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How Do Quantitative Easing and Tightening Affect Firms?[†]

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Abstract

We study how firms respond to quantitative easing (QE) and quantitative tightening (QT) policies of the Federal Reserve. We construct a novel time series of maturity-specific central bank balance sheet shocks covering multiple QE and QT programs. In response to central bank purchases of government bonds, we find that, on average, firms adjust their debt maturity structure, reduce interest expenses and accumulate cash, while their total debt, capital and employment remain largely unchanged. The impact of these policies differs depending on the targeted maturity segment and the credit quality of firms. Policy transmission primarily runs via bond markets. There are positive spillovers to high-rated non-US firms. Our findings can inform the design of balance sheet policies.

Keywords: quantitative easing, quantitative tightening, debt, maturity, real effects

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"The problem with QE is it works in practice, but it doesn't work in theory."

Ben Bernanke

1 Introduction

Do central bank balance sheet policies genuinely affect economic activity in practice? These policies, known as as quantitative easing (QE) and quantitative tightening (QT), typically involve the purchase, sale or run-off of government bonds to influence long-term interest rates, portfolio allocations, and ultimately, real economic outcomes. While the immediate effects of QE and QT announcements on financial markets are well-documented, the granular transmission of these policies over time, especially to firms, remains less understood. In particular, how central bank balance sheet policies – especially across different maturities – affect firm financing, investment, and employment is still an open question.

This paper aims to fill the gap by studying how the Federal Reserve's balance sheet policies affect firm financing and real economic outcomes. We construct a novel time series of maturity-specific balance sheet shocks that isolates unanticipated variation in the Federal Reserve's US Treasury holdings and estimate impulse responses of firm outcomes to these shocks. This allows us to examine how firm financing, investment, and hiring decisions respond to balance sheet interventions over time and across the yield curve.

Our methodology to construct maturity-specific balance sheet shocks leverages the implementation details of QE and QT policies. We construct these shocks by combining surprises on both the Federal Reserve's active purchases as part of its QE programs and the reinvestments of proceeds from maturing securities on its balance sheet. We build measures of market participants' expectations regarding the evolution of the Federal Reserve's US Treasury holdings across different maturity segments. To do so, we use detailed information taken from the Survey of Primary Dealers (SPD), quarterly recommendations of the Treasury Borrowing Advisory Committee (TBAC) to the US Treasury on the size and maturity composition of new issuance, and the Federal Reserve's own announcements of maturity weights in its QE programs. We compute the shocks by subtracting maturity-specific expectations of active purchases and reinvestments from realized amounts. This strategy provides a clean measure of unanticipated shifts in central bank balance sheet policy, capturing time series of surprises across maturity segments covering multiple QE and QT programs between 2011 and 2024. The shocks are economically meaningful, reaching up to around $50 billion per quarter or about 1-2% of the government debt outstanding within each maturity segment.

We combine these shocks with comprehensive firm-level and debt-instrument data obtained from the S&P Global. Our sample covers public and private non-financial firms in the United States and abroad between 2011Q1 and 2024Q2. For each firm, we observe detailed balance sheet information, debt composition by maturity and instrument type, credit ratings, and employment. Debt instruments are categorized into corporate bonds and term loans, allowing us to distinguish the bond market channel from the bank lending channel in the transmission of balance sheet policies. We further augment this with data on bond prices from the S&P Global iBoxx indices dataset to assess the impact of balance sheet policies on corporate bond prices.

Our new central bank balance sheet shock series and detailed firm-level dataset allow us to address the following questions: Do firms borrow more when the central bank purchases more government bonds of a given maturity? Does this borrowing translate into higher investment or employment? And how do these effects vary across firms and along the maturity spectrum? Using local projection regressions, we study the average response of firms to the maturity-specific balance sheet shocks as well as the heterogenous response of firms across the credit quality spectrum. Specifically, throughout the paper, we focus on three maturity segments – short-term (one-to-four years), medium-term (four-to-ten years), and long-term (greater than ten years).

We report four main findings for the average response of US firms to balance sheet policies. First, firms adjust their debt maturity structure responding to favorable financing conditions at different segments of the yield curve. In particular, they extend their debt maturity in response to Federal Reserve's purchases of short-term Treasuries. This effect peaks after one year and dissipates gradually thereafter. However, their total debt does not change significantly reflecting a substitution across different maturity segments. Second, we find no statistically significant impact on term loans across all maturities and horizons. This suggests that the transmission of QE and QT policies involving Treasuries to firm financing operates mainly through corporate bond markets rather than through the banking sector. Third, by adjusting their debt maturity structure, firms are able to cut their interest expenses and accumulate more cash. Finally, we do not find statistically significant effects of balance sheet shocks on firm investment or employment at any maturity segment.

We document substantial heterogeneity in firms' responses across the credit quality spectrum. Investment-grade (IG) firms benefit the most from balance sheet policies. The prices of their medium- and long-term bonds rise in response to central bank Treasury purchases in those segments. Although their total debt does not change, their bond issuance increases, especially after central bank purchases of long-maturity Treasuries. Our results also suggest that this reflects a substitution from term loans to corporate bonds. Bond prices of non-IG firms respond weakly, if at all. Balance sheet interventions at the long end also prompt IG firms to increase spending in research and development, leading to a modest but persistent increase of about 2 percent in response to a one standard deviation shock.

We also find that balance sheet policies in the United States have global spillovers. Non-US IG firms benefit as the price and quantity of their US dollar-denominated bonds increases in response to Federal Reserve's medium- and long-term Treasury purchases. In addition, they also draw more term loans in response to long-term Treasury purchases. These results suggest that the Federal Reserve's balance sheet policies reverberate through global markets, primarily via high-rated firms.

Related literature. Our paper contributes to the literature on the transmission of unconventional monetary policy by isolating unanticipated time series variation in the Federal Reserve's balance sheet operations, and tracing impulse responses of corporate bond prices and firm outcomes. The shock series we construct offer three key contributions to the literature. First, they capture exogenous time variation in the size of QE and QT stemming from policy implementation. This helps address concerns about endogeneity and anticipation effects common in time series and event studies. By comparing realized purchases to market expectations over a longer horizon, we can better isolate the effects of QE and QT beyond announcement dates and assess their medium- to-long-term impact, which can be particularly important when capital moves slowly and policy effects take time to materialize (see e.g. Duffie, 2010; Greenwood et al., 2018; Van der Beck, 2022). Second, while studies using a difference-in-differences approach identify cross-sectional differences due to heterogeneous exposures to shocks, they cannot identify aggregate responses as they typically absorb time variation. Our method allows us to directly estimate the aggregate impact of balance-sheet policies over time, and importantly, covering multiple QE and QT programs. Third, because our shocks are maturity-specific, we can analyze how firms respond to central bank balance sheet operations along the yield curve.

Our main contribution is to study how central bank balance sheet policies affect firm financing and real economic outcomes. Existing firm-level evidence shows that QE generally relaxes financing constraints, yet the evidence on its real effects is mixed. Foley-Fisher et al. (2016) show that under the Federal Reserve's MEP, firms reliant on long-term debt issued more bonds and expanded investment and hiring. Todorov (2020) finds that the announcement of ECB corporate bond purchases reduced eligible firms' yields and spurred issuance, yet much of the proceeds funded dividends rather than capital expenditure. Selgrad (2023) provides evidence for the portfolio rebalancing channel and finds that firms that are more exposed to mutual funds affected by QE increase investment and cash buffers. Acharya et al. (2025) reveal pronounced heterogeneity across firms, with QE subsidizing risky firms just above the IG cutoff, fueling debt-financed acquisitions, and affecting employment and investment of competitors. Focusing on corporate bond purchases by the Federal Reserve during the pandemic as an event study, Darmouni and Siani (2025) show that large issuers used cheap debt to build liquidity buffers instead of investing.[1] Our evidence using a long time series of balance sheet shocks covering QE and QT programs since 2011 suggests that firms changed the maturity profile of their borrowing in response to balance sheet policies. For the average firm, main adjustments took place through reduced interest expenses and higher current assets rather than through investment or employment. We find that IG firms benefited more overall and modestly increased R&D spending.

We also contribute to the literature on the effects of QE and QT on asset prices. A large literature studies high-frequency price effects immediately after QE and QT announcements (e.g. Gagnon et al., 2011; Joyce et al., 2011; Vissing-Jorgensen and Krishnamurthy, 2011; Swanson, 2011; Christensen and Rudebusch, 2012; D'Amico and King, 2013; Bauer and Neely, 2014; Vissing-Jorgensen, 2021; Altavilla et al., 2021; D'Amico and Seida, 2024; Du et al., 2024, among others). A more recent literature takes a demand-based asset pricing approach to study government bond markets in response to central bank asset purchase programs (e.g. Koijen et al., 2021; Eren et al., 2023; Jansen et al., 2024; Chaudhary et al., 2024; Breckenfelder and De Falco, 2024). A growing literature studies the impact of changing maturity structure of Treasuries on Treasury yields (e.g. Greenwood and Vayanos, 2010; Swanson, 2011; Greenwood and Vayanos, 2014; Vayanos and Vila, 2021) and the impact of government bond purchases on corporate bond yields and credit risk (e.g. Gilchrist and Zakrajšek, 2013; Gilchrist et al., 2015; D'Amico and Kaminska, 2019; Selgrad, 2023; Haddad et al., 2024). Another strand of the literature studies the persistence of the QE-induced price effects (e.g. Wright, 2012; Bernanke, 2020; Neely, 2022). Our methodology allows us to trace the short- and long-run responses of prices of government and corporate bonds to balance

[1] See also Haddad et al. (2021) and Falato et al. (2021) for how the announcement of corporate bond purchase program by the Federal Reserve affected corporate bond markets during the pandemic.

sheet policies.

Our study also contributes to the literature studying the transmission channels of balance sheet policies to banks and firms. Rodnyansky and Darmouni (2017) and Di Maggio et al. (2020) study how purchases of mortgage-backed securities (MBS) affected lending in the real estate market through the bank lending channel. Chakraborty et al. (2020) find that MBS purchases led to a decrease in firm investment and Treasury purchases did not cause a large stimulus to the economy through the bank lending channel. Grosse-Rueschkamp et al. (2019) find that firms exposed to ECB corporate bond purchase program substitute bank term loans with corporate bonds, while banks redirect credit to other borrowers. We find that in the United States, the effects of Treasury purchases on firms operated mostly through the corporate bond market rather than through bank lending. These findings on the impact of balance sheet policies on corporate bond markets are also consistent with a "gap-filling" behavior of the corporate sector (Greenwood et al., 2010; Badoer and James, 2016).

Roadmap. The remainder of the paper is organized as follows. Section 2 describes the dataset we construct for our analysis. Section 3 details our methodology for constructing maturity-specific balance sheet shocks. Section 4 shows the impact of these shocks on corporate debt by maturity. Section 5 examines the impact on firm outcomes. Section 6 concludes.

2 Data

We combine multiple data sources to construct a comprehensive dataset to study the impact of central bank balance sheet policies on firm outcomes. Specifically, we draw on firms' financial statements and debt-instrument datasets obtained from S&P Global. To construct measures of central bank balance sheet shocks, we rely on data from the Federal Reserve's balance sheet operations involving US Treasuries, complemented by bond issuance data from the US Treasury. This section provides a concise overview of the datasets employed and the sample restrictions applied. A comprehensive description of the data sources and the filtering criteria is available in Appendix A.

Financial statements. We use quarterly data on firm balance sheets, income statements and cash flow statements from the S&P Capital IQ dataset. The coverage includes both public and private firms from the US as well as other countries. We focus only on financial statements of firms that are not subsidiaries of other firms to avoid double-counting their debt positions arising from parent-subsidiary lending. We restrict our sample to non-financial firms and remove quarters in which firms report negative equity, liabilities or assets. We deflate all variables in nominal terms using the US Consumer Price Index (CPI) retrieved from FRED at the Federal Reserve Bank of St. Louis. Appendix A.1 provides a detailed discussion of the data filters we employ and the parent-subsidiary consolidation procedure that allows us to track financial statements of ultimate parent firms over time. Tables B.2 and B.3 summarize key financial-statement variables for US and non-US firms, respectively. The Capital IQ dataset is especially comprehensive for US companies, while still offering solid coverage of non-US firms. Owing to the richer representation of smaller US firms, the median US company is smaller than its non-US counterpart. As expected, IG firms report markedly larger total assets than non-IG firms.

Employment. Employment data extracted from Capital IQ financial statements often contains many missing observations, especially for privately held firms. To address this issue, we use data on the number of employees from the S&P Headcount Analytics dataset. This dataset tracks more than 220 million employees worldwide and provides monthly headcount series for each firms since 2010, covering over 4.5 million firms across the globe. We merge the end-of-quarter value of the monthly series with the rest of our financial statement variables. As shown in Tables B.2 and B.3, the headcount variable has significantly more observations than the employment variable from the S&P Capital IQ financial statements dataset.

Debt instruments. Our data on firm debt is based on the S&P Capital IQ Capital Structure module. For each firm, we observe the debt outstanding at the security- or loan-level at a quarterly frequency. For every instrument, the dataset records its currency, type (e.g., bonds and notes, term loans), the last interest rate recorded by S&P Global,[2] the amount outstanding, and, importantly, the maturity. We deflate amounts outstanding using the US CPI. To ensure a representative sample, we keep only those non-US countries for which the S&P Capital IQ coverage is broadly in alignment with the aggregate data reported by the Institute of International Finance. Appendix A.2 describes all the data filters and sample restrictions applied to clean the debt instruments data in greater detail. Table B.4 summarizes the composition of outstanding debt across instruments and maturity buckets. In the aggregate, bonds and notes dominate corporate balance sheets relative to bank term loans. This pattern is most pronounced among IG firms, which make limited use of term loans and mainly borrow with long-maturity bonds (> 10 years). Non-IG firms, by contrast, split their borrowing almost evenly between term loans and bonds/notes, with a tilt toward shorter maturities. US firms rely predominantly on bond financing, whereas non-US firms maintain a more balanced mix that includes a larger share of bank lending.

Bond prices. One major drawback of the S&P Capital IQ data is that it does not include price information for bond instruments listed in its Capital Structure module. We overcome this issue by using data from the S&P Global iBoxx indices dataset, which provides pricing information on constituents of a family of fixed income benchmarks and offers a comprehensive representation of the global bond markets. We focus on bond prices for non-financial firms' bonds denominated in US dollars and prices of US Treasuries. The raw data has a daily frequency and we convert it to quarterly by retaining only the bond bid prices from the last day of each quarter. Bond prices are deflated using the US CPI. Appendix A.3 provides further details on the

[2] For variable rate instruments, we only have the most recent value recorded for the interest rate as of 2024Q2. As a result, we cannot draw reliable conclusions from the interest rate data and have excluded it from our analysis.

sample restrictions we applied to prepare the bond price data for our empirical analysis. Table B.5 reports summary statistics for bond duration and price information by issuer types and bond maturity buckets. IG firms typically rely on long-term financing.

