$X_2(f, R_{S_2}, F_{S_2}) = \mu + \gamma \times F_{S_2} - R_{S_2} - \Delta \times f. \tag{2}$$

The term $\gamma \times F_{S_2} \geq 0$ is a reduced form for the aggregate demand externality we assume exists at $t = 2$. The cash flows of any individual firm are greater when more firms are operating at $t = 2$. Individual firms take as given the total number of firms operating, while the social planner recognizes that an additional surviving firm generates positive aggregate demand spillovers on all other surviving firms.[12]

The severity of the recession can affect firm cash flows in the long-run steady state. Specifically, at $t = \infty$, the state of the economy is $S_\infty = B_\infty$ if $S_2 = B_2$ and $S_\infty = G_\infty$ if $S_2 = G_2$. If firm f operates in state S_∞ at $t = \infty$, we assume it generates cash flow:

$$X_\infty(f, R_{S_\infty}) = \mu + \gamma - R_{S_\infty} - \Delta \times f. \tag{3}$$

To introduce financial market frictions at $t = 1$, we assume that private investors can only appropriate a fraction $0 < (1 - \varphi) \leq 1$ of the firm's total value of $t = 2$, where $\varphi \in [0, 1]$. Thus, if firm f requires an outside cash investment at $t = 1$—that is, if $X_1(f, R_1) < 0$—it cannot raise the full value of continuation from outside investors. Financial markets are frictionless in the limit where $\varphi = 0$. Limited pledgeability constraints of this sort emerge from moral hazard problems between investors and firm managers (Holmstrom and Tirole 1997). Alternatively, $\varphi > 0$ can be seen as capturing the idea that some of the surplus a firm generates accrues to stakeholders other than the firm's investors and managers (e.g., to employees).

This model setup abstracts from many of the real-world political economy and microeconomic considerations involved in designing a business credit program. Our goal here is to elucidate the broad macroeconomic rationales for such programs.

12. Aggregate demand externalities refer to market failures that can arise from the fact that individual agents fail to internalize how their actions impact aggregate demand in the macroeconomy and, hence, the broader economic conditions faced by other agents. These externalities arise generically in the presence of nominal price rigidities or a zero lower bound on nominal interest rates (Farhi and Werning 2016), but vanish in frictionless, flexible price settings.

PARAMETRIC ASSUMPTIONS We make a few technical assumptions to focus on the most interesting part of the parameter space. First, we assume a natural ordering of cash flows across states and time periods so firm cash flows are lower in the bad state than the good state and there is recovery between $t = 2$ and the new steady state. Second, we assume that the most exposed ($f = 1$) firms have negative cash flows in all states and all time periods, implying that the recession renders some firms nonviable in the long run and that some firms must tap external investors to survive at $t = 1$ and $t = 2$. Third, we assume that aggregate demand externalities at $t = 2$ are not so powerful that the social planner wants to keep all firms alive at $t = 2$. Finally, to isolate cases where there is option value to delaying exit at $t = 1$, we assume that the marginal firm that operates at $t = 1$ continues to operate at $t = 2$ if the good state is realized but exits if the bad state is realized. These conditions are stated more formally in the online appendix.

II.B. Model Solution

In the online appendix, we solve the model by backward inducting from $t = \infty$. Specifically, for each state S_t, we conjecture that we enter the state with all firms $f \in [0, F_{S_{t-1}}]$ still intact from the preceding state S_{t-1} at time $t - 1$. We then find a new cutoff $F_{S_t} \leq F_{S_{t-1}}$ such that all firms $f \in [0, F_{S_t}]$ continue operating in state S_t at time t. Thus, an equilibrium in our model is a set of five cutoffs $\{F_1, F_{G_2}, F_{B_2}, F_{G_\infty}, F_{B_\infty}\}$ that identify the most exposed firm that is still operating in each state.

At each time, a firm's private value reflects the fact that it has the option to exit and earn zero. Thus, the private value of f firm at $t = \infty$ is:

$$V_\infty(f, S_\infty) = \frac{1}{1-\delta} \bullet \max\left\{X_\infty(f, R_{S_\infty}), 0\right\}, \tag{4}$$

which is simply the value of receiving the greater of $X_\infty(f, R_\infty)$ or zero in perpetuity. At $t = 2$ the private value of the firm is:

$$V_2(f, R_{S_2}, F_{S_2}) = \max\left\{X_2(f, R_{S_2}, F_{S_2}) + \delta \bullet V_\infty(f, R_{S_\infty}), 0\right\}, \tag{5}$$

and at $t = 1$ the private value of the firm is:

$$V_1(f, F_1) = \max\left\{\begin{array}{c} X_1(f, R_1) + (1-\varphi)\delta \\ \bullet \left[\begin{array}{c}(1-p) \bullet V_2(f, R_{G_2}, F_{G_2}(F_1)) \\ + p \bullet V_2(f, R_{B_2}, F_{B_2}(F_1))\end{array}\right], 0\end{array}\right\}. \tag{6}$$

In equation (6), the potential for financial market frictions at $t = 1$ is captured by the fact that the term in square brackets—that is, the firm's expected value at $t = 2$—is multiplied by $(1 - \varphi)\,\delta \leq \delta$.

The planner's solution and the private market solution diverge when there are either aggregate demand externalities at $t = 2$ ($\gamma > 0$) or credit market frictions at $t = 1$ ($\varphi > 0$). When there are aggregate demand externalities, the key difference between the planner's solution and the private market's is that private firms take as given the endogenous state of aggregate demand in the macroeconomy at $t = 2$, captured by F_{S_2}. In contrast, the planner recognizes that its decisions change F_{S_2}, having an impact on the $t = 2$ cash flows of all surviving firms. When there are credit market frictions, the key difference between the planner and the private market is that the planner ignores the friction, effectively acting as though $\varphi = 0$. This does not mean that we are assuming that the planner is immune to frictions facing the private market. We are instead assuming that the planner is willing to make investments that are negative net present value (NPV) from the private market's perspective. Because the planner is maximizing total social surplus, the planner is willing to make an investment in a firm that exceeds the pledgeable value of future firm cash flows even if it will take a direct loss on such an investment.

II.C. Comparing the Planner's Solution with the Private Market Solution

Letting $F^{**}_{S_t}$ denote the cutoffs in the planner's solution and $F^{*}_{S_t}$ denote the cutoffs in the private market solution, the following proposition outlines the basic properties of each solution.

Proposition 1

Under the assumptions outlined above, weakly more firms operate at $t = 1$ than at $t = 2$ in both the planner's solution and the private market solution, reflecting the option value of delaying exit. When either $\varphi > 0$ or $\gamma > 0$, weakly more firms survive in the planner's solution than in the private market outcome at $t = 1$ and in all possible states at $t = 2$ and $t = \infty$. When $\gamma > 0$, strictly more firms survive at all times. Specifically, we have:

- $F^{**}_1 > F^{*}_1$ when $\varphi > 0$ or $\gamma > 0$. Moreover, $F^{**}_1 - F^{*}_1$ is strictly increasing in both φ and γ.
- $F^{*}_{S_1} \geq F^{*}_{S_2}$ and $F^{**}_{S_1} \geq F^{**}_{S_2}$. Furthermore, $F^{**}_{S_2} \geq F^{*}_{S_2}$ when $\varphi > 0$ *or* $\gamma > 0$ (with strict inequality when $\gamma > 0$). $F^{**}_{S_2} - F^{*}_{S_2} \geq 0$ is strictly increasing in γ and is weakly increasing in φ.
- $F^{**}_{S_2} = F^{**}_{S_\infty}$ and $F^{*}_{S_2} = F^{*}_{S_\infty}$.

In both solutions, some firms with negative cash flows continue operating at $t = 1$ in hopes that the good state is realized at $t = 2$. If the bad state occurs, these firms exit. Both market failures in our model lead to fewer surviving firms at $t = 1$ in the private solution than in the planner's solution—that is, the private market underinvests in firm continuation. And, naturally, the underinvestment at $t = 1$ becomes more pronounced as each of the market failures becomes more severe.

We next explore how the initial severity of the recession affects the wedge between the private market and planner's solutions. To capture the intuition as simply as possible, we assume there is no uncertainty about the path of the recession, that is, we assume $R_{G_2} = R_{B_2} = \bar{R}_2$ and $R_{G_\infty} = R_{B_\infty} = \bar{R}_\infty$.

Proposition 2

If $\varphi > 0$ and $\gamma = 0$ and there is no uncertainty about the path of the recession, then, under the assumptions outlined above, $F_1^{**} - F_1^{*}$ is increasing in R_1 and decreasing in both $\bar{R}_2$ and $\bar{R}_\infty$.

For starkness, we focus on the case where there are credit market frictions but not aggregate demand externalities.[13] In this case, the planner and the private market disagree most about firm continuation when the recession is expected to be sharp (i.e., R_1 is large), but short (i.e., $\bar{R}_2$ and $\bar{R}_\infty$ are small). When the shock to the average firm in the economy becomes more transient (i.e., $\bar{R}_2$ and $\bar{R}_\infty$ fall holding fixed R_1), more firms will survive in both the planner's solution and the private market solution. As the initial shock becomes more severe (i.e., R_1 rises holding fixed $\bar{R}_2$ and $\bar{R}_\infty$), however, it becomes more necessary for firms to borrow against the value of future cash flows to survive. When credit market frictions are significant, firms cannot borrow enough in the private market. As a result, injecting funds into these firms so that they can survive is socially worthwhile, even though the planner may not be able to financially recoup these investments in full. In other words, when the fundamental shock that hits the economy is expected to be short and severe, the planner wants to build a temporary bridge to the economy's new steady state. Private markets are less willing to provide this bridge to individual firms because they will be unable to fully capture its social benefits.

13. More generally, the comparative static on R_1 in proposition 2 holds when credit market frictions are relatively important relative to aggregate demand externalities in the sense that $\varphi(\Delta - (1 - \delta)\gamma) > (1 - \delta)\gamma$. The comparative statics on $\bar{R}_2$ and $\bar{R}_\infty$ hold whenever either $\varphi > 0$ or $\gamma > 0$.

This bridging motive is particularly strong in the current recession because the COVID-19 pandemic and associated public health interventions have had an unprecedented short-run impact on firm cash flows. In more normal circumstances, including in a garden-variety recession, if a firm's revenue falls by 75 percent, this is likely to be a strong signal that the firm is not viable in the long run. Thus, it is both privately and socially optimal for firms to exit when they suffer significant revenue losses, and if the government leans against such exits, it may rightly be accused of propping up economically nonviable zombie firms. In contrast, in the current pandemic setting, sharp declines in near-term firm revenues are less informative about long-run firm viability. While the prospects of some businesses may suffer long-run damage from the pandemic (e.g., hotels catering to business travelers), others seem likely to recover once the health emergency ends (e.g., bars, daycare providers, gyms, and restaurants).

While our formal analysis emphasizes government investments that are designed to enable firms to continue operating, a related motive for government investments may arise if financial distress leads to deadweight losses—for example, because financial distress can distort firm investment (debt overhang) or destroy valuable business relationships. In this case, government investments that prevent a temporary decline in firms' cash flows from resulting in value-destroying financial distress may create surplus that private actors are unable to capture on their own due to financial frictions—for example, because of conflicts between a firm's existing debt and equity holders. See Greenwood, Iverson, and Thesmar (2020) for an assessment of financial distress costs in the COVID-19 pandemic.

We next explore the impact of macroeconomic uncertainty on the wedge between the private market and planner's solutions.

Proposition 3

Under the assumptions outlined above, $F_1^{**} - F_1^{*}$ is decreasing in both R_{G_2} and R_{G_∞} when either $\varphi > 0$ or $\gamma > 0$, but does not depend on either R_{B_2} or R_{B_∞}. As a result, a small increase in the amount of time-1 uncertainty about exogenous macroeconomic fundamentals at either $t = 2$ or $t = \infty$, raises $F_1^{**} - F_1^{*}$. Specifically, suppose R_{G_2} declines and R_{B_2} increases such that $\bar{R}_2 = pR_{B_2} + (1 - p)R_{G_2}$ remains fixed. This is associated with an increase in $F_1^{**} - F_1^{*}$.

When $\varphi = 0$ and $\gamma > 0$, there is social option value to keeping firms alive at $t = 1$, over and above the option value each firm perceives in the private market solution. If the good state is realized at $t = 2$, then many firms are viable. The existence of aggregate demand externalities ($\gamma > 0$) means that the demand spillovers the private market does not internalize

are particularly large if the good state is realized. Intuitively, society has access to a valuable real option of generating positive spillovers, which will make the recession shallower, if aggregate uncertainty resolves favorably. Consistent with standard intuitions, the value of this social real option is increasing in the uncertainty about the severity of the recession, so the motive for government interventions is stronger when there is greater uncertainty at $t = 1$ about the future course of the macroeconomy.[14]

When $\varphi > 0$ and $\gamma = 0$, the intuition is even simpler. In this case, an increase in time-1 uncertainty raises the private option value of keeping firms alive until $t = 2$. However, when there are credit market frictions ($\varphi > 0$), private investors cannot fully capture the value of this option. Thus, an increase in time-1 uncertainty leads private markets to underinvest more in firm continuation.