Credit ratings. We use data on credit ratings from the S&P Global Ratings dataset. We rely on the entity ratings when splitting the sample into IG and non-IG firms in the debt- and firm-level regressions. For bond price regressions, we use the ratings in the S&P Global iBoxx indices dataset to split bonds into investment grade and high yield.

Balance sheet shocks. We construct our balance sheet policy shocks focusing both on active purchases and the reinvestment of proceeds of the Federal Reserve. To capture shocks relative to market expectations for the Federal Reserve's active purchases of US Treasuries, we use data on market participants' expectations reported in the SPD conducted by the Federal Reserve Bank of New York. We combine it with the announcements by the Federal Open Market Committee (FOMC) at the beginning of each QE program on its planned weight for each maturity. This allows us to construct maturity-specific shocks. For shocks associated with the Federal Reserve's reinvestment activity, we rely on the Federal Reserve's reinvestment rules, TBAC recommended financing tables and the US Treasury Department's quarterly funding announcements.[3] Section 3 explains in detail the methodology used to construct the central bank balance sheet shock series disaggregated by maturity.

3 Constructing maturity-specific balance sheet shocks

In this section, we describe how we construct our central bank balance sheet shock measure across different maturities. Our methodology leverages institutional features

[3]The Treasury Borrowing Advisory Committee (TBAC) is an advisory body that provides recommendations to the US Treasury department on a variety of technical debt management issues. Its membership comprises senior representatives from a variety of buy- and sell-side institutions, such as banks, broker-dealers, asset managers, hedge funds, and insurance companies. The committee meets quarterly with Treasury officials to discuss market conditions, funding needs and auction strategies.

of the implementation of QE and QT policies.

3.1 Balance sheet shocks across maturities

The Federal Reserve's active purchases and reinvestments of US Treasuries have varied across maturities during different QE and QT programs. During most QE programs, the Federal Reserve has actively bought Treasuries across the maturity spectrum, albeit with different weights. In certain cases, such as the Maturity Extension Program (MEP), it sold short-term Treasury securities and purchased long-term Treasuries. For simplicity, we refer to both purchases and sales during QE programs as active purchases, with sales recorded as negative values. During QT operations, the proceeds from maturing bonds are reinvested in newly issued Treasuries. Due to the operational details of the implementation of balance sheet policies that we discuss below, these reinvestments changed the maturity distribution of the Federal Reserve's holdings based on the maturity distribution of the Treasury supply at the time of reinvestment.

We construct our measure of changes in central bank holdings within a given maturity bin m over quarter t, which we denote as $\Delta CB_{m,t}$. Throughout the paper, we focus on three maturity bins: one-to-four years (including four years), four-to-ten years (including ten years) and more than ten years. This maturity breakdown follows the one used by the Federal Reserve in most of its program announcements (see, e.g. Figure B.2). We agggregate finer maturity buckets into three bins in order to reduce noise and focus on balance sheet policies at the short-, middle- and the long-end of the yield curve. We construct our balance sheet shocks at a quarterly frequency to align them with the frequency of our firm-level data.[4]

To isolate the exogenous component of these changes, we define shocks to central

[4]As we show in Table B.1, in most of the cases, QE and QT announcements happen at the FOMC meetings at quarter-ends and operations begin in the first month of the new quarter. On a few occasions with multiple announcements within a quarter, we use market participants' expectations for each month that are reported prior to the beginning of the quarter.

bank holdings in each quarter. These shocks, denoted as $\widetilde{\cdot}_{m,t}$, represent the unanticipated element of active purchases or reinvestments across maturities. The total shock at maturity m in a given time t is therefore:

$$\widetilde{\Delta CB}_{m,t} = \widetilde{active\ purchase}_{m,t} + \widetilde{reinvestment}_{m,t} \tag{1}$$

We compute these shocks by contrasting the realized values of active purchases and reinvestments with expectations of market participants. We leverage the operational details of QE and QT operations to provide measures of maturity-specific expectations of market participants and shocks. We describe next how we construct shocks in active purchases and reinvestments seperately.

Active purchase shocks. We construct shocks to the implementation of active purchases as follows:

$$\widetilde{active\ purchase}_{m,t} = active\ purchase_{m,t} - E_{t-1}[total\ active\ purchase_t] \times E_{t-1}[weight_{m,t}] \tag{2}$$

where $active\ purchase_{m,t}$ is the realized active purchase in maturity m during quarter t. These data are taken directly from the System Open Market Account (SOMA) transaction reports. $E_{t-1}[total\ active\ purchase_t]$ is the total expected size of active purchases in quarter t and $E_{t-1}[weight_{m,t}]$ is the expected weight allocated to maturity bin m at time t.

We measure the expected total size of active purchases, $E_{t-1}[total\ active\ purchases_t]$, using information from the SPD conducted by the Federal Reserve Bank of New York and available since January 2011. Before each FOMC meeting, the Open Market Trading Desk of the Federal Reserve Bank of New York surveys primary dealers on economic and financial market topics. Each survey contains a question regarding primary dealers' expectations of the pace of Treasury purchases. We use the median of the primary dealers' expectations to construct our measure.

An example from the December 2013 SPD illustrates how we obtain our measure.[5] The survey asked primary dealers about their expectations of monthly purchase amounts during all the upcoming FOMC meetings in 2014. Once the FOMC announces the monthly pace for purchases, it takes effect in the following month.

The median expected monthly pace of total purchases following the December 17-18 and January 28-29 meetings was $45 billion, whereas the median expectation for the March 18-19 meeting was $35 billion, which would only come in effect in April. To construct our measure, we focus on the one-quarter-ahead expectations by SPD participants since all programs starting from QE2 are open-ended and the Federal Reserve gave no forward guidance on the pace of purchases.[6] Our measure for expected active purchases in 2014Q1 is then the sum of $45 billion for January, February and March, since no FOMC meeting took place in February, for a total of $135 billion.

The FOMC announced the pace of active purchases to be $40 billion in its December 2013 meeting, which came into effect in January 2014. It further reduced the pace to $35 billion in its January 2014 meeting, to be effective in February and March 2014. Therefore, for the first quarter of 2014, we obtain a total active purchase of $110 billion. Our quarterly shock measure is then equal to the difference between the realized and expected purchases, i.e., - $25 billion. We follow the same steps for all the SPD waves in our sample.

To determine the expected weights of purchases across different maturities, we rely on the FOMC announcements that describe the maturity breakdown of each program. At the beginning of each QE program, the FOMC announces the operational details of the program, including the tentative allocation across maturity buckets.[7] The realized

[5]Figure B.1 of the Appendix shows the December 2013 survey question and participants' responses.

[6]For example, the FOMC press release on October 30, 2013 indicates that: "Asset purchases are not on a preset course, and the Committee's decisions about their pace will remain contingent on the Committee's economic outlook as well as its assessment of the likely efficacy and costs of such purchases." See https://www.federalreserve.gov/newsevents/pressreleases/monetary20131030a.htm

[7]Figure B.2 shows an example of a typical announcement of the maturity breakdown.

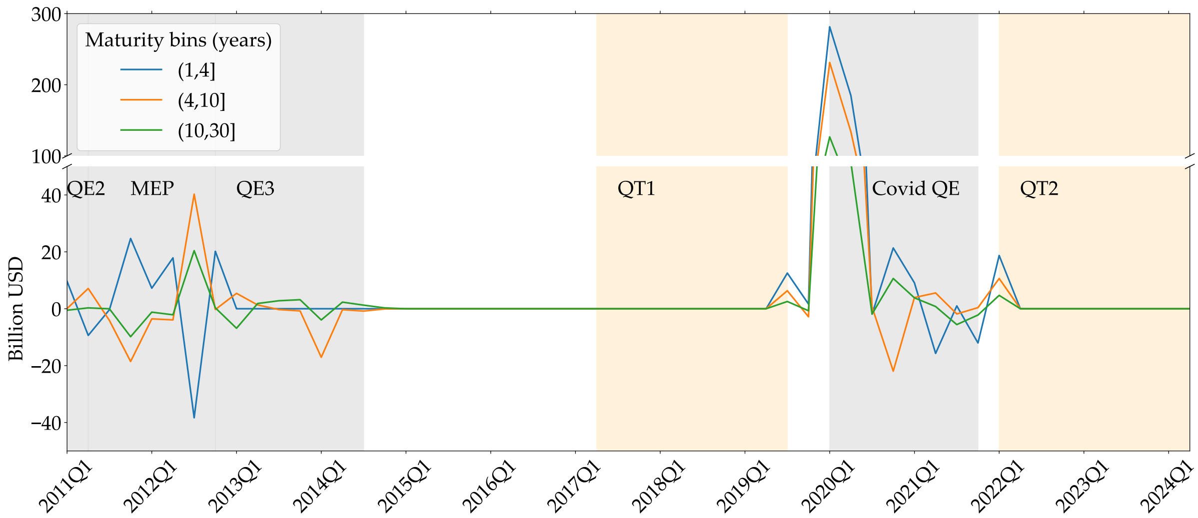
purchases by maturity have consistently tracked these pre-announced allocations.[8]

Based on this information, we allocate the shock across maturity bins as follows. In December 2012, at the beginning of the QE3 program, the Federal Reserve announced the maturity breakdown for its purchases of longer-term Treasury securities scheduled to begin in January 2013. The Federal Reserve planned to tilt most of its purchases towards securities with a remaining maturity between four and ten years (4Y-10Y), which would constitute 68% of its overall volume of purchases, with the rest devoted to purchases of securities with a remaining maturity greater than 10 years. We use the announced weights by maturity before each operation to construct the shock by maturity bin as portrayed in Equation (2).

A potential caveat to using these weights arises when a QE program is first introduced, as it is unclear how market participants initially form expectations about maturity weights, unlike in later stages of the same QE program when weights are clearly specified. We address this issue as follows for various programs. The start of QE2 preceded the first Survey of Primary Dealers, hence a tentative allocation had already been announced before 2011Q1, the first quarter of our shock measure. Prior to the announcement of MEP, the Federal Reserve surveyed primary dealers for their expectations regarding maturity weights. In this case, we use the September 2011 SPD for the expectation of weights. QE3 followed immediately after MEP, and the Federal Reserve had publicly communicated that it would continue to extend the maturity of its holdings after MEP. We therefore assume that market participants expected a continuation of MEP's maturity allocations for longer-term securities, albeit without the accompanying sales of short-term securities. This assumption closely aligns with the realized purchases during QE3. During the COVID-19 QE program (QE4), the Federal Reserve did not release a tentative allocation. Given the significant confounding factors present in the early stages of the pandemic, we exclude the first two quarters of QE4 from our baseline analysis. For the subsequent quarters, we assume that market

[8]Figure B.3 shows the stable maturity breakdown of the active purchases during different QE episodes, which tracks the announced weights.

Figure 1: Quarterly active purchase shocks $\widetilde{active\ purchase}_{m,t}$ by maturity bin



Note: The first two quarters of 2020 are excluded from the baseline sample in our empirical analysis.

expectations for maturity allocations aligned with the preceding quarter's weights, as the Federal Reserve adhered to a relatively stable allocation rule by maturity during QE4 operations.

Figure 1 shows the time series of shocks by maturity bin computed based on equation (2) and the procedure we described above. In our baseline sample, which excludes the first two quarters of 2020, most shock values are in the ± \$50 billion range.

Reinvestment shocks. The second source of central bank balance sheet shocks is the reinvestments of the proceeds from maturing bonds into newly auctioned Treasury securities. The Federal Reserve follows an explicit process which is announced to the public. It places non-competitive bids at Treasury auctions, allocated across the securities being issued on each auction date in proportion to their announced offering amounts.[9] The Federal Reserve can surprise market participants by changing the amount of maturing bonds it decides to redeem in a given program, i.e., the redemp-

[9]Implementation details can be found here: https://www.newyorkfed.org/markets/treasury-rollover-faq.html

tion cap. Additionally, the realization of reinvestments at each maturity can differ from expectations if the US Treasury deviates from TBAC recommendations in its issuance decisions. We explain below how we use this information to construct our measure of reinvestment shocks.

Similar to the active purchase shocks described in the previous section, we compute the reinvestment shocks as:

$$\widetilde{reinvestment}_{m,t} = reinvestment_{m,t} - E_{t-1}[total\ reinvestment_t] \times E_{t-1}[weight_{m,t}] \quad (3)$$

where $reinvestment_{m,t}$ is the realized reinvestment in maturity bin m at quarter t, $E_{t-1}[total\ reinvestment_t]$ is the expected total reinvestment at time t and $E_{t-1}[weight_{m,t}]$ is the expected weight assigned to maturity bin m at time t. Similar to our active purchase shocks, we construct the measure of reinvestment shocks at the quarterly level. We obtain the realized reinvestments, $reinvestment_{m,t}$, from SOMA transaction reports.

Outside of QT periods, maturing government bonds are replaced entirely with new issues. Hence, we set $E_{t-1}[totalreinvestment_t] = total\ reinvestment_t = maturing\ amount_t$ during these periods. In contrast, during QT periods, the Federal Reserve allows bonds to mature subject to a redemption cap which it announces during the FOMC meeting that introduces a particular QT program in order to keep the pace of the balance sheet run-off smooth. For example, a monthly redemption cap of $30 billion means that if the total maturing amount in a given month is above this amount, anything in excess of the cap is reinvested and the Federal Reserve's balance sheet size decreases only by $30 billion. As a consequence, we set $E_{t-1}[total\ reinvestment_t] = maturing\ amount_t - E_{t-1}[redemption\ cap_t]$ during QT episodes.[10] As before, we obtain the $E_{t-1}[redemption\ cap_t]$ from the SPD as the median of primary dealers' expectations of the redemption cap.