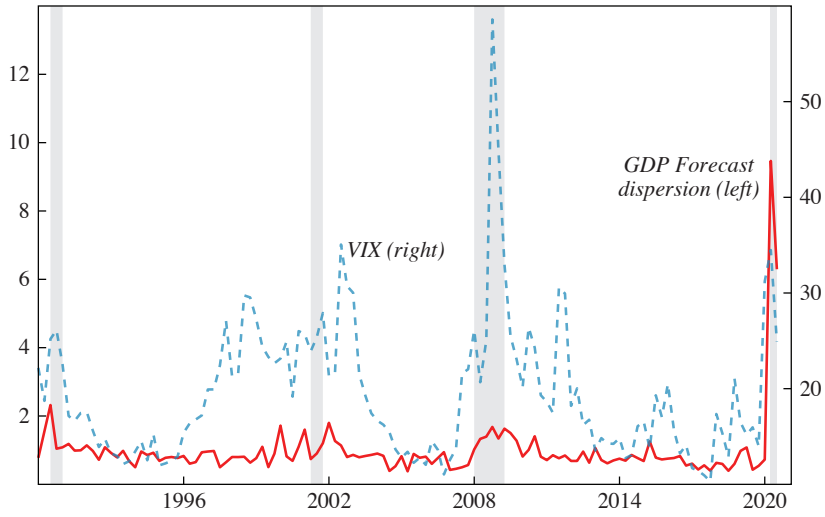
These considerations loom large in the current context. As detailed in Altig and others (2020), macroeconomic uncertainty has arguably never been greater than it is today due to the uncertainty about factors including the underlying epidemiology of COVID-19, the efficacy of our public health responses, new treatment options, and the search for a vaccine. Figure 1 makes this point by plotting cross-sectional dispersion in the Survey of Professional Forecasters (SPF) expectations for current-period real GDP growth and option-implied stock market volatility.

II.D. Implications for Program Design

In addition to providing rationales for government aid to firms during the COVID-19 pandemic, the model also has implications for how the support should be designed. The model does not explicitly feature a support program, but one is implicit in the difference between the planner's solution and the private market outcome. Since the planner's solution involves keeping alive some firms that would exit in the private market solution, we are implicitly assuming that the government provides the funds necessary

14. This social option value point hinges on the idea that the externality is larger when aggregate uncertainty resolves favorably. This need not be the case. For instance, suppose there are fire-sale externalities at $t = 2$. When deciding whether to shut down and liquidate an individual firm, private investors take liquidation prices as given. By contrast, the social planner internalizes the fact that liquidating an additional firm reduces the liquidation price for all firms. In the presence of financial market frictions, the resulting pecuniary externality leads to too many private market liquidations when compared to the social planner's solution. Since this fire-sale externality is more pronounced when the recession is more severe at $t = 2$, a model with only fire-sale externalities will imply that the disagreement between private markets and the planner is *increasing* in R_{G_2} and R_{G_∞}.

Figure 1. Macroeconomic Uncertainty and Financial Market Volatility



Sources: Federal Reserve Bank of Philadelphia (SPF data); CBOE and FRED (VIX data).

Notes: This figure shows the quarterly time series of the CBOE Stock Volatility Index (VIX; right axis) and cross-sectional dispersion in the Survey of Professional Forecasters (SPF) expectations for current-period real GDP growth (left axis) from 1990:Q1 to 2020:Q2. The SPF dispersion measure is calculated as the difference, in percentage points, between the 75th and 25th percentile forecasts reported.

for those firms to keep operating and finances these investments with lump-sum taxes. While these investments are socially worthwhile, the future cash flows of the specific firms receiving funds need not be sufficient to repay the government. In other words, the government's support may be thought of as containing an element of outright grant to the firms it aids.

Three elements of program design emerge directly from the model. First, the government must be willing to make investments in risky, marginal firms that the private sector is unwilling to finance. In proposition 1, $F^{**}_{S_t} \geq F^{*}_{S_t}$ state by state. The planner supports more firms—in other words, it makes financing more widely available—than the private market, and the marginal firms it supports are more exposed to the shock (i.e., they are higher-f firms). To the extent that government support in the model is targeted, it is allocated based on the temporary component of firms' current cash flow shortfalls.

Second and relatedly, the government should expect to lose money on the investments it makes in some firms. When there are either aggregate demand externalities or credit market frictions, the planner is willing to invest enough in marginal firms that they can survive at $t = 1$, even though

it will not directly recoup these investments in expectation. When there are aggregate demand externalities, the spillovers these firms generate if the good state is realized outweigh the direct losses from supporting them. When there are credit market frictions, the marginal firms create enough value to warrant support themselves, but the planner may not be able to directly recoup that value for the same reasons private investors cannot—for example, because some of it accrues to other stakeholders.

Put differently, the logic of intervention in the model is not the standard multiple-equilibrium logic for lender-of-last-resort interventions (Diamond and Dybvig 1983). In a lender-of-last-resort context where there is the potential for a purely non-fundamentally driven bank run, government interventions can coordinate private agents on the good equilibrium where there are no credit losses. In contrast, here the government cannot shift the economy from the bad state to the good state at $t = 2$. Whether we are in the good or bad state at $t = 2$ is solely determined by the path of the pandemic, which is not affected by government financial policies toward firms (though it is, of course, influenced by the government's public health policies). Instead, government intervention here counteracts market failures that lead private markets to underinvest in firm continuation, both in the face of the incipient recession at $t = 1$ and ex post once the severity of the recession is realized at $t = 2$.

A third implication of the model is that government financial support should be staged. That is, disbursements of government financing should initially be just enough to keep firms alive between $t = 1$ and $t = 2$ but should not be sufficient to guarantee that firms can survive beyond that. Proposition 3 implies that this staged financing approach is particularly important when aggregate uncertainty is high. In this case, the planner helps many firms survive at $t = 1$ in hopes that the good state is realized at $t = 2$. If the bad state is realized, however, the planner allows some firms to fail. As in a venture capital setting, staged financing is necessary for the planner to adapt to the information that is revealed over time and to capture the social option value of delaying firm exit. At $t = 1$, the planner should not commit to supporting firms until the steady state; it simply wants to support firms long enough to see whether a quick economic recovery is possible.[15]

In addition to these direct implications for the design of government aid, the logic of the model informally suggests that the repayment terms of any

15. Staging refers to the quantity of funds provided, not to the maturity of the government's investment. Specifically, staging simply means that the first round of funding is only enough to allow firms to survive until $t = 2$.

government investments should be relatively soft rather than hard. Hard investments are more debt-like in an economic sense, featuring repayment terms like short maturities, high collateralization requirements, and little flexibility for borrowers in the timing and amount of interest and principal payments. In contrast, soft investments are more equity-like; they afford borrowers more flexibility in repayment terms and do not require significant collateral. One relevant observation from the model is simply that the government's investments are not riskless: the government cannot expect to directly recoup the full amount it provides to firms in all states of the world. Thus, using relatively hard repayment terms in an effort to guarantee that the government's investments are fully repaid in all states runs counter to the basic logic for providing government support in the first place.

One could imagine further enriching the model to capture other benefits of softer terms. In particular, reducing the seniority of the government's debt claims or giving firms the option to defer interest or principal payments without filing for bankruptcy protection could help bridge more firms through the pandemic and maintain the health of firm balance sheets, mitigating future debt overhang problems that could otherwise hamper the subsequent recovery.[16] In the language of the model, softer contractual terms on government investments would serve three purposes: (1) increasing the cash flows each firm generates at $t = 2$ by mitigating debt overhang, (2) decreasing any potential credit market frictions facing firms at $t = 2$ by improving the health of their balance sheets, and (3) increasing positive spillovers across firms at $t = 2$ by raising the number of firms that survive.

In practice, governments often prefer to make debt rather than equity investments in firms to avoid the significant political economy problems that arise when they have control rights over firms' operating decisions. With this in mind, the terms of the government's debt investments could be softened by reducing seniority and collateralization, extending maturities, and making principal and interest payments deferrable. In other words, government investments could be made more similar to preferred stock.[17]

16. Crouzet and Tourre (2020) analyze the potential for the PMCCF and SMCCF to induce debt overhang.

17. Based on our (admittedly imperfect) understanding of the CARES Act and section 13(3) of the Federal Reserve Act, the government's investments would need to legally qualify as a form of indebtedness. In other words, based on current law, it seems unlikely that the Treasury and the Federal Reserve could establish a facility that made true equity investments in firms. Thus, while existing facilities could not literally purchase preferred stock in firms, they could purchase economically very similar securities—for example, junior subordinated debt with deferrable interest payments.

Notably, the US government's investments in banks during the global financial crisis under the Troubled Asset Relief Program (TARP) took the form of preferred stock, for a similar reason: putting more debt into already over-leveraged banks would have exacerbated their solvency problems; and yet the government was reluctant to put in common equity because it did not want to be seen as nationalizing the banks. To further protect taxpayers, the government could also consider taking equity warrants in participating firms as it did under the TARP program during the global financial crisis.

II.E. Application to the Main Street Lending Program

The implications for program design that emerge from our model stand in contrast to the current design of some of the US government's business lending facilities. Take for instance the Main Street Lending Program (MSLP) that was created by the Federal Reserve and the Treasury to support small and medium-sized businesses. As discussed above, under Main Street, private banks make secured loans to qualifying firms with the MSLP purchasing 95 percent of the loan and the originating bank retaining the remaining 5 percent. Firms are eligible for the Main Street program if they satisfy size restrictions on employees and revenues and have relatively low leverage. All loans have a five-year maturity with no principal payments for two years and carry an interest rate of LIBOR plus 300 basis points.

The requirement that banks retain an economic stake in their Main Street loans seems likely to hamper the program's ability to provide aid to firms that a social planner would choose to invest in but that the private sector is unwilling to finance. Though banks must retain only a small fraction of the loans they make, they will still require a privately satisfactory return on the piece that they must retain. Since the government and banks share borrower repayments proportionally, the return on the piece the banks retain is the same as the return on the overall loan.[18] Thus, unless banks are highly capital constrained, the Main Street program seems unlikely to lead banks to make many additional loans that they would not already be willing to make. In contrast, the model suggests that a key element of any effective government intervention is a willingness to aid marginal firms that private lenders would not see fit to support, even when those private lenders are not capital constrained.

18. This problem can be mitigated to some extent if the banks are also granted generous origination and servicing fees for making the loans. Such fees are indeed a feature of the Main Street Lending Program.

Similarly, Main Street's tight restrictions on firm leverage may also interfere with the program's ability to provide support to marginal firms that private lenders would not finance on their own. By only supporting firms with relatively low leverage, the government may effectively be shutting out those firms where the planner's motives diverge most sharply from those of the private capital providers, and where our model suggests that intervention is most socially valuable.

In addition, the maximum new loan size in the Main Street program is relatively large, ranging from $35 to $50 million depending on the specific subprogram. These large loan sizes may mean that for those small and medium-sized firms that do pass the government's and the banks' lending screens, the program may actually be too generous, in the sense of giving firms enough financing to last several quarters, rather than staging the financing and re-upping only in more positive states of the world.

Putting these observations together, our recommendation would be that, to the extent the government wants to protect its Main Street investments, it should do so less by imposing tough ex ante underwriting standards to decide who qualifies for the facility, and more by meting out the financing in stages for those who do qualify. Again, the analogy to venture capital is helpful here. In a situation of very high uncertainty, venture capital intermediaries do not seek to avoid investing in risky firms, because, of course, that is where all the value-added lies. Rather they protect themselves by carefully controlling the quantity of financing they provide and only adding to their investments when positive new information comes in. This is exactly the option-value approach that we are advocating.

Finally, the terms of Main Street's loans are relatively hard. These loans must be contractually senior to all other firm indebtedness, so we would generally expect participating banks to require collateral to secure Main Street loans. Moreover, their five-year maturity means that firms may be significantly squeezed by the obligation to repay their loans, even if the public health emergency subsides in the next year. Thus, the terms of Main Street loans may create significant future debt overhang problems. To the extent firms anticipate these problems, these terms may limit program take-up ex ante.[19]

19. In some respects, the Small Business Administration's Paycheck Protection Program is closer to the program suggested by the model, though its primary focus was on helping firms maintain employment rather than helping them survive. PPP was widely available—in fact, since it did not condition on firm revenue declines, it may have been too widely available. For firms spending most of the funds on payroll, the terms of the program were quite soft: their loans were fully converted to grants. However, for other firms, the terms were quite hard—e.g., the loans initially had a two-year maturity.