The US Department of the Treasury typically issues coupon bonds and notes in the

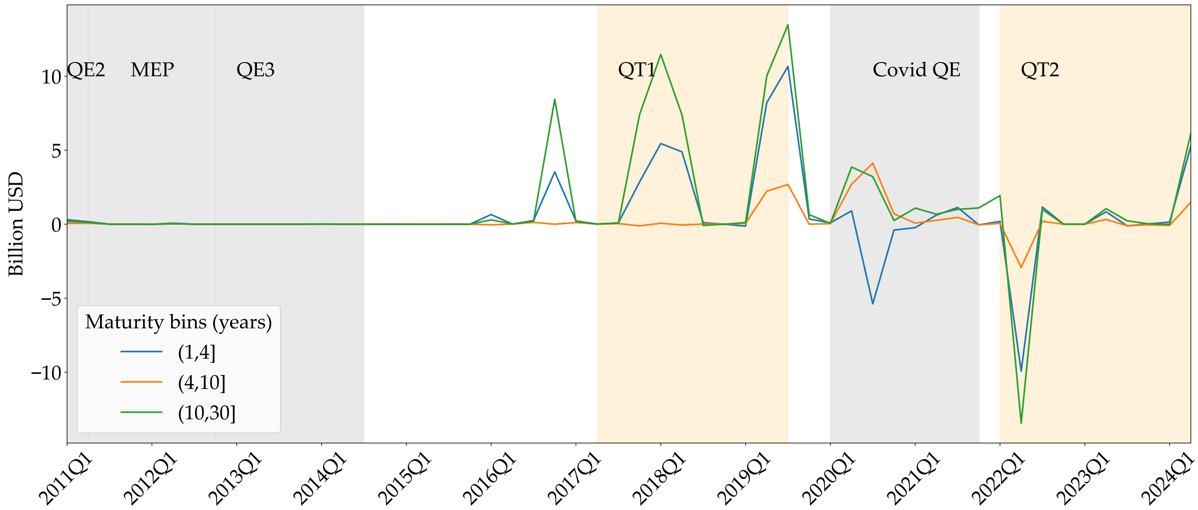
[10] In our sample, total maturing amounts are always above the redemption cap during QT periods.

middle and at the end of each month. The Federal Reserve allocates its reinvestments across these new issues in proportion to the amounts maturing on those same dates. We track each twice-monthly issuance and assign the expected monthly reinvestment caps accordingly.

The following example illustrates the procedure we apply to all reinvestments in our sample. In November 2018, the total maturing amount of Treasury securities on the central bank balance sheet was $59.2 billion: $34.3 billion maturing on November 15 and $24.9 billion maturing on November 30, corresponding to 58% and 42%, respectively. Based on information from the SPD, the expected redemption cap for November 2018 was $30 billion. Hence, the total amount expected to be reinvested in that month was $29.2 billion (i.e., difference between total maturing and the expected redemption cap). The Treasury department typically issues new bonds on the days that old bonds mature to smoothly roll over its debt. In this example, the two bond settlement dates are November 15 and November 30. Based on the pre-announced rules, the Federal Reserve reinvests the proceeds from the bonds that mature proportionally. We therefore assign 58% of $29.2 billion to be reinvested on November 15th and 42% of $29.2 billion to be reinvested on November 30, corresponding to $16.9 billion and $12.3 billion respectively.

The final element of equation (3) that we need to construct is the expected weight for each maturity bin m at time t, $E_{t-1}[weight_{m,t}]$. Unlike active purchases in which the Federal Reserve purchases US Treasuries from market participants in the secondary market based on a pre-announced maturity weight structure, the Federal Reserve does not disclose a set of maturity weights for its reinvestments. Instead, its reinvestments by maturity are shaped by the Treasury's issuance structure. Consequently, we gauge the market participants' expectations of Federal Reserve's reinvestment weights by maturity from recommendations of the TBAC. Each quarter, the TBAC issues recommendations on the maturity composition and size of new issuance for the US Treasury department. The aim of these recommendations is to help the Treasury to manage its

Figure 2: Quarterly reinvestment shocks $\widetilde{reinvesment}_{m,t}$ by maturity bin



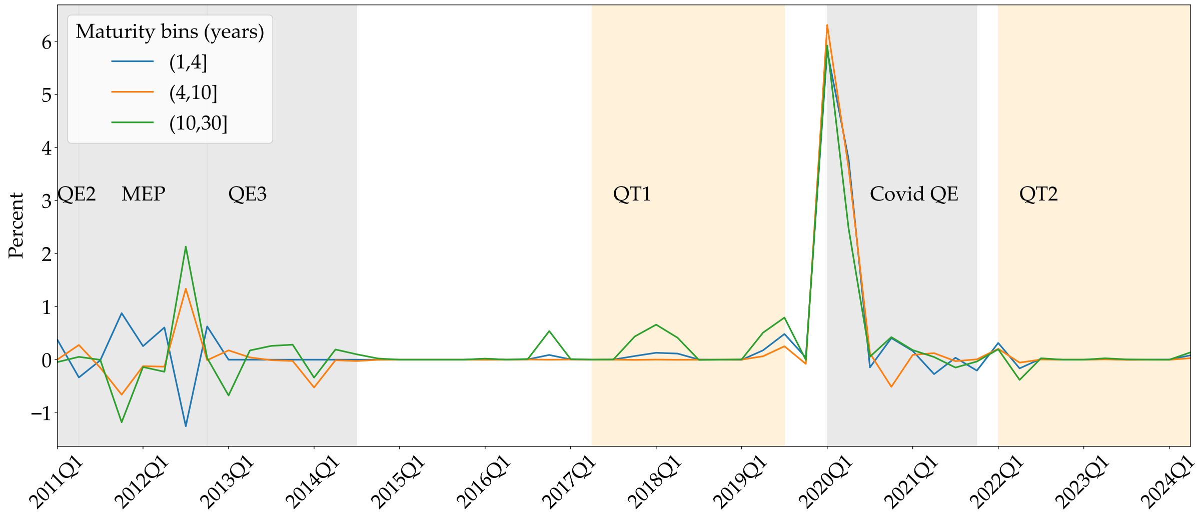
debt portfolio efficiently and transparently.[11]

We use the information released by the TBAC as follows. To continue the example above, the TBAC recommended issuance during the auction on November 15, 2018, was \$37 billion in 3-year notes, \$27 billion in 10-year notes and \$19 billion in 30-year bonds, with corresponding weights of 45%, 32% and 23%, respectively. Given the Federal Reserve's reinvestment policy, these weights can be taken as the expected weights for each maturity bin of the \$16.9 billion that the Federal Reserve was expected to reinvest on November 15, 2018. We repeat the same procedure for the auction on November 30, 2018. We follow the same procedure of all other months and aggregate the shocks at a quarterly frequency.

With all components of Equation (3) in place, we construct reinvestment shocks by applying the expected weights and reinvested amounts in a consistent manner for each US Treasury auction. These shocks are then aggregated at a quarterly frequency to derive the time series presented in Figure 2. Reinvestment shocks tend to be much smaller than active purchase shocks. Nevertheless, at the beginning and end of QT

[11]Figure B.4 of the Appendix provides an example of the detailed recommendations that the TBAC issues every quarter.

Figure 3: Scaled aggregate shocks $BSPshock_{m,t}$ by maturity bin



Note: The first two quarters of 2020 are excluded from the baseline sample in our empirical analysis.

periods, there are large positive and negative shocks, primarily driven by forecast errors about redemption caps.

Aggregating the shocks. Summing up the quarterly shocks based on active purchases and reinvestments, we obtain the overall shock measures $\widetilde{\Delta CB}_{m,t}$ in equation (1). We next scale these shocks by the total outstanding government debt with remaining time to maturity m in a given quarter t, $G_{m,t}$, and plot the aggregate shock series in Figure 3. We denote the scaled aggregate shock measures by maturity as $BSPshock_{m,t} \equiv \frac{\widetilde{\Delta CB}_{m,t}}{G_{m,t}}$.

Most of the variation in our shock measures occurs during QE and MEP periods. This is consistent with active purchase shocks being larger than reinvestment shocks. Importantly, these shocks series are large even outside the pandemic QE, often corresponding to 1-to-2 percent of the total government debt of a maturity bin in a given quarter. In the regressions that follow in section 4, we standardize the combined shock series in our baseline sample, i.e. excluding the values for the first two quarters of 2020.

3.2 Shock validation

In this section, we address several identification concerns that may plague our shock measures and compare our shock series to other monetary policy shocks identified in the literature. First, we show that our central bank balance sheet shocks cannot be predicted using macroeconomic and financial variables, in the spirit of Bauer and Swanson (2023). Next, we address potential concerns due to the time gap between when the SPD respondents form expectations and the dates of FOMC announcements regarding the Federal Reserve's plans for active purchases and reinvestments. Finally, we show that there is a low correlation between our shock series and other monetary policy shocks in the literature, which suggests that our shocks indeed capture a different aspect of central bank policies that has not been previously identified in the literature, i.e. shocks throughout the implementation of QE/QT rather than shocks identified using high-frequency windows around FOMC announcements.

Regressions on macro-financial predictors. We regress our central bank balance sheet shocks $BSPshock_{m,t}$ for each maturity bin $m \in \{$(1Y-4Y], (4Y-10Y], $>$10Y$\}$ on several macro-financial predictors as in Bauer and Swanson (2023). These include the latest non-farm payroll shock $NFP\ shock_{t-1}$, year-on-year employment growth in the preceding quarter $Emp.\ growth\ (12m)_{t-1}$, S&P 500 returns in the previous quarter $\Delta log\ S\&P500\ (3m)_{t-1}$, changes in the slope of the yield curve in the previous quarter $\Delta Slope\ (3m)_{t-1}$, quarterly changes in commodity prices $\Delta log\ Comm.\ price\ (3m)_{t-1}$, and the Treasury skewness at the end of the previous quarter $Treasury\ skewness_{t-1}$. To account for autocorrelation in errors, we construct Newey-West standard errors with four lags. Table B.6 of the Appendix shows that all predictors listed above are statistically insignificant across maturity bins and the R^2 of regressions are low. These results are suggestive evidence of the exogeneity of our central bank balance sheet shocks.

Time gap between the SPD and the FOMC meeting. Another potential concern for shock identification stems from the time gap between the dates when SPD participants are surveyed and the FOMC announcement dates. Since the surveys are received from primary dealers one week before the FOMC meetings, economic developments during this interim period could influence primary dealers' expectations regarding the prospective FOMC announcements, potentially making the SPD replies outdated and an inaccurate measure of market participants' expectations. In order to address this concern, we regress the balance sheet shocks at each maturity following the FOMC announcement dates on the weekly S&P 500 returns prior to the FOMC announcement date and show that they are not correlated. Table B.7 shows our results. Weekly S&P 500 returns prior to the FOMC announcement are statistically insignificant predictors of shocks across maturity bins. This suggests that the shocks we identify are not driven by changes in economic conditions that could have altered the market participants' perceptions regarding future central bank balance sheet policies.

Other monetary policy shocks. An important feature of our shocks that distinguishes them from those in the literature is that they occur continuously throughout the quarter and hence capture the implementation of QE and QT in addition to high-frequency market reactions in short windows around FOMC announcements. While active purchase shocks do occur during FOMC announcements, reinvestment shocks happen at Treasury auctions throughout the quarter. Moreover, our shocks reflect shocks about the volume of central bank balance sheet policies rather than focusing on shocks to price measures as previously done in the literature.

To check whether our shocks differ from the ones previously identified in the literature, we regress our shocks on measures constructed by Nakamura and Steinsson (2018), Swanson (2021), Bu et al. (2021), Jarociński and Karadi (2020). Tables B.8 to B.10 show that there is no statistically significant relationship between our shock measures and the ones listed above. This suggests that our shocks capture a unique aspect of monetary policy based on balance sheet policy implementation.

4 The impact on firm borrowing and bond prices by maturity

In this section, we use our central bank balance sheet policy shocks constructed for different maturity bins, $BSPshock_{m,t}$, to study how firm borrowing responds to balance sheet policy shocks and how bond prices are affected. We focus on bonds and term loans since these are the two major debt instruments through which firms borrow in our sample. In principle, balance sheet policies can impact firm borrowing most notably via the portfolio rebalancing and bank lending channels. For example, in the case of QE, as the Federal Reserve purchases Treasuries, investors that hold Treasuries in their portfolios are incentivized to seek alternatives for government bonds in other markets such as corporate bond markets, i.e. the portfolio rebalancing channel. Similarly, banks that hold Treasuries can swap them for central bank reserves and expand lending through term loans, i.e. the bank lending channel. These channels would generate additional demand for corporate bonds and supply of corporate loans, relaxing the borrowing constraints of firms and allowing them to borrow more.

To study how firms respond to balance sheet policy shocks $BSPshock_{m,t}$ in maturity bin m at quarter t, we estimate impulse response functions of firm debt by type using local projection regressions in the spirit of Jordà (2005):

$$\Delta y^d_{i,m,t+h,t-1} = \sum_{m=1}^{3} \beta^d_{m,h} BSPshock_{m,t} \times \mathbb{I}_m + \sum_{j=1}^{4} \gamma^d_{m,h} \Delta y^d_{i,m,t-j,t-j-1} + \lambda_{i,m,h} + \lambda_{i,t,h} + \varepsilon_{i,m,t,h} \tag{4}$$

where $\Delta y^d_{i,m,t+h,t-1}$ denotes log changes in debt outstanding of firm i in maturity bin m of type d (i.e., bonds or term loans). The log changes are between the quarter preceding the shocks and h quarters later, where $h \in \{0, 1, 2, ..., 8\}$. The main coefficients of interest, $\beta^d_{m,h}$, correspond to the interactions terms $BSPshock_{m,t} \times \mathbb{I}_m$ where $\mathbb{I}_m$ is an indicator function for different maturities ($m \in (1Y - 4Y], (4Y - 10Y], > 10Y$) that takes the value of one depending on the maturity m of firm debt, and zero otherwise.

We control for lagged values of the dependent variable up to four quarter lags. We include firm-maturity fixed effects in each regression corresponding to horizon h, $\lambda_{i,m,h}$. These fixed effects account for any unobservable time-invariant characteristics of a firm's debt at each maturity bin. We also include firm-time fixed effects, $\lambda_{i,t,h}$, to account for any unobservable time-varying firm characteristics. We double cluster standard errors at firm and quarter level separately. We use this specification as our baseline and report robustness checks with alternative specifications in Section 4.6.

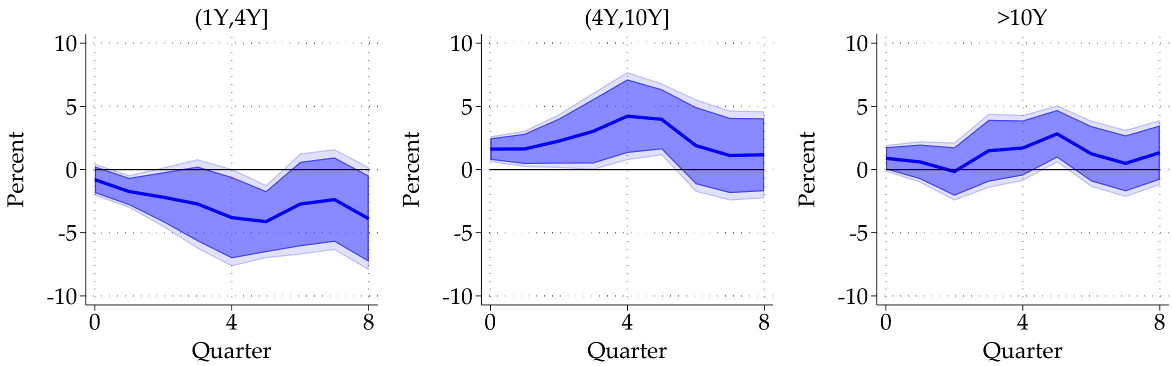
4.1 The average effect on bonds and term loans outstanding

We start by showing evidence of the impact of central bank balance sheet shocks at different maturity bins on US firm borrowing via bonds and term loans denominated in US dollars. The estimates $\hat{\beta}^d_{m,h}$ for bonds are reported in Figure 4a and the estimates for term loans are reported in Figure 4b. The lines correspond to our estimates $\beta^d_{m,h}$ for each regression and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt either via bonds or term loans in the corresponding maturity bin changes by $\hat{\beta}^d_{m,h}$%.[12]

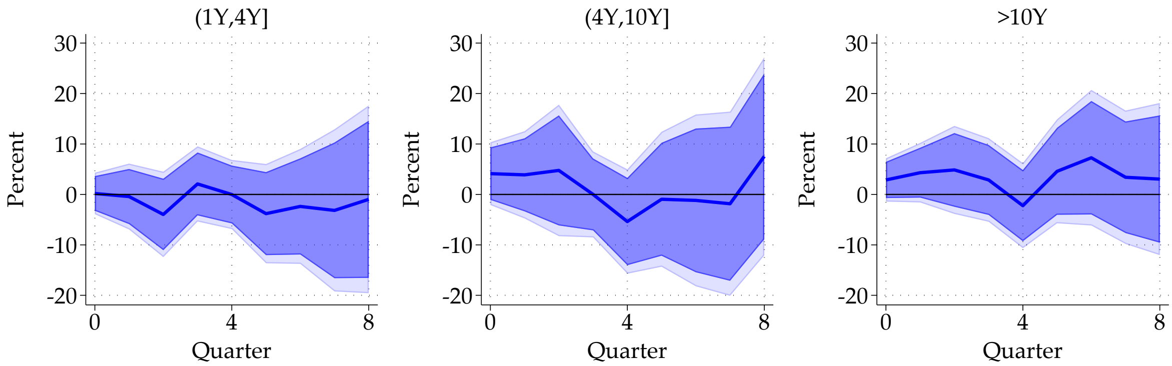
For corporate bonds, we find that the effects of central bank balance sheet policies differ substantially across maturities. When the central bank share in the four-to-ten year maturity segment increases by one standard deviation, outstanding corporate bonds increase by 5% after four quarters and the effect dissipates afterwards. We also find a positive impact on corporate bonds with maturities greater than ten years in response to central bank purchases of Treasuries in the same maturity segment, but the effect is smaller and statistically significant only in the fifth quarter after the shock.

[12] We report results to a one standard deviation shock to ease the comparison between our results and earlier studies. One standard deviation in our shocks correspond approximately to 1% of outstanding debt in each maturity bucket. For example, as of end-March 2024 the outstanding US Treasuries for each maturity bucket stood at i.e. $(1Y-4Y], (4Y-10Y], > 10Y$, were \$6.15 trillion, \$5.15 trillion and \$4.17 trillion, respectively.

Figure 4: The effects of central bank balance sheet shocks on US firms' debt



(a) The average effect of shock m on bonds at maturity bucket m



(b) The average effect of shock m on term loans at maturity bucket m

Note: The figures show estimates $\hat{\beta}^{d}_{m,h}$ obtained from the regression equation (4) estimated for each type of debt $d \in$ {Bonds, Term Loans} and over each horizon $h \in \{0, 1, 2, ..., 8\}$. The sample contains only US firms and debt denominated in dollars and runs between 2011Q1 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for bonds are reported in Figure 4a and the estimates for term loans are reported in Figure 4b. The lines correspond to our estimates $\hat{\beta}^{d}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt in the corresponding maturity bin changes by $\hat{\beta}^{d}_{m,h}$%.

In contrast, we find that when the Federal Reserve buys an unexpectedly large amount of Treasuries with maturities ranging from one-to-four years, firms' outstanding bonds decrease at these maturities. We explore this result further in Section 4.2.

For term loans, Figure 4b shows that, on average, central bank balance sheet shocks have no statistically significant impact at any maturity or horizon. This finding highlights that central bank balance sheet policies involving government debt in the United

States operate mainly through the corporate bond market rather than the banking sector. This finding is consistent with Rodnyansky and Darmouni (2017) and Chakraborty et al. (2020), who also find that Treasury purchases did not provide a meaningful stimulus to the economy through the bank lending channel.

4.2 The impact on debt maturity structure

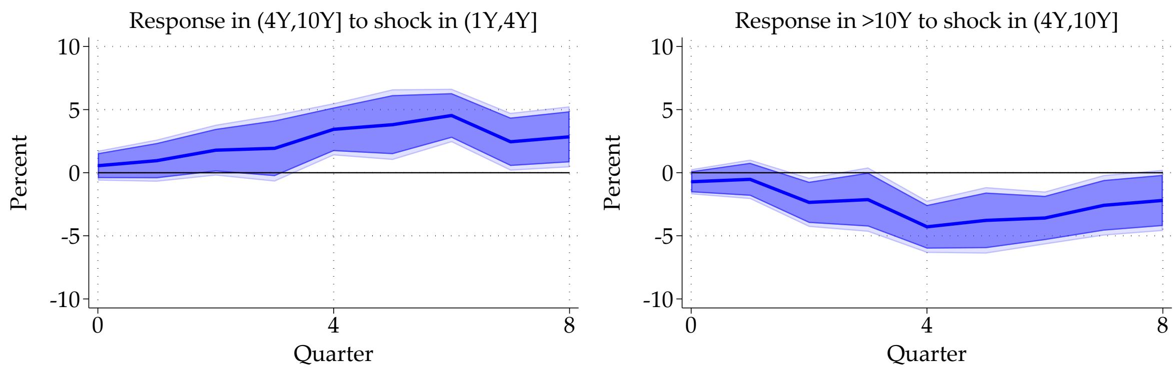
It is notable that corporate bond issuance in the one-to-four-year maturity bucket declines when the central bank purchases Treasuries at these maturities. A potential hypothesis is that firms respond to these short-term purchases by lengthening the maturity of their corporate bonds. Leveraging the maturity-specific nature of our balance sheet policy shocks, we test this *maturity extension* hypothesis. To do so, we modify Equation (4) as follows:

$$\Delta y_{i,m+1,t+h,t-1} = \sum_{m=1}^{2} \mu_{m,h} BSPshock_{m,t} \times \mathbb{I}_m + \sum_{j=1}^{4} \gamma_{m,h} \Delta y_{i,m+1,t-j,t-j-1} + \lambda_{i,m,h} + \lambda_{i,t,h} + \varepsilon_{i,m,t,h} \tag{5}$$

where the only difference between Equation (5) and Equation (4) is the outcome variable and its lagged values on the right-hand side, which both take the value for maturity bin $m+1$ rather than m in Equation (4). Equation (5) hence estimates how firms' outstanding bonds with remaining maturities of four-to-ten years ($m = 2$) respond to central bank purchases of Treasuries with one-to-four year remaining maturity ($m = 1$) and how firms' outstanding bonds with remaining maturities of more-than-ten years ($m = 3$) respond to central bank purchases of Treasuries with four-to-ten year remaining maturity ($m = 2$).

We report the estimates of the main coefficient of interest $\mu_{m,h}$ in Figure 5. Taken together with the results in the previous section, we indeed find evidence that firms extend the maturity of their bonds in response to the Federal Reserve's purchases of US Treasuries with remaining maturity of one-to-four years. Firms' total outstanding

Figure 5: Maturity bunching of US firms' corporate bonds in response to central bank balance sheet shocks



Note: The figures show estimates $\hat{\mu}_{m,h}$ obtained from the regression equation (5) over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and debt denominated in dollars and runs between 2011Q1 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The lines correspond to our estimates $\hat{\mu}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. The first panel plots the response of firm bonds outstanding in the four-to-ten year bin to central bank balance sheet shocks in the one-to-four year bin. The second panel plots the response of firm bonds outstanding in the greater-than-ten year bin to central bank balance sheet shocks in the four-to-ten year bin.

bonds in the one-to-four years maturity segment fall (left panel of Figure 4a) while their four-to-ten year bonds increase (first panel of Figure 5).

However, our results in the right panel of Figure 5 suggest that such maturity extension does not happen across all maturity bins. In the previous section, we documented that firms respond most strongly to central bank purchases of Treasuries with four-to-ten years maturity by increasing their corporate bonds most in that segment, while the response was more muted for bonds with maturity greater than ten years. Figure 5 shows that firms also reduce their debt in maturities of more than ten years in response to central bank shocks in the four-to-ten year maturity bin.

These results point to a *maturity bunching* of corporate bond issuance in the four-to-ten-year segment. Specifically, firms extend the maturity of their debt when the central bank purchases more at the short end of the yield curve, but this extension stops at the belly of the yield curve: if the central bank increases its purchases in the middle maturity segment, firms respond by issuing more debt in that range and scaling back issuance at the long end.[13] This result can be due to firms responding to price signals from corporate bond markets and adjusting their debt maturity structure, in particular if investors demand higher duration assets in their portfolio as they search for yield (Stein, 2013; Rajan, 2013; Becker and Ivashina, 2015; Campbell and Sigalov, 2022). We explore the responses of bond prices in Section 4.4.

4.3 Firm heterogeneity across the credit risk spectrum

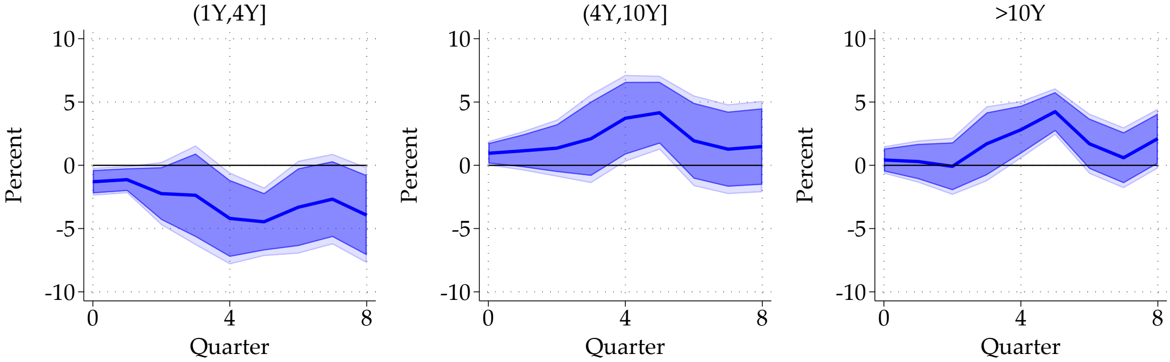
Do firms with different credit ratings respond differently to central bank balance sheet expansions? To address this question, we separately estimate the regression in Equation (4) for firm with and without an investment-grade credit rating. There could be two mechanisms at work when the central bank buys Treasuries which impact these firms differentially. IG firms' debt might respond more strongly because their debt is a closer substitute for Treasuries for investors, while non-IG firms might respond more if they are financially constrained and thus more eager to borrow when conditions ease. We find greater support for the former channel in our sample.

We find that most of the average effects for corporate bonds we uncovered in Section 4.1 are driven by IG firms. Figure 6a shows that the Federal Reserve's purchases of US Treasuries with maturities of four to ten years and over ten years lead to a significant increase in IG firms' bonds within these maturity ranges. This effect is slightly more pronounced in the greater than ten years maturity bin than the average effect illustrated in Figure 4a. Similar to the results above, we find that IG firms reduce their corporate bonds in the one-to-four year segment in response to central bank balance sheet shocks in the same segment, suggesting that they are driving the maturity extension results in response to central bank purchases at the short-end of the yield curve.

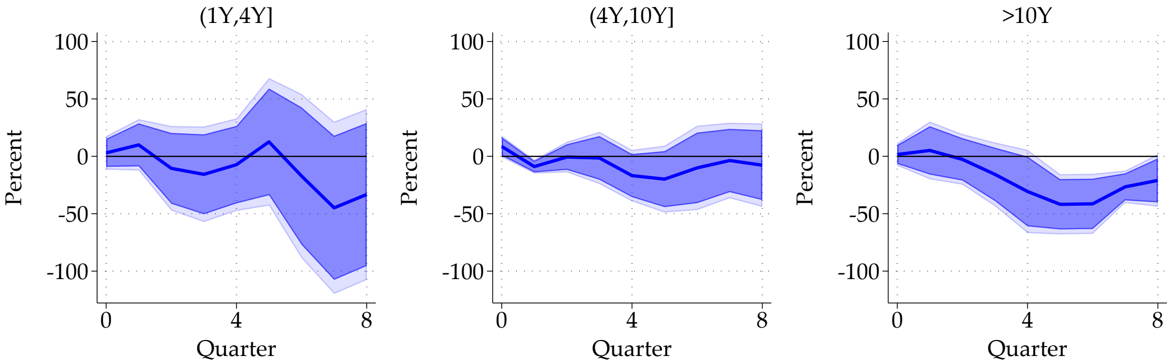
Our results also suggest that IG firms substitute between bonds and terms loans in response to balance sheet policies at the long-end of the yield curve. Figure 6b shows

[13] We find no evidence that central-bank shocks induce *maturity compression* in corporate bonds, that is, firms' shorter dated bonds do not decline significantly when the Federal Reserve purchases Treasuries of longer maturity. Figure B.5 in the Appendix presents these results.