Alternatively, if there is ultimately a lot of take-up, the hardness of the loans may contribute to an otherwise avoidable wave of defaults and bankruptcies just as the economy is beginning to emerge from the recession.

Our discussion thus far has treated the US government as a single integrated actor. In practice, the relevant fiscal powers reside with the Treasury, which controls the ESF. The Federal Reserve only has the authority to establish facilities making loans that "are secured to the satisfaction" of the Fed.[20] In other words, while the Treasury can assume the risk and even the expectation of losses on its ESF investments, the Fed is not supposed to take risk on the loans it extends (English and Liang 2020). Thus, while it makes no difference for the US government's consolidated fiscal position, it is legally necessary for the Treasury to make sufficiently large equity investments in each credit facility so that the Fed is highly unlikely to suffer any losses.

Nevertheless, it would seem that the Treasury and the Federal Reserve could together implement all of our core recommendations for the Main Street program under current law. The Treasury has considerable untapped fiscal capacity under the CARES Act—by our count, the Treasury has made equity investments totaling $215 billion across all of the Fed's facilities versus a $454 billion appropriation under the CARES Act—that could be used to insulate the Fed from losses if Main Street or other facilities were to extend credit to riskier, more marginal firms.[21] Thus, most of Main Street's restrictive terms likely reflect an institutional unwillingness to assume risk, rather than a legal inability to take on risk.

II.F. Business Credit Programs outside the United States

In countries outside the United States, business credit programs feature some, but not all, of the characteristics suggested by our model. Table 2 gives a brief summary. Programs in the United Kingdom, France, and Germany feature both cash grants and loan subsidies or guarantees. In other words, these programs provide financing to firms on terms the private sector

20. Furthermore, the Federal Reserve cannot establish section 13(3) lending facilities that extend credit to "insolvent" borrowers—that is, firms who are currently in bankruptcy proceedings—or to firms that are on the verge of failing.

21. To be sure, there is also scope for helpful congressional action. For instance, to the extent that it is desirable for Main Street's loans to have a grant-like character, Congress could remove the provision in the CARES Act that explicitly forbids the government from forgiving any loans made by joint Treasury and Federal Reserve facilities. Relatedly, Congress could further clarify its intention under the CARES Act that the Treasury has the power to make ESF investments that expose taxpayers to the risk of loss when the Treasury deems this necessary to stabilize financial markets and the broader economy.

Table 2. Characteristics of Government Business Credit Programs: International Context

Country	*Program name*	*Better terms than private sector*	*Widely available*	*Staging*	*Soft loan terms*
United Kingdom	Coronavirus Business Interruption Loan Scheme	Yes	Yes	No	Yes, interest holiday
United Kingdom	Coronavirus Large Business Interruption Loan Scheme	Yes	No	No	Yes, interest holiday
United Kingdom	Bounce Back Loan Scheme	Yes	Yes	No	Yes, interest holiday
United Kingdom	Future Fund	No, matching fund	No	No	No
United Kingdom	Small Business Grant Fund and Retail, Hospitality, and Leisure Grants Fund	Yes	Yes	No	Yes, grant
Germany	Immediate Assistance Program (Soforthilfe)	Yes	Yes	Uncertain	Yes, grant
Germany	Financial assistance for SMEs (Überbrückungshilfe für kleine und mittleständische Unternehmen)	Yes	Yes	Uncertain	Yes, conditional grant
Germany	Economic stabilization fund (Wirtschaftsstabilisierungsfonds)	Uncertain	No	No	No
Germany	Instant loans (KfW-Schnellkredit)	Yes	Yes	Uncertain	No
Germany	Entrepreneur loans (KfW-Unternehmerkredit)	Yes	Yes	No	No
Germany	Special program (KfW-Konsortialfinanzierung)	No, bank participation	No	No	No
Germany	Corona matching facility (Corona Matching Fazilität)	No, VC coinvestment	No	No	Yes, equity investments
France	Government-guaranteed loans (Prêt garanti par l'État)	Yes	Yes	Uncertain	Yes, payment holiday
France	Solidarity fund (Fonds de solidarité)	Yes	Yes, small firms	Yes	Yes, grant
France	Subsidized loans (Prêts à taux bonifiés)	Yes	Yes, medium firms	No	No
France	Equity loans (Prêts participatifs exceptionnels)	Yes	Yes, small firms	No	Yes, junior in priority

Source: Authors' compilation.

Notes: This table lists major business support programs in the United Kingdom, Germany, and France and interprets their characteristics through the lens of features in our model. We use "Uncertain" in cases for which the government's future actions will determine whether that characteristic ultimately applies. Information on UK programs comes from HMRC guidance pages (available at https://www.gov.uk) and from press reports in the *Financial Times* and BBC. Information on German programs comes from official government websites for each program (e.g., https://www.kfw.de) and from Bruegel, which is a European think tank. Information on French programs comes from fact sheets at the Ministry of the Economy and Finance (available at https://www.economie.gouv.fr) and press reports in the *Financial Times* and *Le Monde*.

will not. In the United Kingdom under the Bounce Back Loan Scheme and Coronavirus Business Interruption Loan Scheme, in France under the Prêt garanti par l'État program, and in Germany under the KfW-Schnellkredit program, guarantees cover the full loan, ensuring that private sector willingness to lend does not restrict the set of firms that can participate.

Generally speaking, these programs are widely available, with restrictions only based on firm size and recent revenues. In some cases, such as the United Kingdom's Retail, Hospitality, and Leisure Grant Fund and Germany's Überbrückungshilfe für kleine und mittelständische Unternehmen, eligibility for grants or loan forgiveness extends only to firms in hard-hit industries or with substantial revenue losses due to the pandemic.

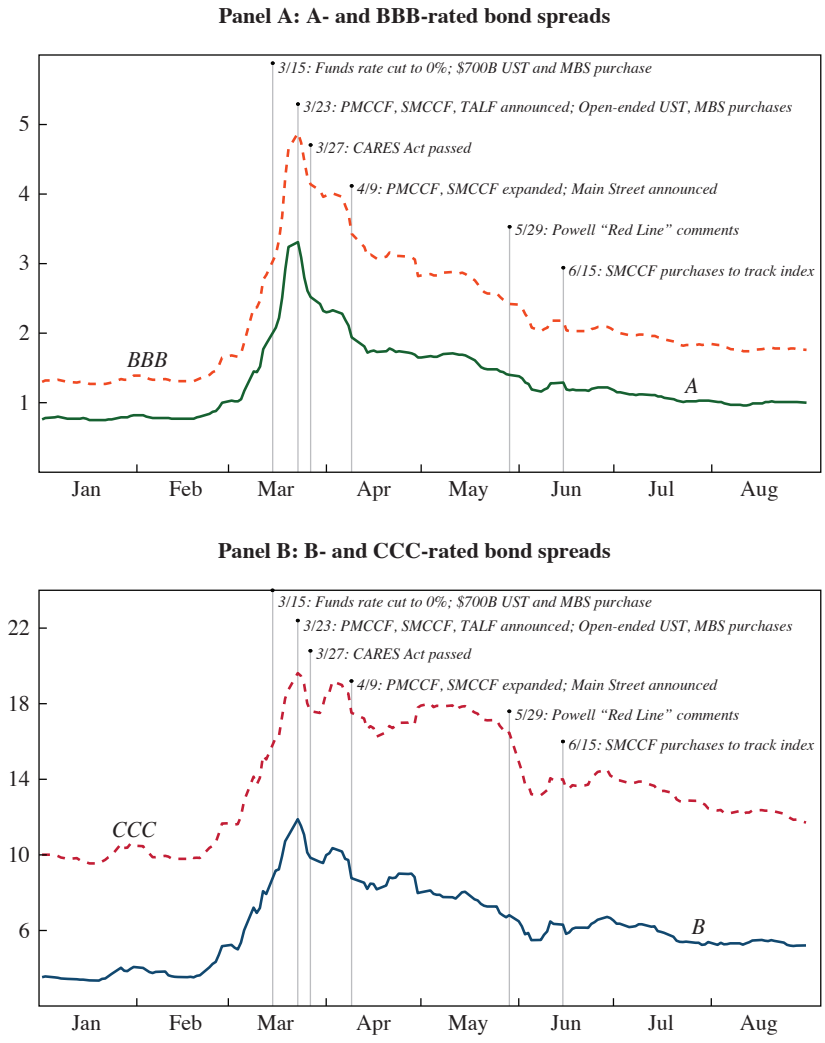
In many countries, including the United Kingdom, France, and Germany, the maximum amount of support is a fraction of firms' precrisis annual revenues, costs, or profits. While this financing is not explicitly staged, the governments have the option of renewing the programs, thus capturing some of the benefits of staging suggested by our model. Few countries have granted loans with soft terms, though France has a program (Prêts participatifs exceptionnels) focused on making equity investments, and the United Kingdom and Germany have small programs (the Future Fund and Corona Matching Fazilität, respectively) that match equity or convertible investments made by private investors. Finally, several countries have used value-added tax or payroll tax deferrals and holidays, which provide additional liquidity to firms.

III. Secondary Market Corporate Bond Purchase Programs

While the US government's existing programs are quite different from the policy interventions suggested by our model in section II, they have had surprisingly powerful effects on financial markets. As figure 2 shows, the corporate bond market, which had been under tremendous strain in March, rallied sharply following the announcement of the PMCCF and SMCCF on March 23, 2020. In this section, we present a simple model exploring the possibility that the sharp increase in corporate bond prices since March has occurred, in part, because investors are overestimating the Federal Reserve's willingness to intervene in markets going forward.

In the model, the Federal Reserve may purchase outstanding corporate bonds in response to shocks—in other words, the Fed has a bond purchase reaction function. Even before the Fed actually buys anything, the prospect of its state-contingent purchases can increase bond prices, for two reasons: they reduce the future volatility anticipated by private market investors

Figure 2. Investment-Grade and High-Yield Corporate Bond Spreads in 2020



Source: ICE Bank of America/Merrill Lynch Corporate Bond Indexes, obtained from FRED.

Notes: This figure shows the daily time series of Option-Adjusted Spreads, in percentage points, for A-, BBB-, B-, and CCC-rated corporate bonds. The sample begins on January 1, 2020, and ends on August 31, 2020. Gray lines indicate the following news events: March 15, when the Federal Reserve cut the funds rate to 0 percent and announced $700 billion of Treasury and MBS purchases; March 23, when the Federal Reserve announced the PMCCF, SMCCF, TALF, and open-ended Treasury and MBS purchases; March 27, when the CARES Act was passed; April 9, when the Federal Reserve expanded the PMCCF and SMCCF programs and announced Main Street; May 29, when Chairman Powell gave his "Red Line" speech at Princeton; and June 15, when the Federal Reserve announced the SMCCF would purchase corporate bonds to track an index. Panel A shows the time series of A- and BBB-rated spreads; panel B shows the time series of B- and CCC-rated spreads.

and thus the risk premium investors charge ex ante; and they create an asymmetric put, mitigating downside outcomes for investors while allowing them to keep the upside.

Private market investors make conjectures about the Federal Reserve's purchase reaction function, and crucially, we allow for the possibility that these conjectures may be incorrect. We show that when the market's expectations about the Fed's reaction function are overly optimistic, bond prices will initially be too high and there is a risk of a subsequent crash. If a negative fundamental shock is realized, bond prices fall both because of the direct effect of the shock and because the market learns that the Fed will not provide the support it had previously anticipated.

III.A. Baseline Amplification Model without Federal Reserve Intervention

We first introduce our baseline model without Federal Reserve intervention. The model considers the market for a single defaultable corporate bond and has three dates: $t = 1$, 2, and 3. The bond pays a random cash flow equal to X_3 at $t = 3$—that is, the bond is subject to fundamental credit risk. Specifically, we assume that the bond's time-3 cash flow is given by:

$$X_3 = \bar{X} + \varepsilon_{X_2} + \varepsilon_{X_3}, \tag{7}$$

where $\bar{X} > 0$ is a constant and ε_{X_2} and ε_{X_3} are mean-zero independent and identically distributed random variables that are realized at dates $t = 2$ and 3, respectively, each with variance $\sigma_X^2 > 0$.

At $t = 1$ and $t = 2$, the net supply of the bond must be held by a group of risk-averse investors with mean-variance preferences over their one-period-ahead wealth. We solve the model backward. At $t = 2$, investors' demand for risky bonds is given by:

$$D_2 = \frac{1}{\gamma}\frac{E_2[X_3] - P_2}{Var_2[X_3]} = \frac{1}{\gamma}\frac{\left[\bar{X} + \varepsilon_{X_2}\right] - P_2}{\sigma_X^2}, \tag{8}$$

where $\gamma > 0$ denotes investors' risk aversion.