Figure 6: The effect of central bank balance sheet policies on US IG firms' debt



(a) The effect of shock m on bonds of IG firms at maturity bucket m



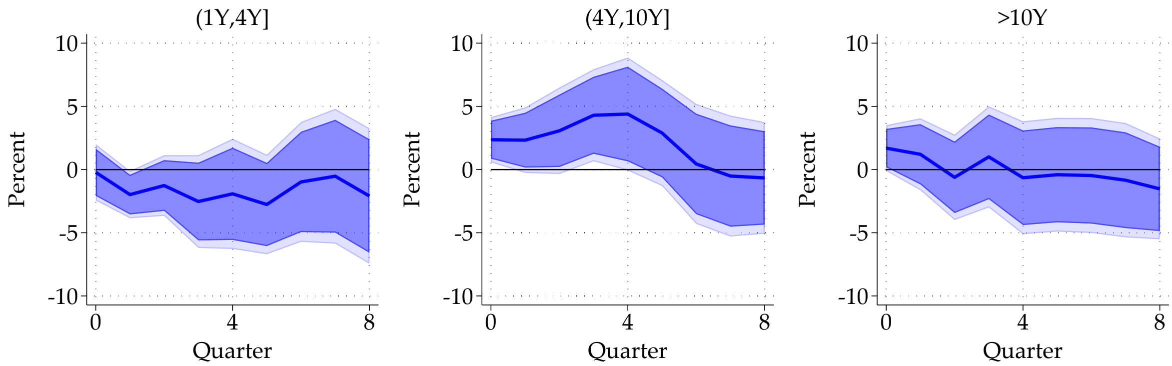
(b) The effect of shock m on term loans of IG firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}^d_{m,h}$ obtained from the regression equation (4) estimated for each type of debt $d \in \{\text{Bonds, Term Loans}\}$ and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms, which have an investment grade rating, and debt denominated in dollars and runs between 2011Q1 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for bonds are reported in Figure 6a and the estimates for term loans are reported in Figure 6b. The lines correspond to our estimates $\hat{\beta}^d_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt in the corresponding maturity bin changes by $\hat{\beta}^d_{m,h}$%.

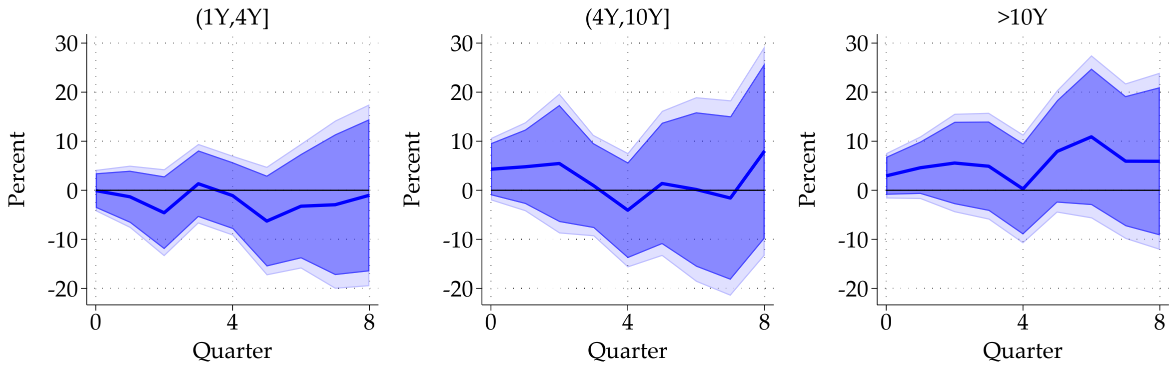
that when the Federal Reserve purchases Treasuries with maturities greater than ten years, there is a significant drop in IG term loans with similar maturities.

For non-IG firms, Figure 7a shows a more modest response of bond outstanding to central bank balance sheet shocks. Only firms issuing bonds in the four-to-ten year maturity bin see their bonds outstanding of those maturities rise in response to a central bank balance sheet shock of equivalent maturity, although the response is statistically

Figure 7: The effect of central bank balance sheet policies on US non-IG firms' debt



(a) The effect of shock m on bonds of US non-IG firms at maturity bucket m



(b) The effect of shock m on term loans of US non-IG firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}^d_{m,h}$ obtained from the regression equation (4) estimated for each type of debt $d \in$ {Bonds, Term Loans} and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms, which do not have an investment grade rating, and debt denominated in dollars, and runs between 2011Q1 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for bonds are reported in Figure 7a and the estimates for term loans are reported in Figure 7b. The lines correspond to our estimates $\hat{\beta}^d_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt in the corresponding maturity bin changes by $\hat{\beta}^d_{m,h}$%.

significant for a shorter period of time.[14] Similar to our average effect results shown in Figure 4b, non-IG firms term loans do not exhibit any significant response to balance sheet shocks at any maturity (Figure 7b). The more pronounced response of IG firms'

[14]The finding that only IG firms are able to increase borrowing at long maturities is consistent with market segmentation. IG firms are able to issue bonds at longer maturities, whereas others are only active at the shorter end of the yield curve. Table B.4 shows that IG bonds have an average duration of 7.8 years, whereas high-yield (HY) bonds have an average duration of 3.7 years.

bonds suggests that institutional investors rebalance their portfolios into bonds with closer substitutability to Treasuries in terms of credit risk. In the next section, we show that, consistent with this hypothesis, IG bond prices respond more strongly to balance sheet shocks.

4.4 Corporate and government bond prices

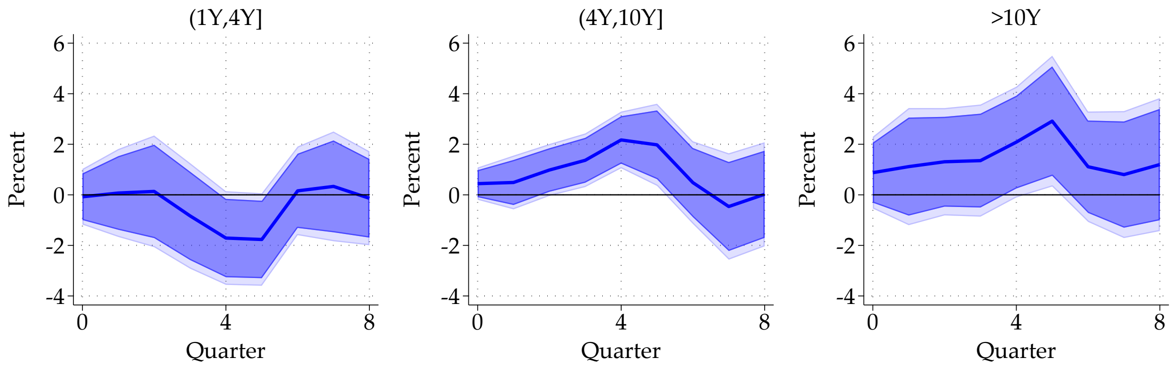
Corporate bond prices. How do balance sheet policies affect corporate bond prices? Are there differences for bonds of firms with IG rating and others? To answer this question, we extend the firm-maturity level regression (4) to the bond level regression (6) and estimate the corporate bond price responses:

$$\Delta p_{b,i,m,t+h,t-1} = \sum_{m=1}^{3} \beta_{m,h} BSPshock_{m,t} \times \mathbb{I}_m + \sum_{j=1}^{4} \gamma_{m,h} \Delta p_{b,i,m,t-j,t-j-1} + Duration_{b,i,m,t} + \lambda_{b,h} + \lambda_{i,m,h} + \lambda_{i,t,h} + \varepsilon_{b,i,m,t,h} \quad (6)$$

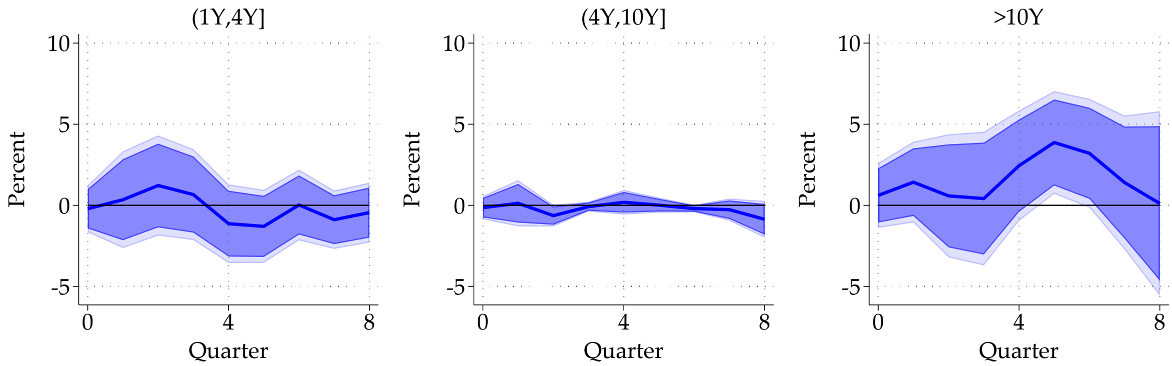
where $\Delta p_{b,i,m,t+h,t-1}$ denotes the log price change of bond b issued by firm i in maturity bin m for h quarters ahead. We also include a bond fixed effect and a time-varying bond-specific duration as additional controls. Figure 8 illustrates how bond prices for both IG and HY bonds respond to our maturity-specific central bank balance sheet shocks.

We find that, for IG firms, balance sheet shocks at the middle and long-end of yield curve lead to a significant increase in prices. This finding shown in Figure 8a mirrors to a great extent our evidence in Figure 6a. Higher quantities accompanied by higher prices are suggestive of increased demand by bond investors for IG bonds consistent with the interpretation that portfolio rebalancing of preferred habitat investors favoring closer substitutes to Treasuries in terms of credit risk. In addition, the muted price response to shocks at one-to-four year maturity is consistent with firms reoptimizating their debt maturity responding to price signals and can explain the results we documented in Section 4.2. Finally, corporate bond prices adjust slowly to balance sheet

Figure 8: The effect of central bank balance sheet policies on bond prices of US firms



(a) The effect of shock m on IG bond prices of US firms at maturity bucket m



(b) The effect of shock m on HY bond prices of US firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (6) estimated for corporate bond prices and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The regression sample contains bonds issued in USD by US firms only. For investment-graded (IG) bonds, the regression sample runs between 2012Q2 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. For firms issuing high-yield (HY) bonds, the regression sample runs between 2013Q3 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for IG bond prices are reported in Figure 8a and the estimates for HY bond prices are reported in Figure 8b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding bond prices in the corresponding maturity bin changes by $\hat{\beta}_{m,h}$%.

shocks over several quarters as shown in Figure 6a. This is consistent with the view that Treasury and corporate bond markets are partially segmented and capital is slow-moving from treasury market to corporate bond market (see, e.g. Greenwood et al., 2018). Moreover, we take the relatively large and persistent cross-asset price effects as a validation of the relevance of our shocks.

For high-yield (HY) bonds issued by US firms, we document little to no response to central bank balance sheet shocks. Figure 8b shows that only prices for bonds with a remaining maturity greater than 10 years show a modest increase temporarily a year after the balance sheet shock to that maturity bin. Such a muted response in prices of HY bonds is consistent with our evidence in Figure 7a of more muted quantity response by non-IG firms.

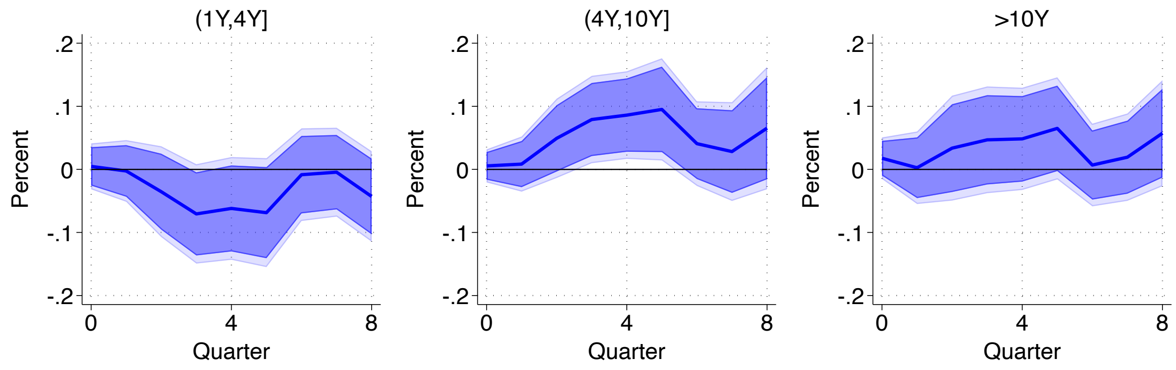
Government bond prices. Since our primary focus is on the corporate sector's response to balance sheet policies, corporate bond pricing is of central importance. However, to trace the full transmission of the shocks, we also report the corresponding results for US Treasury prices in Figure 9. D'Amico and Seida (2024) construct unexpected balance sheet surprises in a similar spirit to us using the Survey of Primary Dealers and document intra-day Treasury yield changes around selected QE and QT announcements. We complement their event-study evidence by estimating lower-frequency responses across maturity bucket. We show that a one-standard-deviation central bank purchase shock in the four-to-ten year segment raises Treasury prices by roughly 0.1% (around a 1–2 bp yield drop), which persists for more than a year. For other maturities, while we find a small, positive price effect in the same quarter as the shock, the estimates remain statistically insignificant throughout, which may reflect the depth and liquidity of the Treasury market allowing efficient absorption of shocks around announcements, while the price effects don't last for quarters. [15]

4.5 Global spillovers

In this section, we test whether balance sheet policies in the United States spill over to non-US firms with US dollar-denominated debt. In particular, we estimate Equation

[15] These findings are consistent with those in several other papers, which find a relatively short-lived price effect for Treasuries in response to QE shocks (see, e.g. Wright, 2012; Selgrad, 2023). Interestingly, Treasury price responses exhibit a shape similar to the IG-bond responses in Figure 8a. We interpret this pattern as evidence of spillovers from the Treasury to the corporate bond market. Because of market segmentation and slow-moving capital, institutional investors adjust their portfolios gradually as the Fed implements Treasury purchases, leading to the more persistent reactions observed in corporate bond prices.

Figure 9: The effect of central bank balance sheet policies on Treasury prices



Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (6) estimated for US government bond prices and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains US Treasury notes and bonds and runs between 2012Q2 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, Treasury prices corresponding maturity bin change by $\hat{\beta}_{m,h}$%.