We assume that there is financial market amplification at $t = 2$: the marginal investors we focus on must hold a larger quantity of corporate bonds when the price of these bonds turns out to be lower than expected. Specifically, the net supply, S_2, that these investors must hold at $t = 2$ is:

$$S_2 = \bar{S} + \varepsilon_{S_2} - \lambda \bullet \left(P_2 - \bar{P}_2\right), \tag{9}$$

where $\overline{P}_2 = \overline{X} - \gamma\sigma_X^2\overline{S}$ is the unconditional average price at $t = 2$. Net supply at $t = 2$ has two components. The first component, $\overline{S} + \varepsilon_{S_2}$, is an exogenous net supply term, where $\overline{S} > 0$ and ε_{S_2} is a mean-zero supply shock with variance $\sigma_S^2 \geq 0$ that is uncorrelated with fundamental news ε_{X_2}. The second component, $-\lambda \cdot (P_2 - \overline{P}_2)$, captures in a reduced form a variety of positive feedback mechanisms in financial markets. These include: (1) biased investors outside the model who over-extrapolate recent price changes (De Long and others 1990; Barberis and others 2015); (2) traders who face price-based leverage constraints and are forced to unwind at fire-sale prices following an initial negative shock (Geanakoplos 2009; Stein 2012); and (3) open-ended investment vehicles—for example, hedge funds and mutual funds—that face capital outflows when performance is poor and are similarly forced to liquidate their holdings (Shleifer and Vishny 1997). The expression $\lambda \geq 0$ captures the strength of these channels. When $\lambda > 0$, the marginal investors in our model must hold a larger than expected quantity of bonds when prices are lower than expected.

Equating demand and supply—that is, setting $D_2 = S_2$—the equilibrium price at $t = 2$ is:

$$P_2^* = \left[\overline{X} - \gamma\sigma_X^2\overline{S}\right] + \frac{\varepsilon_{X_2} - \gamma\sigma_X^2\varepsilon_{S_2}}{1 - \lambda \cdot \gamma\sigma_X^2}. \tag{10}$$

We assume $0 < \lambda \cdot \gamma\sigma_X^2 < 1$, implying that $1/(1 - \lambda \cdot \gamma\sigma_X^2) > 1$ so there is amplification at $t = 2$. Specifically, when λ becomes larger, time-2 prices become more responsive to both fundamental news ε_{X_2} and to the exogenous net supply shock ε_{S_2}.

Folding back to $t = 1$, the additional volatility induced by financial market amplification at $t = 2$ makes bonds riskier for investors at $t = 1$. Due to this additional risk, time-1 prices are lower than they would be in a world without amplification. Specifically, at $t = 1$, we assume that the net supply of corporate bonds is $S_1 = \overline{S} > 0$ and that investors' demand for bonds is given by:

$$D_1 = \frac{1}{\gamma}\frac{E_1[P_2^*] - P_1}{Var_1[P_2^*]}. \tag{11}$$

Thus, equating demand and supply—that is, setting $D_1 = S_1$—the equilibrium price at $t = 1$ is:

$$P_1^* = E_1[P_2^*] - \gamma Var_1[P_2^*]\overline{S}. \tag{12}$$

Computing the expected time-2 price and the variance of the time-2 price as of $t = 1$ and substituting these values into equation (12), we find that:

$$P_1^* = \left[\overline{X} - \gamma\sigma_X^2\overline{S}\right] - \gamma\left[\frac{\sigma_X^2 + (\gamma\sigma_X^2)^2\sigma_S^2}{(1 - \lambda \cdot \gamma\sigma_X^2)^2}\right]\overline{S}. \tag{13}$$

When $\sigma_S^2 = \lambda = 0$, equation (13) becomes $P_1^* = \overline{X} - \gamma 2\sigma_X^2\overline{S} = E_1[X_3] - \gamma Var_1[X_3]\overline{S}$, which one can think of as the benchmark efficient markets price in our model. This price is equal to the expected time-3 cash flow ($E_1[X_3]$) minus a risk premium that depends only on investor risk aversion (γ), the volatility of the time-3 cash flow ($Var_1[X_3]$), and the initial supply of bonds ($\overline{S}$).

When $\sigma_S^2 > 0$ or $\lambda > 0$, time-1 prices are lower than this efficient markets benchmark. Specifically, equation (13) shows that time-1 prices are lower when time-2 amplification is high—that is, $\partial P_1^*/\partial\lambda < 0$—because amplification raises the volatility of time-2 prices. Similarly, time-1 prices are lower when there is more nonfundamental supply risk at $t = 2$—that is, $\partial P_1^*/\partial\sigma_S^2 < 0$.

III.B. A Federal Reserve Purchase Reaction Function

We now extend this baseline model to allow for Federal Reserve purchases and sales at $t = 2$. We begin by supposing that the Fed has a linear purchase reaction function that governs the quantity of corporate bonds it will purchase in different states of the world at $t = 2$:

$$B_2 = \theta_S \cdot \varepsilon_{S_2} - [\theta_X/(\gamma\sigma_X^2)] \cdot \varepsilon_{X_2} - \theta_P \cdot (P_2 - \overline{P}_2). \tag{14}$$

Equation (14) says that the Fed will purchase more bonds when the net supply rises unexpectedly (when ε_{S_2} is high), when credit fundamentals are unexpectedly poor (ε_{X_2} is low), or when prices are lower than expected.[22] The linear form of the reaction function makes the algebra simple to work with but prevents us from analyzing nonlinear, put-like behavior on the part of the Fed. We return to this point in more detail below.

In the model, corporate bonds are all of the same credit quality and the Federal Reserve has one purchase reaction function. In reality, bonds differ in their riskiness with high-yield bonds having substantially higher default

22. Since there are just two shocks at $t = 2$, the three-parameter reaction function in equation (14) is over-parameterized. We over-parameterize the reaction function this way to exposit different economic rationales for purchasing risky bonds.

probabilities than investment-grade bonds. If we extended the model to include a range of bonds with different credit risk exposures, our mean-variance investors would apply a consistent price of credit risk across all bonds and would require higher returns on riskier bonds. Further, the Fed would have a bigger impact on time-1 prices if it purchased riskier bonds—that is, if it concentrated its purchases in high-yield bonds. This is the analog of the idea that quantitative easing has larger effects when the Fed buys longer-maturity Treasury bonds (Tobin 1958; Vayanos and Vila 2021). In such an extended model, if the Fed primarily bought investment-grade bonds, it would have a smaller impact on overall credit spreads.

Equating demand and supply—that is, setting $D_2 + B_2 = S_2$—the price at $t = 2$ is given by:

$$P_2^{**} = \left[\overline{X} - \gamma\sigma_X^2\overline{S}\right] + \frac{(1-\theta_X)\bullet\varepsilon_{X_2} - (1-\theta_S)\bullet\gamma\sigma_X^2\varepsilon_{S_2}}{1-(\lambda-\theta_P)\bullet\gamma\sigma_X^2}. \tag{15}$$

Thus, there will be less time-2 price volatility when the Federal Reserve chooses θ_X closer to 1, θ_S closer to 1, or θ_P closer to λ.

Folding back to time 1, we begin by assuming that investors accurately perceive the Federal Reserve's time-2 reaction function and know it with certainty. The equilibrium time-1 price is then given by:

$$P_1^{**} = \left[\overline{X} - \gamma\sigma_X^2\overline{S}\right] - \gamma\frac{(1-\theta_X)^2\bullet\sigma_X^2 + (1-\theta_S)^2\bullet(\gamma\sigma_X^2)^2\sigma_S^2}{(1-(\lambda-\theta_P)\bullet\gamma\sigma_X^2)^2}\overline{S}, \tag{16}$$

which can be contrasted with the no-intervention price in equation (13). A more aggressive reaction function raises time-1 prices—that is, we have $\partial P_1^{**}/\partial\theta_P > 0$, $\partial P_1^{**}/\partial\theta_X > 0$, and $\partial P_1^{**}/\partial\theta_S > 0$.

One case of interest is where $\theta_S = 1$, $\theta_X = 0$, and $\theta_P = \lambda$. In this case, the Federal Reserve completely offsets exogenous net supply shocks ($\theta_S = 1$) and neutralizes all market-based amplification at $t = 2$ ($\theta_P = \lambda$) but allows prices to impound whatever fundamental news arrives ($\theta_X = 0$). Loosely speaking, this reaction function seeks to fully offset the effect of any "technical" factors that push prices away from fundamental value but does not interfere with the adjustment of prices to fundamental news. This reaction function shares some similarities with traditional lender-of-last-resort functions: the goal is not to offset weak fundamentals but rather to dampen positive feedback loops that push market prices away from fundamentals. However, if λ and σ_S^2 are large, this reaction function necessarily

requires the Federal Reserve to take on large amounts of credit risk in some states at $t = 2$. Thus, even in this case, when it does not attempt to lean against fundamental news, the Fed is going well beyond its normal lender-of-last-resort role. In this case, equation (16) becomes $P_2^{**} = \overline{X} + \varepsilon_{X_2} - \gamma\sigma_X^2\overline{S} = E_2[X_3] - \gamma Var_2[X_3]\overline{S}$—that is, the efficient-markets price at $t = 2$. Similarly, equation (10) reduces to $P_1^{**} = \overline{X} - \gamma 2\sigma_X^2\overline{S} = E_1[X_3] - \gamma Var_1[X_3]\overline{S}$, the efficient-markets time-1 price.

Another interesting case is where $\theta_S = 1$ and $\theta_X = 1$. Here the Federal Reserve is committed to pegging the time-2 risky bond price at the constant level: $\overline{P}_2^{**} = \overline{X} - \gamma\sigma_X^2\overline{S} = \overline{P}_2$. To operationalize such a peg and prevent bond prices from impounding any negative fundamental information, the Fed would need to purchase risky bonds very aggressively in response to any negative fundamental news at $t = 2$. Such a reaction function would potentially require the Fed to take on even more credit risk at $t = 2$.

III.C. Investor Misperceptions about the Federal Reserve's Purchase Reaction Function

Next, we consider the possibility that investors may hold mistaken beliefs at $t = 1$ about the Federal Reserve's time-2 reaction function. Specifically, we assume investors believe that the Fed's reaction function is given by:

$$B_2 = \hat{\theta}_S \cdot \varepsilon_{S_2} - \left[\hat{\theta}_X / (\gamma\sigma_X^2)\right] \cdot \varepsilon_{X_2} - \hat{\theta}_P \cdot (P_2 - \overline{P}_2). \tag{17}$$

Given these beliefs, the equilibrium time-1 price becomes:

$$\hat{P}_1^{**} = \left[\overline{X} - \gamma\sigma_X^2\overline{S}\right] - \gamma \frac{\left(1 - \hat{\theta}_X\right)^2 \cdot \sigma_X^2 + \left(1 - \hat{\theta}_S\right)^2 \cdot (\gamma\sigma_X^2)^2 \sigma_S^2}{\left(1 - \left(\lambda - \hat{\theta}_P\right) \cdot \gamma\sigma_X^2\right)^2} \overline{S}. \tag{18}$$

Of course, time-1 prices will be higher when investors believe that the Fed has a more aggressive reaction function at $t = 2$—that is, $\partial\hat{P}_1^{**}/\partial\hat{\theta}_P > 0$, $\partial\hat{P}_1^{**}/\partial\hat{\theta}_X > 0$, and $\partial\hat{P}_1^{**}/\partial\hat{\theta}_S > 0$.

We can then compare the actual market price ($\hat{P}_1^{**}$) to what the market price would be if investors properly perceived the Federal Reserve's reaction function (P_1^{**}). Doing so, we obtain:

$$\hat{P}_1^{**} - P_1^{**} = \gamma \left(\begin{array}{c} \dfrac{(1 - \theta_X)^2 \cdot \sigma_X^2 + (1 - \theta_S)^2 \cdot (\gamma\sigma_X^2)^2 \sigma_S^2}{\left(1 - (\lambda - \theta_P) \cdot \gamma\sigma_X^2\right)^2} \\ - \dfrac{\left(1 - \hat{\theta}_X\right)^2 \cdot \sigma_X^2 + \left(1 - \hat{\theta}_S\right)^2 \cdot (\gamma\sigma_X^2)^2 \sigma_S^2}{\left(1 - \left(\lambda - \hat{\theta}_P\right) \cdot \gamma\sigma_X^2\right)^2} \end{array} \right) \overline{S}. \tag{19}$$

Equation (19) says prices will initially be too high if investors overestimate the aggressiveness of the Fed's future reaction function. This effect arises since time-2 prices will be more volatile than investors anticipate and because investors do not charge for this unanticipated risk at $t = 1$. Thus, one implication of equation (19) is that it illustrates the scope for a sudden decline in prices if investors update their beliefs about the Fed's reaction function in the direction of the truth. This might happen, for example, following new Fed communications that occur shortly after $t = 1$.[23]

Alternatively, we can compare the realized price change between times 1 and 2 when investors initially have mistaken beliefs ($P_2^{**} - \hat{P}_1^{**}$) with the corresponding price change when investors have correct beliefs ($P_2^{**} - P_1^{**}$). Suppose investors are overly optimistic about the Federal Reserve's purchase reaction function, so $\hat{P}_1^{**} > P_1^{**}$. It follows that for any possible realization of fundamentals or time-2 supply, we will have $P_2^{**} - \hat{P}_1^{**} < P_2^{**} - P_1^{**}$. Thus, the realized change in prices is always less favorable when investors initially overestimate the aggressiveness of the Fed's purchase reaction function. Misperceptions of the Fed's reaction function create an obvious trade-off: greater misperception raises the time-1 price but always results in a less favorable price change between times 1 and 2.

III.D. An Asymmetric Federal Reserve Purchase Reaction Function

Thus far we have assumed the Federal Reserve's purchase reaction function is linear. To capture the idea of a Fed put, we instead suppose the Fed's reaction function is asymmetric and is given by

$$B_2 = \theta_P \max\left\{\overline{P}_2 - P_2, 0\right\}, \tag{20}$$

and that investors believe that the Fed's reaction function is

$$B_2 = \hat{\theta}_P \max\left\{\overline{P}_2 - P_2, 0\right\}, \tag{21}$$

23. As opposed to overestimating the government's resolve, one might theoretically expect rational investors to discount government commitments to make large purchases of risky bonds in certain future states. Specifically, the government may have a time-consistency problem, finding it desirable to stabilize markets by announcing interventions and then failing to follow through on those announcements to avoid actually taking risk. If markets recognize this time-consistency problem, they may react little to government announcements. While such a situation may arise in the future, it does not seem to capture the market's response to recent events.

where $\overline{P}_2 = \overline{X} - \gamma\sigma_X^2\overline{S}$. In other words, the Fed will buy when P_2 is lower than $\overline{P}_2$ and will buy more as prices fall further. However, the Fed will not sell if P_2 is higher than $\overline{P}_2$. Further, since $\hat{\theta}_P$ need not equal θ_P, we allow for the possibility that investors misperceive the Fed's purchase reaction function.[24]

Equation (21) implies that investors anticipate the following time-2 pricing function:

$$(22)\quad \hat{P}_2^{**} = \left[\overline{X} - \gamma\sigma_X^2\overline{S}\right] + \frac{1}{1-\left(\lambda-\hat{\theta}_P\right)\cdot\gamma\sigma_X^2}\times\left(\varepsilon_{X_2} - \gamma\sigma_X^2\varepsilon_{S_2}\right)$$
$$+\left(\frac{1}{1-\lambda\cdot\gamma\sigma_X^2} - \frac{1}{1-\left(\lambda-\hat{\theta}_P\right)\cdot\gamma\sigma_X^2}\right)\times\max\left\{\varepsilon_{X_2} - \gamma\sigma_X^2\varepsilon_{S_2}, 0\right\}.$$

In other words, $\hat{P}_2^{**}$ is an increasing, piece-wise linear function of the time-2 news ($\varepsilon_{X_2} - \gamma\sigma_X^2\varepsilon_{S_2}$) with a smaller slope when time-2 news is bad ($\varepsilon_{X_2} - \gamma\sigma_X^2\varepsilon_{S_2} < 0$) and a larger slope when time-2 news is good ($\varepsilon_{X_2} - \gamma\sigma_X^2\varepsilon_{S_2} > 0$). This change in slope reflects the fact that the Federal Reserve is only anticipated to buy bonds when time-2 news is bad, muting downside amplification but not upside amplification. The actual time-2 pricing function takes a similar form, replacing $\hat{\theta}_P$ in equation (16) with θ_P. Folding back to $t = 1$, we have $\hat{P}_1^{**} = E_1[\hat{P}_2^{**}] - \gamma Var_1[\hat{P}_2^{**}]\overline{S}$. If we assume the news shocks are normally distributed, we can compute $E_1[\hat{P}_2^{**}]$ and $Var_1[\hat{P}_2^{**}]$ in closed form to obtain:

$$(23)\quad \hat{P}_1^{**} = \left[\overline{X} - \gamma\sigma_X^2\overline{S}\right]$$
$$+\overbrace{\left(\frac{1}{1-\lambda\cdot\gamma\sigma_X^2} - \frac{1}{1-\left(\lambda-\hat{\theta}_P\right)\cdot\gamma\sigma_X^2}\right)\sqrt{\frac{\sigma_X^2 + (\gamma\sigma_X^2)^2\sigma_S^2}{2\pi}}}^{\text{Impact of perceived Fed put on } E_1\left[\hat{P}_2^{**}\right]}$$
$$-\gamma\left[\begin{array}{c}\left(\frac{1}{1-\lambda\cdot\gamma\sigma_X^2} - \frac{1}{1-\left(\lambda-\hat{\theta}_P\right)\cdot\gamma\sigma_X^2}\right)^2\frac{\pi-1}{2\pi}\\ +\left(\frac{1}{1-\left(\lambda-\hat{\theta}_P\right)\cdot\gamma\sigma_X^2}\right)\left(\frac{1}{1-\lambda\cdot\gamma\sigma_X^2}\right)\end{array}\right]\underbrace{\left(\sigma_X^2 + (\gamma\sigma_X^2)^2\sigma_S^2\right)\overline{S}}_{\text{Investors' perception of } Var_1\left[\hat{P}_2^{**}\right]}$$

24. The analysis here is qualitatively unchanged if we instead assume that the Fed's purchase reaction function is $B_2 = \max\{\theta_S\cdot\varepsilon_{S_2} - [\theta_X/(\gamma\sigma_X^2)]\cdot\varepsilon_{X_2} - \theta_P\cdot(P_2 - \overline{P}_2), 0\}$.

This expression implies intuitive comparative statics: since $\partial E_1[\hat{P}_2^{**}]/\partial\hat{\theta}_P > 0$ and $\partial Var_1[\hat{P}_2^{**}]/\partial\hat{\theta}_P < 0$, a higher value of $\hat{\theta}_P$ now raises $\hat{P}_1^{**}$ through two separate channels. The fact that the expectation of a more aggressive Federal Reserve reaction function raises time-1 prices because it reduces anticipated time-2 price volatility ($\partial Var_1[\hat{P}_2^{**}]/\partial\hat{\theta}_P < 0$) is the same effect we emphasized above in the case where the Fed has a symmetric reaction function. The fact that $\partial E_1[\hat{P}_2^{**}]/\partial\hat{\theta}_P > 0$ is new and arises from the option-like payoff created by investors expecting the Fed to step in to mute price declines but not expecting the Fed to mute price increases. Thus, if we initially have $\hat{\theta}_P > \theta_P$ and investors revise down their beliefs about the aggressiveness of the Fed's purchase reaction function shortly after time-1, this will lead prices to fall for two distinct reasons.

With an asymmetric reaction function, there will also be an asymmetry in the way that investors revise their beliefs about the Federal Reserve's reaction function when news is revealed at $t = 2$. Specifically, when $\hat{\theta}_P > \theta_P$ and the news at $t = 2$ is good, the Fed will not transact in the bond market at $t = 2$ and investors will never realize that they had misperceived the Fed's reaction function at $t = 1$. By contrast, if $\hat{\theta}_P > \theta_P$ and the news at $t = 2$ is bad, prices will fall for two reasons. First, prices will fall because of the bad news. However, prices will fall even more because the bad news will lead investors to realize that they had overestimated the Fed's willingness to support prices. Thus, when $\hat{\theta}_P > \theta_P$, the time-2 price expected at time-1 by a rational and fully informed outside observer who knows the true level of θ_P will be less than the time-2 price that is expected by investors who think $\hat{\theta}_P > \theta_P$.

Our model is essentially a one-shot game between investors and the Federal Reserve. As a result, if the time-2 news is bad and the Fed intervenes less aggressively than investors had anticipated, time-2 prices will still be higher than they would have been if the Fed had not intervened at all. However, in a multi-shot extension of our model, investor misperceptions of the Fed's purchase reaction function could lead prices to fall below the no-intervention counterfactual. For instance, assume investors initially expect the Fed to always make some minimal purchases $\underline{\theta}_P > 0$ to mute downside amplification. Suppose a financial crisis leads the Fed to want to provide a higher level of downside support $\theta_P > \underline{\theta}_P$ to market prices, but investors overinterpret the Fed's commitment and expect $\hat{\theta}_P > \theta_P > \underline{\theta}_P$. If the Fed's subsequent purchases disappoint investors, this might reduce the Fed's credibility, leading investors to revise their estimate of the Fed's downside support to some new $\hat{\theta}_P < \underline{\theta}_P$. In a multi-period setting, this could actually lead prices to fall to a lower level than they would have if the Fed had never signaled its heightened commitment to support prices.

III.E. Is the Market Currently Misperceiving the Federal Reserve's Reaction Function?

As the above discussion suggests, the risk of an abrupt market correction in the prices of risky bonds is related to the extent to which investors overestimate the aggressiveness of the Federal Reserve's bond-purchase reaction function. In what follows, we present some suggestive—although admittedly not dispositive—evidence that the market may be misperceiving the Fed's current intentions to intervene in the corporate bond market going forward.

We focus on two lines of argument. First, with a few exceptions, the Federal Reserve's announcements suggest a greater willingness to purchase investment-grade than high-yield corporate bonds. For instance, under its current terms, the SMCCF will purchase individual corporate bonds that either currently have an investment-grade rating or that had an investment-grade rating on March 22, 2020, but have since been downgraded to a rating no lower than BB-/Ba3. Similarly, while the SMCCF has purchased some high-yield ETFs, it has concentrated its purchases in investment-grade ETFs.[25]

In the same way that Federal Reserve purchases of short-dated Treasuries should have a smaller impact on term premia than purchases of long-dated Treasuries, a commitment to purchase low-risk investment-grade bonds should have a smaller impact on credit risk premia than a commitment to purchase higher-risk, speculative-grade bonds. However, despite their focus on investment-grade bonds, the Fed's announcements appear to have had a powerful impact on spreads throughout the corporate bond market, suggesting that investors may be overinterpreting the scope of the Fed's backstop. Specifically, as shown in figure 2 and table 3, the announcement of the PMCCF and SMCCF was associated with large rallies not only in investment-grade bonds but also in high-yield bonds. Further Fed communications about these programs—in particular, the expansion of the programs on April 9 and Chairman Powell's "red lines" comments on May 29—were also associated with large rallies in lower-rated bonds.[26]

25. Specifically, the Fed is targeting a portfolio of individual corporate bonds consisting of 42 percent AAA-, AA-, and A-rated bonds, 55 percent BBB-rated bonds, and 3 percent BB-rated bonds. As of August 31, the Fed had purchased $8.7 billion of corporate bond ETFs, of which $1.1 billion or 13 percent have been high-yield ETFs.

26. The window around Chairman Powell's May 29 speech also includes Gilead's June 1 announcement that the antiviral drug Remdesivir showed promise in phase 3 trials. While most market participants attribute the market rally to Chairman Powell's speech and not this public health news, we cannot cleanly separate these two events.

Table 3. Changes in US Corporate Bond Spreads around Major Market Announcements during 2020

		AAA	*AA*	*A*	*BBB*	*BB*	*B*	*CCC*
Panel A: Federal Reserve announcements								
March 23	PMCCF, SMCCF, TALF; open-ended Treasury purchases[a]	−68	−66	−70	−64	−143	−176	−160
April 9	Expansion of PMCCF, Main Street	−19	−29	−39	−61	−134	−153	−188
May 29	Powell's "red line" comments	−8	−4	−6	−9	−15	−48	−196
June 15	Term sheet for SMCCF amended	−9	−10	−10	−15	−41	−45	−44
Panel B: Public health news								
April 6	Wuhan reopens; NYC deaths plateau over weekend	−18	−20	−22	−29	−60	−63	−64
April 13	Governors of NY, NJ, CT, and PA announce reopening plans	−1	−12	−20	−30	−27	−29	−71
May 18	First Moderna human trial results; Italy begins to reopen	−18	−15	−17	−22	−61	−64	−66
July 1	EU reopens borders	−1	−4	−5	−8	−44	−48	−55
Panel C: Macroeconomic news								
March 27	CARES Act signed into law	−24	−25	−29	−28	−53	−56	−8
April 29	2020:Q1 GDP release: −4.8 percent	0	−2	−6	−26	−16	−99	84
May 8	April jobs report: −20.5 million jobs	2	0	2	1	−16	−20	−22
June 5	May jobs report: +2.5 million jobs	−1	−3	−8	−15	−4	−10	−42
July 2	June jobs report: +4.8 million jobs	−5	−6	−6	−7	−26	−35	−30
July 30	2020:Q2 GDP release: −32.9 percent	0	1	−2	0	0	0	−40

Source: ICE Bank of America/Merrill Lynch Corporate Bond Indexes, obtained from FRED.