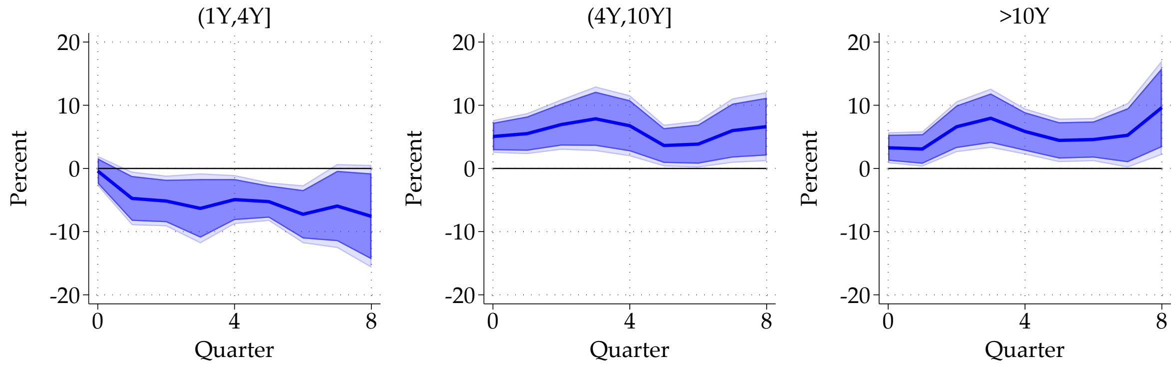
(4) pooling non-US IG and non-IG firms separately. Figure 10 shows the results for bonds and term loans of non-US IG firms.[16] We find that non-US IG firms benefit similarly as their US counterparts, with their bonds enjoying a positive quantity and price response. In addition to positive bond quantity response, we also find an increase in non-US IG firms' term loans outstanding in response to shocks to the long end of the yield curve.[17] Lastly, we find little to no response of non-US non-IG firms to shocks to the Federal Reserve purchases across maturities in Figure B.7, similar to the evidence for US non-IG firms presented in Figure 7.

Overall, these results suggest that balance sheet policies in the United States affect corporate bonds denominated in US dollars with comparable credit ratings similarly regardless of the nationality of issuers. This is consistent with the special role of US dollar assets in global investors' portfolios (e.g. Maggiori et al., 2020) and the significant influence of US monetary policy on global financial intermediaries (Miranda-

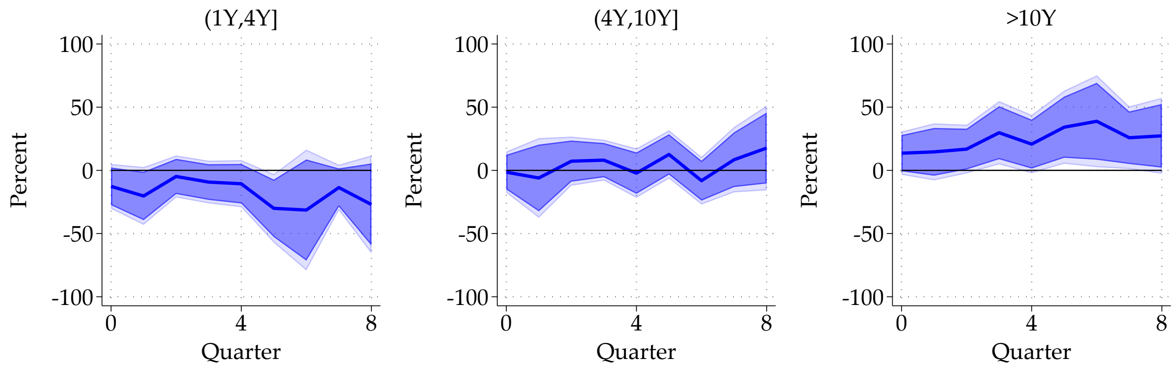
[16] Figure B.6a in the Appendix shows the bond price results for non-US IG firms.

[17] Combined with the result that US IG firms' term loans decreases in this maturity bucket (Figure 6b), this might indicate that non-US IG firms replace US IG firms in banks' loan portfolios as US IG banks tilt to bond market for long-term borrowing, reflecting the mechanism highlighted in Grosse-Rueschkamp et al. (2019).

Figure 10: The effect of Federal Reserve's balance sheet policies on non-US IG firms' debt



(a) The effect of shock m on bonds of non-US IG firms at maturity bucket m



(b) The effect of shock m on term loans non-US of IG firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}^d_{m,h}$ obtained from the regression equation (4) estimated for each type of debt $d \in$ {Bonds, Term Loans} and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only non-US firms, which have an investment-grade rating, and debt denominated in dollars and runs between 2011Q3 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for bonds are reported in Figure 10a and the estimates for term loans are reported in Figure 10b. The lines correspond to our estimates $\hat{\beta}^d_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt in the corresponding maturity bin changes by $\hat{\beta}^d_{m,h}$%.

Agrippino and Rey, 2020).

4.6 Robustness checks

Controlling for other monetary policy shocks. One concern that may arise when interpreting our results is that other monetary policy shocks, e.g. those capturing shocks during FOMC announcements rather than implementations of central bank policies, could drive the responses of corporate debt we documented above. More specifically, the FOMC could provide unexpected changes to its forward guidance policy, altering significantly the middle segment of the yield curve. In our setup, this would translate to a confounding factor for the shock to the maturity bin one-to-four years. To address this concern, we add the maturity-specific shocks constructed by Swanson (2021) to our baseline regression in Equation (4), as those shocks are specifically constructed to capture unexpected changes in policy during FOMC announcements.

Swanson (2021) uses high-frequency changes in US Treasury yields of different maturities and a principal component analysis to construct shocks to the target rate, forward guidance and large scale asset purchase programs (LSAP), disentangling the effects of different monetary policy tools of the Federal Reserve on the yield curve. We map the three shocks from Swanson (2021) into our framework as follows. The shock to the Federal Reserve funds target is mapped into the (0Y,1Y] maturity bin for debt in our sample, while the shock to forward guidance is mapped into the (1Y,4Y] maturity bin. For debt with time-to-maturity greater than four years (i.e., maturity bins (4Y,10Y] and >10Y), we use the LSAP shock from Swanson (2021) to proxy for announcement effects of changes in Federal Reserve policies that affect the longer end of the yield curve. We consolidate the FOMC date-specific shocks at the quarterly level by summing up all the shocks that occur in a given quarter. Figure B.8 of the Appendix shows that including shocks constructed by Swanson (2021) does not materially alter the results we document in Figure 4.[18]

Including COVID-19 crisis in the sample. Another concern that may arise when assessing the quantitative importance of our estimates is that omitting the COVID-19 crisis might bias the results. To address this issue, we re-estimate our baseline regres-

[18]Our baseline regression, as outlined in equation (4), incorporates firm-time fixed effects. This approach ensures that any variables that are time-specific but not maturity-specific (e.g., monetary policy shocks identified by Jarociński and Karadi, 2020) are accounted for during estimation. Consequently, verifying the robustness of our results to other monetary policy shocks would require removing these fixed effects. We therefore settled on making the more restrictive fixed-effects approach our baseline.

sion in Equation (4) including the first two quarters of 2020 in the regression sample. Figure B.9 of the Appendix shows that our estimates become more noisy compared to the ones reported in Figure 4 when including the COVID-19 crisis quarters, but the signs of point estimates remain broadly consistent with our baseline results. Importantly, adding the first two quarters of 2020 to the sample strengthens our results for IG firms (Figure B.10). This could reflect the effects of the Federal Reserve's corporate bond-buying program (i.e., the Secondary Market Corporate Credit Facility) that affected the pricing of IG corporate bonds directly (Gilchrist et al., 2024) above and beyond the effects of the Federal Reserve's purchases of US Treasury securities. In contrast, adding the COVID-19 crisis to the estimation sample for non-IG firms seems to dampen somewhat the bond responses to our shock measures (Figure B.11), likely reflecting the fact that the bonds of many non-IG firms did not qualify for the Federal Reserve's corporate bond-buying program. Interestingly, one feature common across all figures that include the COVID-19 crisis (i.e., Figures B.9 to B.11) is that the term loan responses are typically negative for all but the one-to-four year shock. This may reflect the rapid reduction in term loans that banks engaged in during 2020 in response to a sharp increase in their credit line drawdowns (Greenwald et al., 2025).

Alternative specification. In the baseline specifications, we have used Equation (4) to study average responses of firm borrowing, and have used Equation (5) study the maturity extension. Our baseline specifications pool debts under different maturity bins and use fixed effects to absorb any firm-time and firm-maturity level variations. As a robustness check, we use an alternative specification as in Equation (7), running regressions for debts in different maturity bins separately and estimating the responses to shocks in all three maturity bins. Contrary to our baseline specifications, this specification allows us to study the average response of firms' borrowing in a maturity bin to shocks in one specific maturity bin, controlling for shocks in the other two maturity bins. Our main take-aways remain similar using this specification. We report the results of these robustness checks for US firms' debt in Figure B.12.

5 The impact on firm-level outcomes

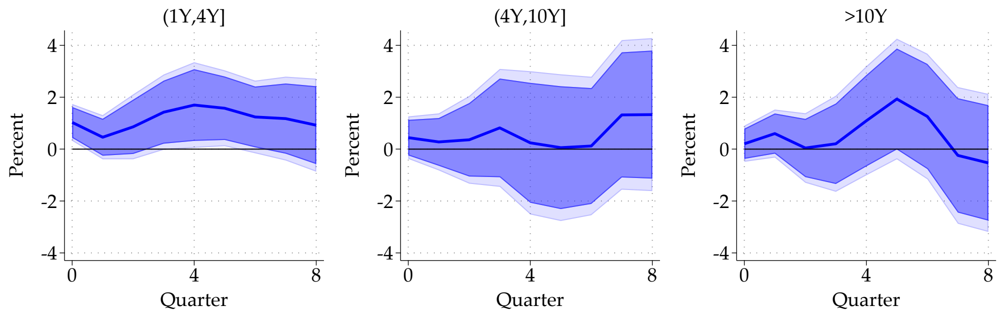
After having established that firm debt responds to central bank balance sheet policies at different maturities, we study how balance sheet policies impact firm-level outcomes, such as total debt, interest expenses, current assets, investment and employment. To do so, we estimate the following firm-level version of our baseline regression in Equation (4):

$$\Delta y_{i,t+h,t-1} = \sum_{m=2}^{4} \beta_{m,h} BSPshock_{m,t} + \sum_{j=1}^{4} \gamma_{j,h} \Delta y_{i,t-j,t-j-1} + \xi_h \cdot \mathit{Firm\ assets}_{i,t-6,h} + \nu_h \times \Delta \mathit{Macro\ controls}_{t,h} + \lambda_{i,h} + \varepsilon_{i,t,h} \quad (7)$$

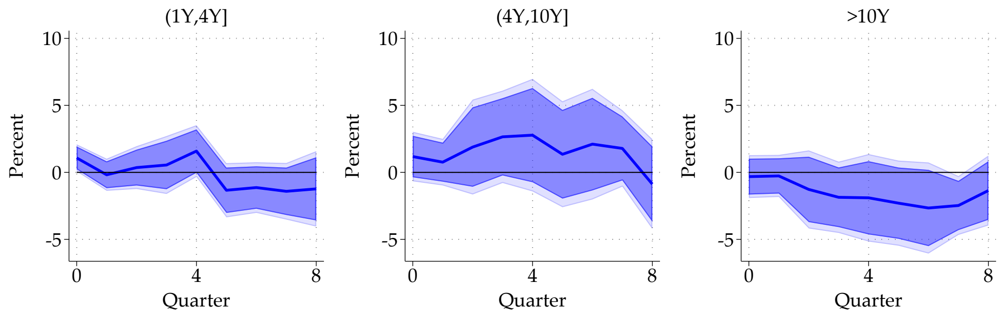
where $\Delta y_{i,t+h,t-1}$ denotes log changes in the dependent variable for firm i in quarter t. The log changes are between the quarter preceding the shocks and h quarters later, where $h \in \{0, 1, 2, ..., 8\}$. The main coefficients of interest, $\beta_{m,h}$, are the estimates for each of our central bank balance shocks by maturity bin, $BSPshock_{m,t}$. The regression also includes past changes in the dependent variable and log of firm assets as a stand in for firm-level controls.[19] We also add as controls changes in several macroeconomic and financial variables that could impact firm-level decisions above and beyond our shocks measures. The set of such variables that we consider is as follows: the change in the US GDP, the change in volatility proxied by the VIX index, the change in the US unemployment rate, and the change in the fitted yield of a five-year zero coupon bond. Our regressions also include a firm-level fixed effect that accounts for unobservable variation at the firm-level. We cluster standard errors at the firm and quarter level.

[19] We use lagged log assets, with a six-period lag, to avoid multicollinearity between assets and changes in some of the dependent variables used as controls that come from balance sheet data, such as total debt. Our results are robust to excluding log assets as controls and to using the contemporaneous assets as a control.

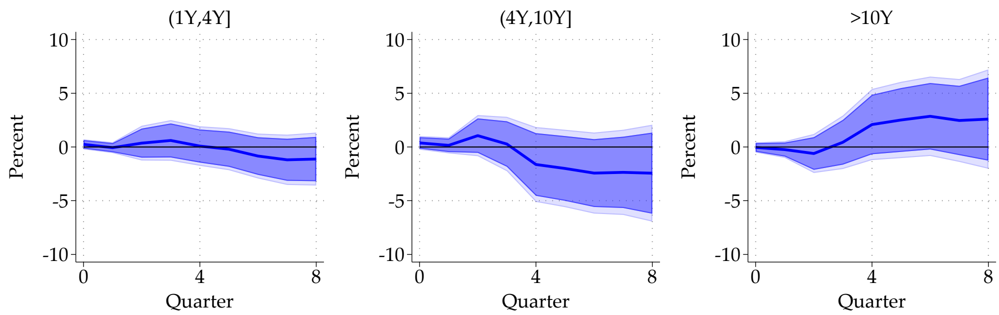
Figure 11: The effect of central bank balance sheet policies on US firms' debt outstanding



(a) The effect of shock m on total bonds outstanding



(b) The effect of shock m on total term loans outstanding



(c) The effect of shock m on total debt outstanding

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for debt of each type {Bonds, Term Loans, Total} and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for total bonds outstanding are reported in Figure 11a, the estimates for total term loans outstanding are reported in Figure 11b, and the estimates for total debt outstanding are in Figure 11c. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of debt changes by $\hat{\beta}_{m,h}$%.

5.1 The average impact on firm outcomes

Total debt. Do firms increase their overall debt in response to central bank balance sheet shocks? Figure 11 shows the results of estimating equation (7) where the dependent variable is either total bonds and notes outstanding, total term loans outstanding or total debt outstanding, which includes all debts reported on a firm's balance sheet.