Notes: We report three-day changes ($S^i_{t+2} - S^i_{t-1}$) surrounding events in basis points.

a. The reported three-day changes are over $S^i_{t+3} - S^i_t$. We do this since credit spreads rose initially on March 23 but fell dramatically over the following three days.

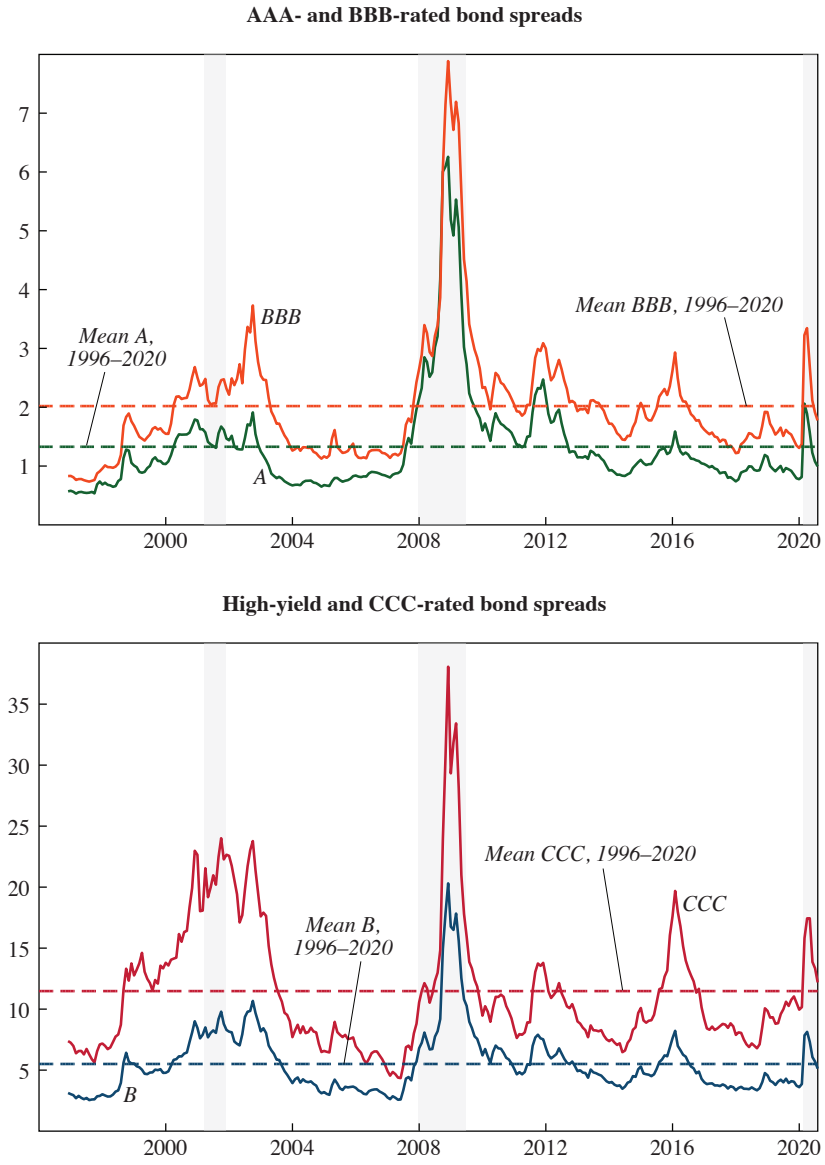
Second, while in the language of our model it is plausible that the Federal Reserve's reaction function effectively embeds meaningfully positive values of θ_S and θ_P, it seems unlikely that it embeds a nonzero value of θ_X. In words, one can imagine the Fed leaning against non-fundamental supply shocks or market amplification mechanisms, but it is much harder to believe that they will try to prevent bond prices from adjusting to a significant deterioration in credit fundamentals. For example, the Fed might step in to stem a fire sale that is driven by outflows from bond mutual funds, but if there is a wave of downgrades or defaults because firms are facing large cash flow shortfalls, it seems quite doubtful that the Fed will—or even can—try to support the prices of these fundamentally distressed bonds. Indeed, when the Fed first announced the PMCCF and SMCCF in March 2020, there was evidence of market dysfunction in the corporate bond market, particularly for investment-grade bonds. Given this timing, one could interpret the Fed's program announcements as declaring that θ_S and θ_P were positive.

Yet, it is difficult to rationalize current market pricing, particularly of high-yield bonds, without appealing to the notion that investors believe that $\hat{\theta}_X > 0$. Simply put, credit spreads are currently at a level that suggests that investors believe the Federal Reserve will offset even fundamental shocks to the value of risky bonds. Specifically, figure 3 shows that the rally that began after March 23 has resulted in credit spreads significantly below the levels typically witnessed during recessions. Even more strikingly, figure 3 shows that spreads on investment-grade and most high-yield bonds are currently below their unconditional averages over the past twenty-five years. (Spreads on CCC-rated bonds remain slightly above their long-run average level today.) By standard asset pricing logic, these low credit spreads must either signal low future credit losses or low future excess returns over default-free Treasuries. Specifically, under simplifying assumptions, the expected return on a corporate bond in excess of like-maturity default-free Treasuries is given by $E[R_{Corp} - R_{Govt}] = S - \pi \times L$, where S is the bond's initial credit spread over Treasuries, π is the bond's constant default hazard probability (i.e., the probability the bond defaults in the next year conditional on surviving thus far), and L is the bond's expected loss given default (i.e., the expected fraction of par an investor will lose upon default).

Consider B-rated corporate bonds.[27] Based on data from the ICE BofAML Index, the average level of B-rated corporate bond spreads since 1996 has

27. The formula is valid if a bond's default hazard probability is expected to be constant over time. In the data, this assumption has historically been reasonable for B-rated bonds.

Figure 3. Investment-Grade and High-Yield Corporate Bond Spreads, 1996–2020



Source: ICE Bank of America/Merrill Lynch Corporate Bond Indexes, obtained from FRED.

Notes: This figure shows the monthly time series of ICE BofAML Option-Adjusted Spreads for A-rated, BBB-rated, B-rated, and CCC- and lower-rated bonds. Dashed lines indicate each series' unconditional mean over the sample period, which runs from December 1996 to August 2020.

been 5.5 percent. According to S&P Global Ratings (Kraemer 2020), the one-year default rate for B-rated bonds averaged 3.3 percent from 1981 to 2019. Thus, assuming a typical loss given default of 60 percent, our formula implies an average excess return on B-rated bonds of $E[R_{Corp} - R_{Govt}]$ = 5.5 percent − 3.3 percent × 60 percent = 3.5 percent. On August 31, 2020, B-rated bond spreads stood at 5.2 percent, slightly below their long-run average, despite the fact that the United States is now in the midst of a severe recession. According to S&P Global Ratings (Kraemer 2020), the default rate on B-rated bonds has topped 11 percent in the last three recessions, reaching 13.8 percent in 1991, 11.6 percent in 2001, and 11.0 percent in 2009. If the default rate were to again reach 11 percent in this recession, that would imply an expected excess return of $E[R_{Corp} - R_{Govt}]$ = 5.2 percent − 11 percent × 60 percent = −1.4 percent. However, since B-rated bonds are quite risky, as well as less liquid than Treasuries, investors should always require a positive expected excess return to hold them. While highly simplistic, this analysis suggests that investors either expect defaults of highly levered firms to be much lower in the COVID-19 recession than in past recessions or that the Federal Reserve will somehow put a firm floor beneath the prices of these highly risky bonds.[28]

The rally in CCC-rated bonds is also noteworthy. CCC-rated bonds have very high default probabilities even in normal times (averaging 27 percent from 1981 to 2019) and their default probabilities topped 45 percent in the last two recessions (Kraemer 2020). Under the current terms of the SMCCF, the Federal Reserve will not purchase CCC-rated bonds directly and will only support them indirectly through its purchases of high-yield bond ETFs. Moreover, because of limitations in section 13(3) of the Federal Reserve Act, the Treasury and the Federal Reserve's joint facilities cannot buy the bonds of firms that are in bankruptcy proceedings, which presumably reduces the US government's appetite for buying CCC-rated bonds, which are close to default. Thus, the large compression in CCC-rated spreads since March is particularly striking.

Firms have responded to this powerful market rally by issuing record quantities of corporate bonds and equity in recent months. The issuance

28. Cox, Greenwald, and Ludvigson (2020), Gormsen and Koijen (2020), and Landier and Thesmar (2020) conduct analogous exercises for the US stock market and conclude that either low investor risk aversion or positive market sentiment play a key role in explaining the current high level of US stock prices.

boom began in the investment-grade bond market following the Federal Reserve's March 23 announcement. US investment-grade corporations issued $808 billion in bonds between March and May 2020, more than double the amount in any prior three-month period on record. The issuance boom spread to lower-rated corporate bonds in April and then to public equities in May. According to data from Refinitiv Thomson ONE, the volume of high-yield bond issuance ($125 billion), convertible bond issuance ($46 billion), and seasoned public equity issuance ($100 billion) between April and June each exceeded any prior three-month period in US history.

There is an alternative explanation for today's low level of corporate bond spreads that does not involve investor misperceptions: the Federal Reserve's interventions may have actually reduced the amount of corporate credit risk in the economy. Specifically, the market rally and subsequent issuance wave may have allowed firms to build up enough of a cash buffer to survive until the public health emergency ends and cash flows return to more normal levels. In this case, the lower credit risk going forward means that the Federal Reserve will not actually have to lean against fundamental shocks in its bond buying.

This alternative is difficult to rule out definitively, but a couple of pieces of evidence suggest it is not the whole story. First, as shown in table 3, other types of news—for example, news about recent improvements in the labor market—have not had as powerful an effect on credit spreads as Federal Reserve announcements. In other words, the market appears to be reacting more strongly to Fed news than to fundamental macro news. Second, we are in fact already seeing a surge in credit rating downgrades and defaults. According to S&P Global Ratings (Kraemer, Palmer, and McCabe 2020), the number of corporate defaults in the first six months of 2020 (eighty-three) exceeded the total for the entirety of 2019 (seventy-seven). Furthermore, S&P tallied more rating downgrades in the first six months of 2020 than in any prior twelve-month period.

III.F. Normative Implications: When Is Central Bank Magic Most Potent?

On July 26, 2012, in the face of escalating market worries about the potential breakup of the euro, European Central Bank president Mario Draghi famously said: "Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough." In the wake of Draghi's speech, yields on Spanish and Italian sovereign debt declined

dramatically and financial markets stabilized more generally.[29] The words "whatever it takes" have since become a shorthand for the almost magical ability of central bank announcements to stabilize markets, in some cases with little in the way of follow-up action.

The power of central bank magic of this sort is most easily rationalized in the context of models with multiple equilibria such as Diamond and Dybvig's (1983) seminal model of bank runs. With regards to Draghi's quote, one can readily imagine circumstances in which there may be multiple equilibria in the market for Italian sovereign debt. If Italian interest rates are high, Italy will struggle to service its debt load, and there will be a significant risk of an Italian default, validating the high interest rates. Conversely, if Italian interest rates are low, Italy can more comfortably service its debt, and Italian default risk is mostly eliminated, validating the low interest rates.[30] In a setting like this, if Italy is initially stuck in the high-rate equilibrium, a powerful commitment by the European Central Bank to buy Italian bonds can shift the market to the low-rate equilibrium. And once the market shifts to this new low-rate equilibrium, little bond buying may actually be necessary; all that is required is a credible off-equilibrium-path commitment. This ability to affect outcomes with promises alone, without taking any risk in equilibrium, is one way of thinking about central bank magic.

On the surface, the Federal Reserve's March announcements of the PMCCF and the SMCCF, and the Fed's follow-up communications, including Chairman Powell's May 29 "red lines" remarks, have had a similar "whatever it takes" shock-and-awe kind of impact on markets. Moreover, these words have not only led to a powerful rally in credit and equity markets, they have unleashed a wave of issuance by both investment-grade and high-yield firms that has undoubtedly helped improve the balance sheet health of issuing firms and, thus, the resilience of the broader economy. Indeed, in some recent models (He and Milbradt 2014; Greenwood, Hanson, and Jin 2019) improvements in investor sentiment may enable firms who might otherwise default to survive by allowing them to refinance maturing debt on more favorable terms. In other words, there is some potential for

29. On July 24, 2012, the spread between the yield on ten-year Spanish government bonds and that on ten-year German bonds had reached 630 basis points. The corresponding spread for Italy was 530 basis points. By July 27, one day after Draghi's speech, Spanish and Italian spreads had fallen to 530 and 450 basis points, respectively. And, by the end of 2012, Spanish and Italian spreads stood at 390 and 320 basis points.

30. Beginning with Calvo (1988) and Cole and Kehoe (2000), there is a large body of literature that studies the potential for self-fulfilling sovereign debt crises of the sort.

self-fulfilling dynamics to exist in the corporate bond market, just as in the sovereign bond market.[31]

Nevertheless, despite the potential for such positive feedback effects, it is hard to argue that we are currently in a situation where the strongest form of central bank magic is available to the Federal Reserve—namely that the Fed can stabilize credit markets and move the economy to a better equilibrium without the prospect of having to actually take on significant credit risk. While all the issuance sparked by the Fed's communications has undoubtedly lowered the near-term default risk of many firms, given the magnitude of the economic downturn triggered by the pandemic, we still face the possibility of a coming wave of credit downgrades and defaults. If this negative scenario comes to pass, the Fed may feel pressure to step in and assume a considerable amount of credit risk to avoid disappointing investors. Alternatively, if the Fed does not step in, there is a risk that these downgrades and defaults will lead market sentiment to worsen considerably, generating a credit crunch that triggers further firm defaults. In the latter case, the favorable self-fulfilling dynamics we have witnessed in credit markets since late March may begin to go in reverse.

To be clear, none of this is to suggest that the Federal Reserve's aggressive response to the crisis—or even the market's potential overinterpretation of the Fed's intentions—have been undesirable from a normative perspective. Quite the contrary: the Fed's efforts to stabilize financial markets since March, and especially the large volumes of issuance they have triggered, have had a clear benefit to the real economy. Indeed, we would argue that the Fed's forceful efforts to stabilize financial markets since March have thus far stemmed the potential for a damaging negative spiral, in which deteriorating financial conditions amplify the initial impact of the pandemic-induced shock. Our far more modest point is only that, in contrast to other settings where central bankers (or the government more broadly) can be helpful with their words alone, and without assuming a significant amount of fiscal risk, we are in a situation where risk-taking by the government may be a crucial part of the equation.

31. In Greenwood, Hanson, and Jin (2019), there is a two-way feedback loop between investors' biased beliefs and credit market outcomes. Investors form beliefs about default probabilities in part by naively extrapolating firms' recent repayment history. Following periods of low defaults, investors believe that corporate debt is safer than it truly is, and they refinance maturing debt on more attractive terms than unbiased investors would. Thus, investors' current biased beliefs influence future credit market outcomes, and past credit market outcomes shape investors' current biased beliefs.

This observation connects back to the themes in the first part of the paper. There is an obvious parallel between the key point there—namely, that we are not in a classic multiple-equilibrium lender-of-last-resort situation and the Main Street facility therefore will have to take on meaningful levels of credit risk if it is to be effective—and our point here about the bond purchase programs. Simply put, the economic impact of the pandemic is so devastating that even with the best possible financial policy response, enormous fundamental uncertainty remains; there is no low-solvency/risk equilibrium that can be readily attained. And if the government is not willing to take some credit risk in its programs, these programs cannot hope to be fully effective. The question then becomes not whether the government should take risk, but how to balance the fiscal costs of these risks against the benefits of intervention, and how to mitigate these risks with intelligent program design features where possible.[32]

IV. Conclusion

The recession induced by the COVID-19 pandemic has not only been unusually severe, it has differed qualitatively from recent recessions in two important ways. First, the current level of macroeconomic uncertainty is extraordinarily high, and the resolution of this uncertainty seems to depend largely on noneconomic factors, such as the future path of the pandemic and the rate of progress in developing and then deploying a vaccine against the novel coronavirus. Second, the precipitous revenue declines that many firms have experienced in recent months have been driven primarily by their exposure to this temporary public health crisis—with those in so-called nonessential industries that rely on close physical proximity being especially hard hit—and thus may carry little information about the long-run economic viability of these firms.

Our basic point is that, in such a setting, the theory of the case for government intervention in business credit markets is fundamentally different from the classic lender-of-last-resort liquidity provision motive that shaped much of the response to the 2007–2009 global financial crisis and that remains a dominant policy paradigm more generally today. In particular, an effective policy response to the pandemic will require the government to accept the prospect of meaningful losses on any credit it extends to private sector firms. An analysis based on this premise also yields a number of

32. See, for example, Hanson, Scharfstein, and Sunderam (2019) for an explicit analysis of government fiscal risk-taking.

more specific implications for policy design, which we have attempted to flesh out in some detail. But unless policymakers are prepared to embrace the essentially fiscal nature of the interventions that are required today, they are unlikely to be as successful as they might otherwise be in mitigating the economic and financial fallout from the COVID-19 pandemic.

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Comment and Discussion

COMMENT BY

NELLIE LIANG This is a terrific paper. It is very constructive and provides many useful insights into designing government programs to support business credit. The paper offers two different models for designing government programs when normal channels of credit intermediation are disrupted. It uses the models to highlight the features of two programs, the Main Street Lending Program and the corporate credit facilities. The overarching message of the paper is that the 2020 pandemic crisis is not the same as the 2008 financial crisis, and government needs to embrace a greater risk of credit loss when designing programs to help businesses survive the economic fallout from the pandemic.

In this discussion, I'm going to focus on how the design and success of the two credit programs are affected by the Federal Reserve's existing authorities as a lender of last resort. Both credit programs are provided jointly by the Treasury and the Federal Reserve, with the Treasury providing equity capital available from the Coronavirus Aid, Relief, and Economic Security (CARES) Act, and the Federal Reserve lending based on that capital to absorb first losses. But even with equity, the Fed as the lender of last resort still faces constraints related to credit risk.

Two conditions provide a general picture of the limitations. First, the lending authority of the Federal Reserve, even under emergency authorities with equity capital provided by the Treasury, requires that the borrowers must be solvent, although there is some discretion for how to define solvent. Second, the security for emergency loans needs to be sufficient to protect taxpayers from losses. These conditions set limits

on lending by the Federal Reserve when there is the prospect of high credit losses.[1]

I agree generally with the basic conclusion of the paper that the government needs to embrace a greater risk of credit loss in this pandemic crisis. I believe that the actions taken by the Federal Reserve and the Treasury are cushioning the economy as it adjusts to the virus and are helping to speed up the recovery. The actions have greatly reduced the potential that large losses in household and business income would initiate a negative feedback loop between financial markets and economic activity and make the pandemic recession even more severe.

But the emergency liquidity and credit actions taken by the Federal Reserve and the Treasury cannot be a full substitute for fiscal responses, which could spend taxpayer funds to support businesses. Through that lens of spending versus lending, I think the Main Street program is an odd fit for the Fed, which is restricted to lending, and believe the less-than-full alignment of objectives and authorities may explain its limited success thus far. I believe the tension for the Fed for the Main Street program to be greater than the authors of this paper do. In contrast, I agree with the authors that the corporate credit program is better aligned with the Fed's responsibilities as a lender of last resort in unusual and exigent circumstances, but I believe the Fed needs to clarify its objectives or risk that the program does not remain successful.

MAIN STREET LENDING PROGRAM The model in the paper to help describe this program is based on two key frictions that lead to differences between the private market and the planner's outcomes. The first is a credit market friction, where the near-term falloff in revenues because the virus is constraining business and consumer activities makes current financial information about any business less informative about its long-run viability. The second friction is that there are positive aggregate demand externalities that a private business would not consider when making its own decisions to borrow and continue to operate and maintain employees. These frictions lead to some interesting model predictions: the government should invest in riskier firms than the market would on its own, and the government should expect to lose some money on its investments. A third prediction—an interesting innovation of the model—is that it predicts staged financing. Staged financing provides funds to firms in increments, rather than in a one lump sum, and each installment is conditional on the firm's survival. It may

1. English and Liang (2020) spell out in more detail the constraints on Federal Reserve lending and implications for the design of the Main Street Lending Program.

encourage banks to make more loans and helps firms get to the next stage, when aggregate macro uncertainty is high.

At least two of these elements are not currently incorporated into the Main Street program. The Main Street program was extremely difficult to set up: while the Federal Reserve announced it in March, the terms were not released until a couple months later, and it has been revised multiple times since then. There has been very little take-up so far, about 120 loans for about $1.1 billion as of August.[2]

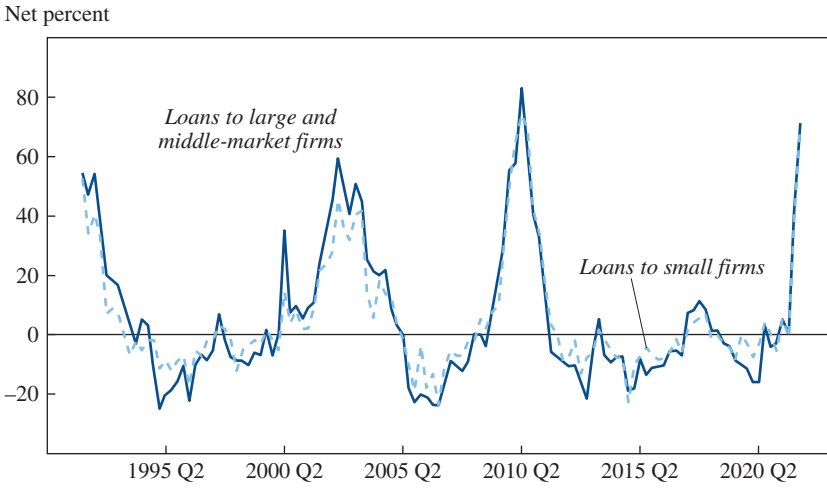
One reason for limited success is that because of its legal constraints, the Federal Reserve needs banks to underwrite the loans and provide assurance that the firms getting the loans are solvent. To ensure bank incentives are aligned with the government, banks are required to keep a share, 5 percent, of the loans they make. But if banks are required to retain a share, they are likely to stick closely to loans they would make on their own, and so the program is not expanding support to borrowers who are too risky for the market.

The most recent responses to the Federal Reserve's Senior Loan Officer Opinion Survey illustrate the problem. The recent observation from July 2020 shows that banks on net are reporting a sharp tightening of lending standards on commercial and industrial loans to small businesses (figure 1). As a reason for the tighter standards, banks reported concern about increased risks of borrowers more than that they faced balance sheet constraints. The current net tightening level is about as high as it was in the global financial crisis. But at that point in time, banks couldn't make the loans. In the current situation, banks don't want to make the loans given the new loans are likely exposed to the same risks as the loans they already have on their books.

Another consideration for designing the program is that it can help borrowers only by lending, not providing a grant, and many borrowers may not want to take on more debt in this environment. Staged financing could help because it could encourage more firms to borrow. If firms are highly uncertain about the path of the pandemic and the economy, they may not want to take on a lot more debt. Staged financing would give firms more options and could help lenders too, and total loan commitments would be less burdensome if the recovery did not stay on track. In addi-

2. Board of Governors of the Federal Reserve System, "Funding, Credit, Liquidity, and Loan Facilities," https://www.federalreserve.gov/funding-credit-liquidity-and-loan-facilities.htm.

Figure 1. Net Percentage of Domestic Respondents Tightening Standards for Commercial and Industrial Loans



Source: Board of Governors of the Federal Reserve System (US).

tion, I agree with the authors that softer standards, such as more equity-like features for the loans, could help borrowers and still be consistent with the Federal Reserve's legal constraints.

But I also think the program may need to pay more fees to the banks to encourage them to make some loans, basically to offset the risk of losses for the share of the loan they are required to retain. English and I (2020) have suggested higher fees, as well as some other marginal changes to increase the use of this program; given the Federal Reserve was assigned this task to help small to midsize businesses with a Main Street program, they should do it as well as they can. But after several revisions by the Fed, each to loosen more terms, I now think a more fundamental change in the program is warranted. Mainly, rather than additional marginal changes, it would be more helpful for Congress to acknowledge this type of support for businesses should really be a fiscal program. One idea would be to revise the CARES Act legislation to allow Main Street loans to offer conditional forgiveness if macro conditions were to deteriorate. This would involve some fiscal resources and not rely principally on the Fed, which can provide only liquidity. But there may still be some political risk for banks because when the Fed is involved, banks would still need to retain a share.

CORPORATE BOND FACILITIES In contrast to the Main Street program, the corporate bond purchase programs have dramatically eased financial conditions, with most of the improvement occurring well before any bonds were actually purchased by the Secondary Market Corporate Credit Facility (SMCCF). Moreover, no new bonds have been issued to the Primary Market Corporate Credit Facility (PMCCF). But the programs helped to ignite a boom in bond issuance with corporations issuing long-term bonds to private investors and locking in low interest rates. This financing has greatly reduced the near-term default risks of corporations.

The second model presented by the authors highlights that this program, despite its apparent success, may not be credit-risk free if investors misperceive the Federal Reserve's reaction function. I believe, as I think the authors do, that this program may not be well understood by market participants.