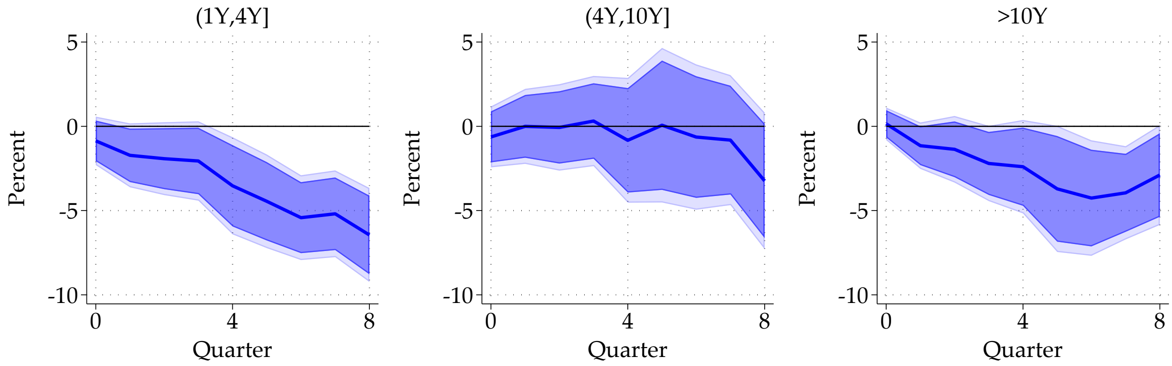
We find that firm debt outstanding does not increase significantly following a central bank balance sheet shock, irrespective of the maturity that the Federal Reserve targets and the type of debt used as the dependent variable in equation (7). The only statistically significant increase at the 5% level occurs for total bonds outstanding when the Federal Reserve surprises market participants by purchasing more Treasuries with remaining maturities between one and four years (Figure 11a, left panel). However, even this response is modest, as the estimated coefficients remain below 2% for all eight quarters after the shock. Figure 11b shows that total term loans outstanding also do not respond to changes in central bank balance sheet policy. Importantly, Figure 11c illustrates that total debt also remains flat irrespective of the maturity bin targeted by the Federal Reserve.

Taken together with the evidence in Section 4, this evidence indicates that, on average, firms respond to central bank balance sheet policies primarily by adjusting the maturity structure of their bonds responding to price signals in the corporate bond market rather than increasing their overall debt.

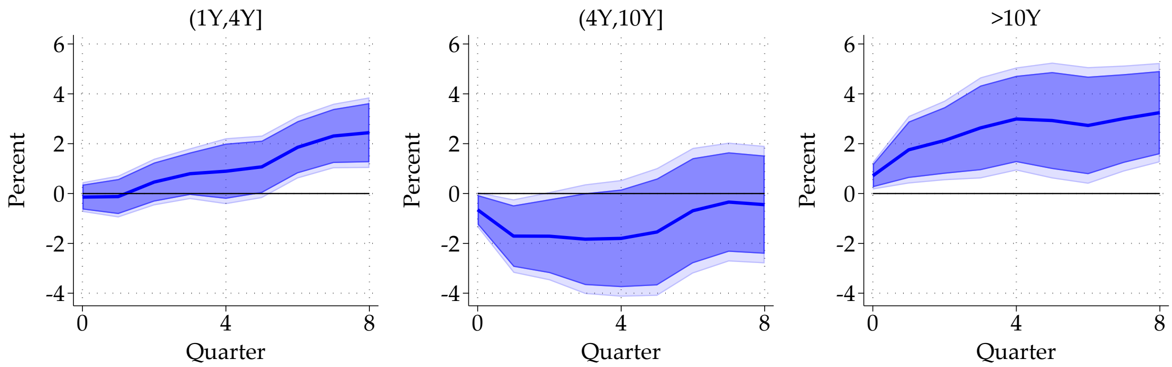
Interest expenses and current assets. While firms may not increase their total debt, adjusting the maturity structure of their corporate bonds to segments with more favorable prices might nevertheless help firms save on interest expenses and increase their cash buffers.[20] We test this conjecture by estimating the regression model in (7) using firm-level interest expenses and current assets as dependent variables. Figure

[20]Firms could also choose to return the costs savings stemming from lower interest expenses to shareholders by increasing dividend distributions and share repurchases. Figure B.14 of the Appendix shows that this is not the case in our sample.

Figure 12: The effect of central bank balance sheet policies on US firms' interest expenses and current assets



(a) The effect of shock m on interest expenses



(b) The effect of shock m on current assets

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated with firm interest expenses and current assets as dependent variables over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for interest expenses are reported in Figure 12a and the estimates for current assets are in Figure 12b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, interest expenses or current assets change by $\hat{\beta}_{m,h}$%.

12a shows that interest expenses indeed decline in response to surprise purchases of Treasuries by the Federal Reserve. The responses are significantly negative for central bank balance sheet shocks at the short- and the long-end of the yield curve. Figure 12b shows that the response in current assets mirrors that of interest expenses. As firms reduce their expenses when subjected to a central bank balance sheet shock, they tend to accumulate more current assets, especially when the Federal Reserve purchases Treasuries with a remaining time-to-maturity greater than ten years.

Capital and employment. Do central bank purchases of government securities increase firms' capital stock and employment? Figure 13 shows the responses of firm-level capital and headcount to surprise purchases of US Treasuries by the Federal Reserve. The point estimate for all three shock measures increases for capital (Figure 13a), suggesting an increase in firm investment, but the confidence intervals are wide, nullifying the effect in statistical sense. While physical capital may not increase, firms can instead choose to increase their intangible and organization capital following a reduction in their borrowing costs. Figure B.15 of the Appendix shows that measures of investment in intangible and organization capital, such as firm expenses on research and development (R&D) or selling general and administrative (SGA) expenses, also remain flat following the change in central bank balance policy. [21]

Similar to the patterns we document for capital, the point estimates for firm-level headcount (Figure 13b) do not change in a statistically significant way following surprise purchases of Treasuries across all maturities by the Federal Reserve.[22] Our evidence on investment and employment is consistent with one in Darmouni and Siani (2025) who show limited real effects of the Federal Reserve's policies during 2020.

5.2 Firm heterogeneity: IG versus non-IG firms

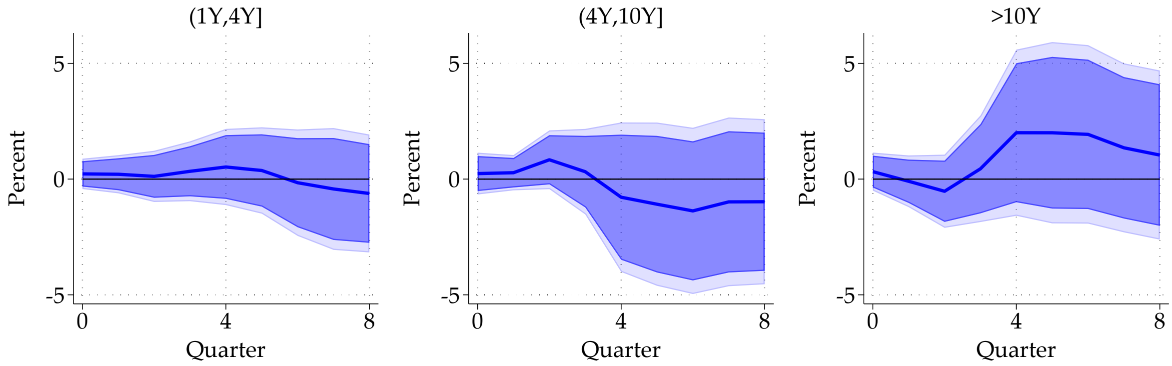
The evidence we presented above for firm-level outcomes may be masking important differences across groups of firms. Again, we compare outcomes for IG and non-IG firms and find important differences in how balance sheet policies at different parts of the yield curve affect firms across the credit risk spectrum.

One important characteristic that can alter the ability of firms to borrow and invest

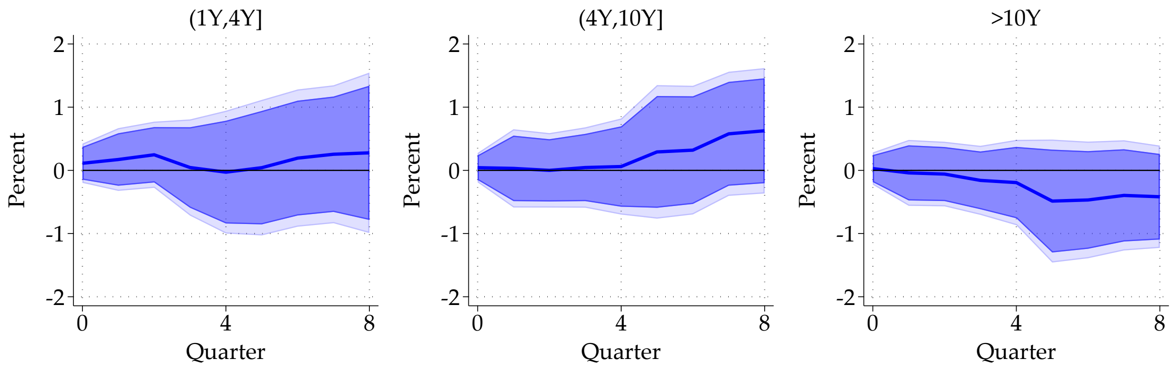
[21] R&D and SGA expenses are typically considered in the literature as ways through which firms can increase its stock of intangible and organization capital. See for example Crouzet and Eberly (2023).

[22] Figure B.16 of Appendix also shows that firm employment based on data from quarterly statements does not respond significantly to changes in central bank balance sheet policies.

Figure 13: The effect of central bank balance sheet policies on US firms' physical capital and employment



(a) The effect of shock m on physical capital

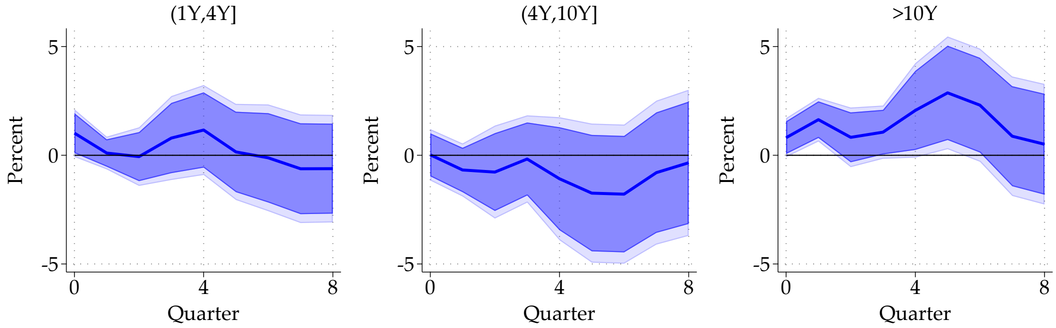


(b) The effect of shock m on headcount

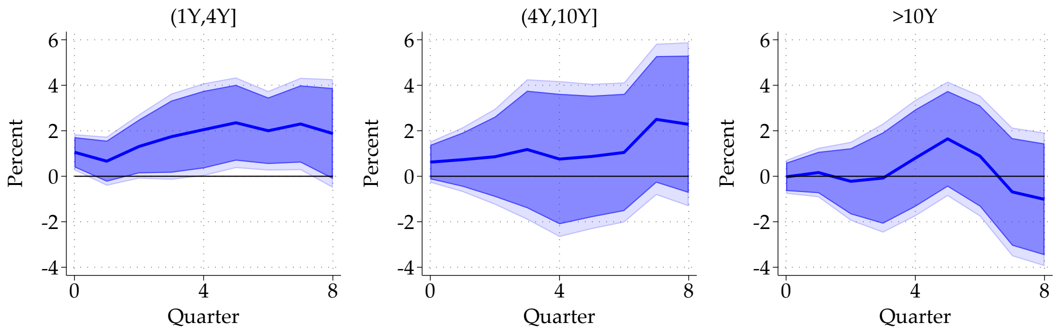
Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for firm capital and headcount over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. Capital is defined as net property, plant and equipment. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for capital are reported in Figure 13a and the estimates for headcount are in Figure 13b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, capital or employment change by $\hat{\beta}_{m,h}$%.

is their credit rating. Figure 14 shows that IG and non-IG firms differ in terms of how their total bonds and notes outstanding change in response to the Federal Reserve balance sheet shocks. IG firms' corporate bonds react more to central bank balance shocks to the long end of yield curve, while corporate bonds of non-IG firms seems to react more to shocks to the short end of the yield curve. This evidence likely reflects the compositional differences in terms of maturity of corporate bonds, as non-IG firms are less likely to be able to borrow by issuing longer-term bonds than IG firms.

Figure 14: The effect of central bank balance sheet policies on total bonds and notes outstanding of US IG and non-IG firms



(a) The effect of shock m on total bonds outstanding of IG firms



(b) The effect of shock m on total bonds outstanding of non-IG firms

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for total bonds and notes outstanding over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for investment-grade (IG) firms are reported in Figure 14a and the estimates for non-investment-grade (non-IG) firms are in Figure 14b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the total bonds and notes outstanding changes by $\hat{\beta}_{m,h}$%.

Similar to the results above, we do not find a statistically significant increase in total debt, which includes term loans in addition to bonds and notes, for either type of firm as we show in Figure B.13 in the Appendix. Taken together with the results in Section 4, these results are consistent with the notion that balance sheet policies primarily affect firms' debt maturity structure and debt instrument choice rather than increasing their total debt.

Importantly, we find that the impact of balance sheet policies on the interest expenses and current assets of IG and non-IG firms is similar. The results shown in Figure B.17 and Figure B.18 in the Appendix show that both types of firms are able to save interest costs from adjusting their debt maturity structure in response to central bank balance sheet policies and use these savings and build cash buffers.

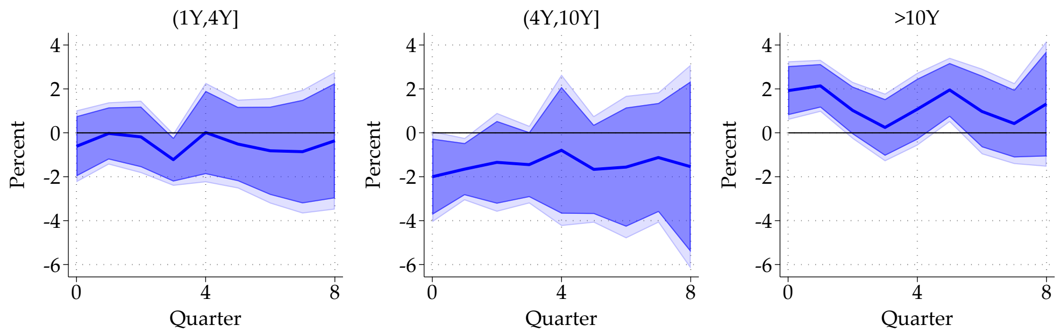
While physical capital of both IG and non-IG firms does not change materially following surprises purchases of Treasuries by the Federal Reserve, a more pronounced pattern emerges for R&D spending. Figure B.19 shows that physical capital of IG and non-IG firms remains flat, with the exception of IG firms' physical capital response during the first quarter following a shock to the maturity bin greater than 10 years. Figure 15 shows that R&D spending of IG firms does respond positively to central bank purchases of Treasuries with time-to-maturity greater than 10 years. This result is consistent with firms increasing the duration of their assets together with the duration of their liabilities as shown in Section 4.2.