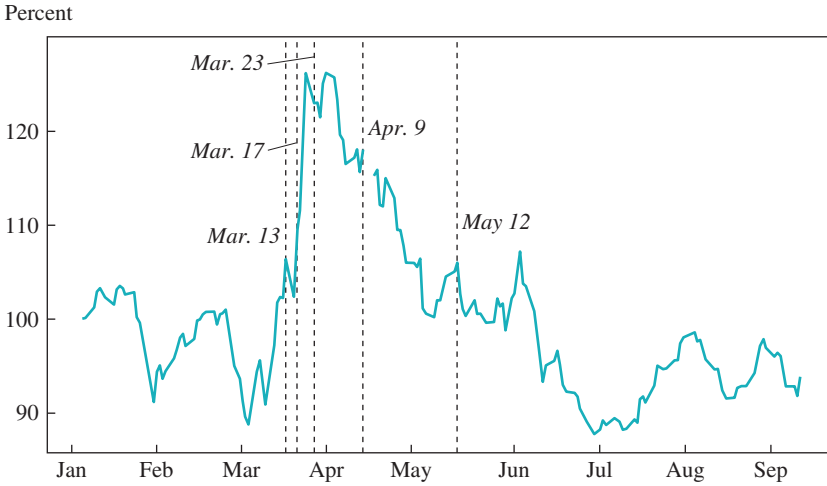
Certainly, the language around the introduction of the SMCCF "to support credit to employers by providing liquidity to the market" allows for some ambiguity about the Federal Reserve's intentions.[3] One intent that is clear is that it aims to fix dysfunction in market liquidity. That action, however, will also boost asset prices, raising expectations that the goal is to raise the value of corporate bonds, rather than to fix the technical market functioning problems that are holding down bond prices.

To highlight the importance of these distinctions in reaction functions, the Federal Reserve as traditional lender of last resort would aim to offset technical factors that push bond prices away from its economic fundamentals, such as future cash flow. But under this reaction function, the Fed would not interfere with the adjustment of prices to changes in fundamentals. The model shows, however, that this mode of operation could still require the Fed to take on some credit risk in a future bad state of the world if investor risk aversion and supply variance were high.

Alternatively, the Federal Reserve's reaction function could be viewed as pegging the risky bond price. This would basically be an interpretation that the SMCCF is acting as a monetary policy tool—quantitative easing with purchases of corporate debt rather than Treasury debt—to reduce interest rates and promote looser financial conditions. This objective would go beyond that for a lender of last resort. In that case, the Fed would purchase risky bonds very aggressively if there were negative news and a decline in fundamentals.

3. Board of Governors of the Federal Reserve System, "Funding, Credit, Liquidity, and Loan Facilities," https://www.federalreserve.gov/funding-credit-liquidity-and-loan-facilities.htm.

Figure 2. Ratio of Investment-Grade to High-Yield Corporate Bond Spreads



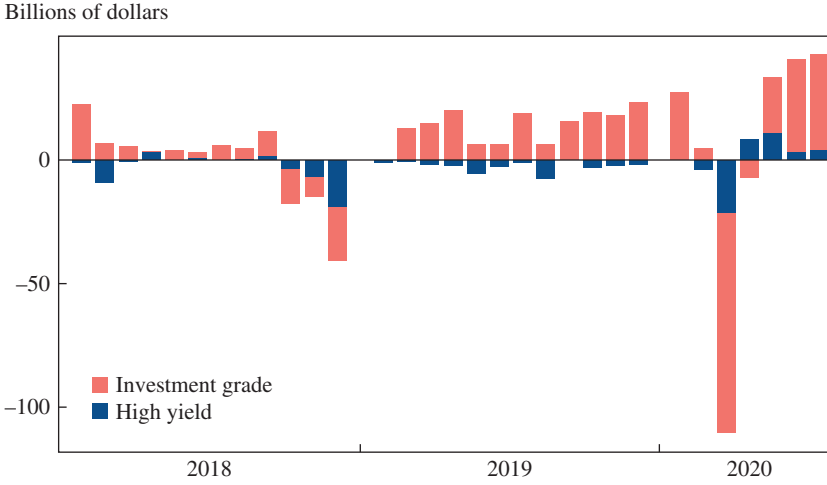
Sources: ICE BofA High Yield Index Option Adjusted Spread, from FRED; US Corporate Index Option-Adjusted Spread.

Notes: Relevant dates are when the Federal Reserve announced Treasury and mortgage-backed securities purchases (March 13); announced Primary Dealer Credit Facility (March 17); announced PMCCF, SMCCF, and additional Treasury and mortgage-backed securities purchases (March 23); expanded PMCCF and SMCCF (April 9); and made first purchases of bond ETFs (May 12).

The paper offers some evidence that investors believe the Federal Reserve is focused on price. They show that spreads are compressed relative to the past twenty-five years and that they also are well below recession levels. I think these observations are telling. But I want to offer some evidence that the Fed is operating more as a traditional lender of last resort. This is important because if investors believe the Fed is pegging the price, but in fact it is offsetting market dysfunction, there could be large costs to investors and potentially the economy if the Fed doesn't provide the high level of support that the market has come to expect, even if the economic recovery is on track.

I offer three points to argue that the Federal Reserve is operating as a traditional lender of last resort in these corporate credit programs. First, the most immediate effect of the announcement of the corporate credit facilities was a sharp decline in corporate bond spreads, with a disproportionate decline in investment-grade bonds. Figure 2 shows the ratio of investment-grade corporate bond spreads to high-yield corporate bond spreads (Liang 2020). It rose sharply in March until the Fed announced the PMCCF/SMCCF on March 23, after which it began a substantial downward

Figure 3. Net New Cash Flow to Corporate Bond Mutual Funds



Source: Investment Company Institute, "Trends in Mutual Fund Investing."

trend. In a typical recession when concern about default risk intensifies, high-yield bond spreads usually rise more than investment-grade spreads. The pattern observed suggests this crisis was unusual and that there were significant technical factors leading to greater-than-normal increases for investment-grade bonds.

Second, the price impact of trades and the bid-ask spreads for investment-grade corporate bonds rose more sharply than for high-yield bonds (O'Hara and Zhou 2020; Boyarchenko, Kovner, and Shachar 2020; Gilchrist and others 2020). As another illustration, while the credit default swap (CDS) premiums for investment-grade bonds rose between February and mid-March, the bond spreads for the same set of bonds rose considerably more, consistent with signs of illiquidity in investment-grade bond markets. In contrast, there was not a similar widening of the gap between bond spreads and CDS premiums or high-yield bonds (Haddad, Moreira, and Muir 2020). In addition, a significant gap opened between the exchange traded funds (ETF) price and the net asset value of the same pool of investment-grade bonds, but not for a pool of high-yield bonds.

A third distinction is evident in investor redemptions from bond mutual funds (figure 3). Investor redemptions from investment-grade bond mutual funds reached record levels in March, leading to large sales for corporate

bond and Treasury securities, which put significant selling pressures on both markets (Liang 2020; Ma, Xiao, and Zeng 2020). While there also were significant outflows from high-yield bond funds as well, they were not unusually large.

Collectively, there is strong evidence of significant technical problems in the investment-grade corporate bond market which supports the need for the SMCCF. I think, however, that markets may be misperceiving the reaction function as the paper says.

The implication of this misperception is that corporate bond prices may be too high, and if fundamentals were to deteriorate, they would fall by more than justified by that deterioration. The reason is that investors would, at the same time, have to adjust perception of this reaction function to one that the Federal Reserve was not pegging bond prices. The possibility of this misperception suggests that there could be benefits for the Fed to clarify its objective function with respect to this program and how it would expect to react if the fundamentals deteriorate meaningfully.

To summarize, I think the authors' proposals to soften the terms of Main Street loans and accept some more risk could be helpful. I also think that because the Federal Reserve requires banks to participate in the program and banks already have considerable exposure to risks arising from COVID-19, the program should offer higher fees to banks to encourage more participation. That said, I think there is little interest from small to midsize firms to take on considerable debt in light of the uncertainty about the virus and the economic recovery. Instead, the program needs a much more fundamental change where it doesn't require the Federal Reserve to provide loans as a lender of last resort.

On the corporate credit programs, the authors highlight a potential cost associated with investor misperceptions about the intent of the programs and how the Federal Reserve will react to future news. I think the Fed should reduce this misperception to help ensure that these programs continue to be successful.

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GENERAL DISCUSSION Janice Eberly summarized two types of questions from the teleconferencing chat function. The first type had to do with whether the long-run costs of the program, such as debt overhang, should be taken into consideration when thinking about the design of the Main Street Lending Program. The second type wondered whether the Main Street Lending Program encouraged taking on credit risk and whether loans—instead of grants—were the right policy instrument.

Gabriel Chodorow-Reich asked about the role of regulatory forbearance. He noted that many midsize and large firms have credit lines—which have not been exhausted—with maturities into 2022 or beyond. He said that although these credit lines seem like a useful way to complement new liquidity programs, sales are down at many of these firms. He wondered how banks would react to declining sales and whether there was room for regulators to encourage the treatment of existing pre-committed liquidity as a complement to new programs.

Steven Davis stated that the political argument for supporting firms during the pandemic typically maintains that the most adversely hit sectors and firms should receive the most support. He observed that this argument contrasted with some of the paper's policy recommendations, which call for the government to pull back financing support. Davis asked whether

and how such political economy matters should be considered when designing policy.

Wendy Edelberg commented that the Coronavirus Aid, Relief, and Economic Security (CARES) Act allocated a substantial amount of money to fund the Main Street Lending Program. But, she remarked, the Federal Reserve is not allowed to lose money for taxpayers in expectation. As a result, the Federal Reserve used the money to leverage up the Main Street Lending Program, which avoids losing money for the taxpayer in expectation. She inquired why the Federal Reserve didn't instead use the money to absorb any losses in expectation.

Şebnem Kalemli-Özcan noted that there are differences between large firms and small and midsize enterprises (SMEs), especially smaller SMEs that are not in the corporate bond market. She contemplated whether subsidizing these firms through grants, instead of loans, was a better way to support them and whether these grants could be administered through the tax system.

Michael Kiley wondered about three microeconomic aspects of emergency credit support. He mentioned first that the primary market for corporate credit facilities and the Main Street Lending Program have restrictions—which make a great deal of sense to the taxpayer—on capital distributions, compensations, and other activities of borrowers. However, he wondered what features might be incorporated to alleviate the risk that the incentives of firm insiders may lower the efficacy of the program. Second, he commented, any government credit program involves a long-run relationship between the nonfinancial borrowers and the government as a lender. The Main Street Lending Program, he continued, has overcome this challenge by relying on private lenders; however, these private lenders may view a partnership with the government as substantially risky, at least from a political or supervisory sense. Last, he remarked that the paper focused on the need to be willing to originate riskier loans. This emphasis indicates an examination of the back end—such as what happens when the borrower is under distress. Together, he concluded, these three issues point to a greater role for grants relative to loans.

Donald Kohn commented that although he agreed with Nellie Liang that the Federal Reserve could better explain its objectives, it is also important for the Treasury to clarify its appetite for risk. In addition, Kohn questioned whether the compression of spreads is really a consequence of misperception rather than a consequence of optimism around the timing of the vaccine. Finally, he discussed how permanent shifts in the economy will render some firms unviable and how these changes will make it difficult to figure out which firms to lend to.

Jeremy Stein mentioned the ambiguity surrounding both where the constraints lie and what the Federal Reserve's authority is. He stated that at a minimum the Federal Reserve has to be secured to its satisfaction, so that it is protected against losing money. This objective can be reached, Stein continued, by having a big enough equity contribution to the special purpose vehicle from the Treasury.

Stein reflected on whether the securities held by the special purpose vehicle had to be classified as debt, pointing out that the paper argues for a softer design, similar to preferred equity. Although this might not work in practice, Stein said, as it is not clear whether the special purpose vehicle is legally allowed to own preferred equity. Preferred equity, however, can be approximated through junior debt with deferrable interest payments. Unfortunately, Stein expressed, at the Treasury's insistence, many of the design features, such as seniority and collateral, go in the opposite, harder direction—which could make the workouts tougher as the banks will be well secured and more inclined to pull the plug.

Stein argued that the banks have been a bottleneck in the program. Thus, he argued, the program would likely be better off without the banks as underwriters. Even if underwriting by the banks was required, Stein contended that putting the banks on equal footing with the Federal Reserve is inimical to the idea of the program. Indeed, he affirmed, the whole point of the Main Street Lending Program was to make loans that the private sector wouldn't. One example to help with alignment would be to lop off 1 percent of whatever amount of interest is coming in and give this 1 percent to the banks only if the firm survives for five years or so. This incentive would motivate the banks to underwrite but also give them better economics than the Federal Reserve. The most important facet, Stein concluded, was for the program to do more than just make loans that are also available on the private market.