5.3 Robustness checks

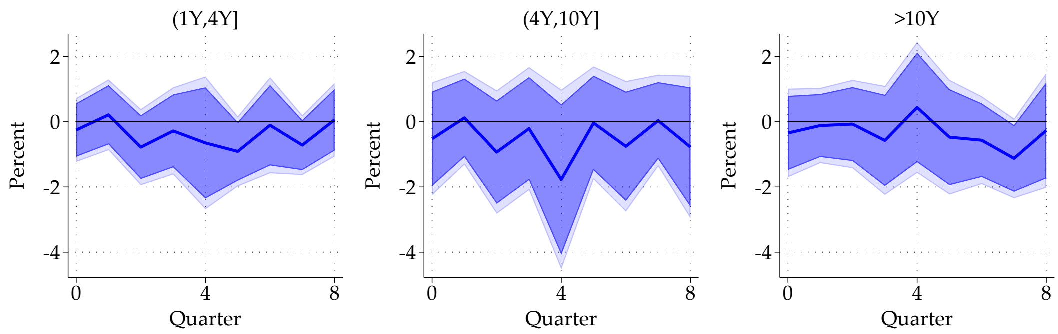
As in Section 4.6, we test whether adding the Swanson (2021) shocks as additional regressors to Equation (7) changes our results. Figure B.20 shows that including additional shocks does not change our baseline estimates of the impact of the central bank balance sheet shocks on firms' total bonds and notes outstanding. Note that the period of analysis is shorter when including Swanson (2021) shocks in the regression, as these shocks end in 2019Q3, compared to our shock measures that run until 2024Q2. This difference explains why we get a positive significant estimate for total bonds and notes in the one-to-year and the greater than ten years maturity bins in Figure B.20 compared to mostly insignificant results in Figure 11a.[23]

[23]The estimates for the rest of variables do not differ much for the case when we control of Swanson (2021) shocks compared to estimates without such shocks used as controls.

Figure 15: The effect of central bank balance sheet policies on the R&D expenses of US IG and non-IG firms



(a) The effect of shock m on R&D expenses of IG firms



(b) The effect of shock m on R&D expenses of non-IG firms

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for firms' research and development (R&D) expenses over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. Capital is defined as net property, plant and equipment. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for investment-grade (IG) firms are reported in Figure 15a and the estimates for non-investment-grade (non-IG) firms are in Figure 15b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, firm's R&D expenses change by $\hat{\beta}_{m,h}$%.

6 Conclusion

This paper investigates how the Federal Reserve's balance sheet policies involving US Treasuries affect firms' financing decisions and real outcomes. We construct novel maturity-specific balance sheet policy shocks that capture unanticipated changes in the Federal Reserve's Treasury holdings leveraging policy implementation details. This allows us to overcome several limitations faced in the literature and directly estimate the aggregate impact of balance sheet policies targeting different maturities over time covering multiple QE and QT programs.

Our findings can be summarized as follows. On average, the main channel balance sheet policies operates in the United States is by allowing firms to adjust their debt maturity structure responding to favorable financing conditions. As a result, firms save on interest expenses and build cash buffers. Beyond that, we do not find compelling evidence of an increase in total debt, investment and employment. However, there are important differences across the credit risk spectrum, especially in relation to policies targeted at different maturities. Overall, IG firms benefit more from balance sheet policies, especially in response to long-term Treasury purchases. In response to Treasury purchases at the long-end, IG firms increase R&D spending, albeit modestly. We also document positive spillovers to high-rated non-US firms with dollar-denominated debt. Finally, our results suggest that balance sheet policies in the United States mainly affect firms through bond markets rather than through bank lending.

Taken together, these findings have important policy implications. They suggest that balance sheet policies primarily influence the composition of corporate debt, but that their direct impact on firm investment and hiring decisions is limited. That said, the effects are shaped by the maturity of central bank purchases and the credit quality of firms, indicating that the design of central bank balance sheet policies – especially the maturity profile of purchases – matters for their transmission.

Our work can be extended in several dimensions. First, while we include multiple QE and QT programs in our sample, our sample is not long enough to meaningfully study any potential asymmetries between QE and QT. As more data on QT policies become available, our work can be extended to study potential asymmetries. Second, our focus is exclusively on balance sheet policies involving US Treasuries. Our work can be extended to study the impact of policies involving MBS. Finally, subject to isolating unanticipated balance sheet surprises, our work can be extended to other jurisdictions that have implemented balance sheet policies to compare transmission mechanisms.

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Appendix

A Data description and filters

A.1 Financial statements

We rely on quarterly financial statements from the S&P Global Capital IQ dataset for our analysis on how firms respond to changes in central bank balance sheet policies. We extract the financial statements data, and the debt structure data, using the S&P Global Xpressfeed. We apply the following sample restrictions before using this data in our empirical analysis.

1. We drop firms with Standard Industrial Classification (SIC) codes between 6000 and 6499, and between 6600 and 6999. This filters out firms in the finance and insurance industries. We also drop firms with SIC codes greater or equal than 9000 to exclude firms that are classified as government companies. Firms that do not report a SIC code are also excluded from the sample.

2. We filter out financial statements for firms that are owned in a given quarter by other companies at the time of reporting, or have an unknown parent. We explain in section A.1.1 the procedure we employ to track firm ownership across time.

3. We exclude data for firm-quarters during which firms were under bankruptcy procedures or were in the pre-initial public offering (IPO) process. We do not observe the firm ownership structure during these two episodes and are forced to drop such data to avoid assigning firm debt to a firm involved in bankruptcy or IPO for which the parent company also reports the same debt, effectively double counting debt instruments.

4. We remove firm-quarters in which firms report negative equity, liabilities or assets.

A.1.1 Tracking firms' ultimate parent across time

We only include independent firms in our regression analyses to ensure that we do not double count debt positions or firm outcomes by including data for both subsidiaries that report unconsolidated statements and ultimate parents that report data on their subsidiaries in their consolidated financial statements. Focusing on independent firms also ensures that we avoid omitted variable biases characteristic for regressions using samples that include subsidiaries of larger companies. In such instances, regression results will be biased if one doesn't control for parent-level outcomes when data for a subsidiary is included in the sample.

The Capital IQ data provides a static ultimate parent company identifier for each firm (i.e., an parent identifier "as of date" of the data extraction). We construct the ultimate parent history of a firm over time using data on spin-offs, mergers and acquisitions (M&A), and IPOs obtained from the S&P Capital IQ Pro transactions screener and data on bankruptcies from the S&P Capital IQ Pro key developments screener. The M&A and IPO data is available for other countries besides the US, while the bankruptcy data covers US firms mostly, with a few exceptions for firms in other countries. For each event type (M&A, IPO, spin-off or bankruptcy), we obtain the dates when the event was completed. Among the 127,807 firms covered in the Capital IQ data on financial statements, 31,563 firms have M&A events or spin-off events, 758 firms have bankruptcy records, and 23,937 firms have IPO events. We track the ultimate parent history for all firms, finding that 23,937 were not independent for at least some periods or throughout their entire history.

We construct the ultimate parent history for firms in our data as explained below. We start with the raw (unfiltered) Capital IQ data.

1. **Adjustment for firms with spin-off events only.** For firms with spin-off events only, we assign them as independent after the spin-off event is completed. We also assign the firm's parent to *unknown* before the spin-off event if it is reported

as its own ultimate parent before the spin-off event in the Capital IQ data. Recall that the ultimate parent variable is static and, hence, can misrepresent the parent before spin-offs. For example, Altice USA, Inc (company id 25933) became independent in 2018Q2, we track it as independent since 2018Q2, and set the ultimate parent to unknown before 2018Q2.

2. **Adjustment for firms with M&A events.** For firms that undergo an M&A event, we consider these firms to be independent before the first M&A event, then assign the M&A buyers as parent company after each M&A event. If a spin-off event occurs between M&A events, we assign the firm as independent until its next M&A event. If the spin-off event occurs before any M&A event, as described in step 1, we assign the firm's parent company as unknown before the spin-off event.

3. **Adjustment for ownership chains.** Some M&A events will have as acquirers companies that are not independent themselves. To ensure we keep track of the ultimate parent for each firm in our sample, we loop through the ownership chain of acquirers until the ultimate parent is independent.

4. **Adjustment for firms with bankruptcy**. For firms with bankruptcy events, we can observe the start date and (or) close date of the bankruptcy event. For firms with both bankruptcy start date and close date, we assign a bankruptcy tag to the between periods. If only a start date is available, we classify all subsequent quarters as bankruptcy periods. Conversely, if only a close date is provided, we designate the firm as under bankruptcy for all preceding periods. Firm-quarters classified as bankruptcy periods are excluded from our regression samples.

5. **Adjustment for firms with pre-IPO events.** For firms undergoing an IPO, we assign a pre-IPO tag to all firm-quarters prior to the IPO event. These pre-IPO observations are excluded from our regression samples.

A.2 Debt Structure

Besides data on financial statements, the Capital IQ database also contains data on firms' debt outstanding at a quarterly frequency for each debt instrument reported by firms in their financial filings. Some entries for debt instruments have duplicates in each quarter for a given firm due to multiple filings for each debt instrument in a quarter used by S&P to extract data on debt outstanding or due to records of both credit limits and outstanding balances for the same debt instrument.

We deal with duplicated observations for debt instruments as follows:

1. Firms can report the same debt in different filings (e.g., 10K forms, annual reports, or Q forms). S&P collects data from all these available sources. Firms can also correct their filings after an initial release, which would be picked up as a separate entry in the Capital IQ data. We keep only the last reported entry in a given quarter for each debt instrument.

2. Firms can report both drawn credit and the credit limit for their term loans and revolving credit. The Capital IQ data keeps track of both entries. We drop the data entries for credit limits from our debt structure sample to avoid inflating a firm's debt position.

Once the debt instruments data is cleaned of duplicates, we apply the following filters to prepare the sample for our debt-level regressions:

1. We filter out firms for which we do not observe total debt outstanding across all quarters in a given calendar year to avoid including firms in our analysis for which there is missing data on debt instruments for a given quarter of a year.

2. We drop firms for which debt increases or decreases by more than 90% between two consecutive quarters. This ensures that outliers will not drive our results for the debt-level regressions.

3. Following Colla et al. (2013) and Choi et al. (2018), we drop debt instruments for

firms which report total debt outstanding in the debt structure data (i.e., sum of debt outstanding across all debt instruments) that is 10% greater than liabilities reported in the Capital IQ balance sheet data.

4. Some of the debt instrument observations in the Capital IQ debt structure have missing maturity days (46% of the observations) or missing maturity months (37% of the observations). For cases that have a missing maturity day, we assign the value of 1 as the maturity day, i.e. the start of the month. For cases that have a missing maturity month, we assign July as the month of maturity. We make this change to avoid excluding a large number of observations. Given the large width of the maturity bins used in our analysis (e.g., 1-to-4 years), this modification does not alter our results substantially as we could assign these debt instruments by year of maturity alone which is not missing for any of our observations.

5. We drop debt instruments for which S&P reports a maturity year of 7777, which stand for debts that are recorded as “default, maturity date has passed, but it is not known when debt will be repaid" in the Capital IQ data. We also drop debt instruments for which S&P reports a maturity year of 9999, which stands for debts that are recorded as having “no maturity date available in document".

6. After cleaning the date variables in the previous step, we compute a time to maturity in number of days and drop debt instruments that have a negative time to maturity.

7. We keep only debt instruments that are categorized by S&P as "Bond and Notes" or "Term Loan". While the debt structure data includes also information on other instruments such as credit lines and capital leases, we found that these instruments are typically missing a maturity date. Excluding them from our analysis allows us to minimize measurement error. Moreover, judging by the relatively lower amounts outstanding of these instruments compared to bond and notes

and term loans, these debt instruments represent a small fraction of debt outstanding for most firms in our sample.

8. We also drop debt instruments that have a missing repayment currency.

For regressions that are based on the debt structure data for non-US firms, we use an additional filter based on data from the Institute for International Finance (IIF) to ensure the representativity of our results as debt reported in the Capital IQ data may represent a small share of overall debt in a non-US jurisdiction. We provide details on the IIF data in section A.4 below. The filter we apply based on this dataset is as follows. For each country in our sample of debt structure data, we compute the total amount of debt by firms reporting debts in a given year in the Capital IQ data subject to the same filters we described above (e.g., filtering out financial firms). We then divide the total amount of Capital IQ reported debts per country-year by the overall amount of corporate debt reported in the IIF data to construct a coverage share of Capital IQ debt in IIF debt for each year, as well as an average coverage share for each country across years. We drop countries from our sample where the coverage share is above one in any given year (i.e., Hong Kong, India, South Korea, Mexico, Malaysia, New Zealand, Thailand). Figure A.1 shows a heatmap of the yearly and average coverage ratios in our data. Most countries in our sample, have an average coverage share above 20%. As a consequence, in the regressions using data on the debt structure of non-US firms (i.e, section 4.5), we filter out firms from countries where the average share is below 20%.

A.3 Bond prices

To study the impact of our central bank balance sheet shocks on corporate and government bond prices, we use data from the S&P Global iBoxx indices dataset. This dataset has detailed information on all corporate and government bonds that enter the iBoxx indices, including information on prices and maturity that are key for our analysis. For corporate bonds, we use data on all the constituents of the investment grade and high yield indices.

The raw data has a daily frequency. We focus only on prices in the last day of a given quarter to ensure that we can match these prices to our quarterly shock series. When merging the bond price data and our shocks data, we restrict the sample to the period 2010Q1-2024Q2. For high-yield bonds, our price data starts in 2013Q1. We drop bonds for which prices decline or increase by more than 90% between two consecutive quarters. We homogenize the country names to ensure that differences in name formats do not create duplicate countries in our final dataset. We drop the bonds for which the issuer country is listed under the "MULT" category. We construct time to maturity bins using the date of maturity for each bond and the date at which we observe the bond price. We filter out observations for which the year of maturity is missing. We use only data for USD denominated bonds and deflate bond bid prices using the US CPI index.

A.4 Other data

CPI. We deflate all level variables used in our regression using the Consumer Price Index for the US. We retrieve the Consumer Price Index for All Urban Consumers: All Items in US City Average [CPIAUCSL] from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CPIAUCSL.

Institute of International Finance (IIF) data. We use data from the IIF to check the representativeness of our corporate debt data from S&P Capital IQ. The IIF Global Debt Monitor database tracks indebtedness by sector across a number of advanced economies and emerging markets at quarterly frequency combining national and international data sources (e.g. BIS). We use data from a total of 49 countries to compare with the S&P Capital IQ dataset. More information can be found at https://www.iif.com/Key-Topics/Debt/Monitors

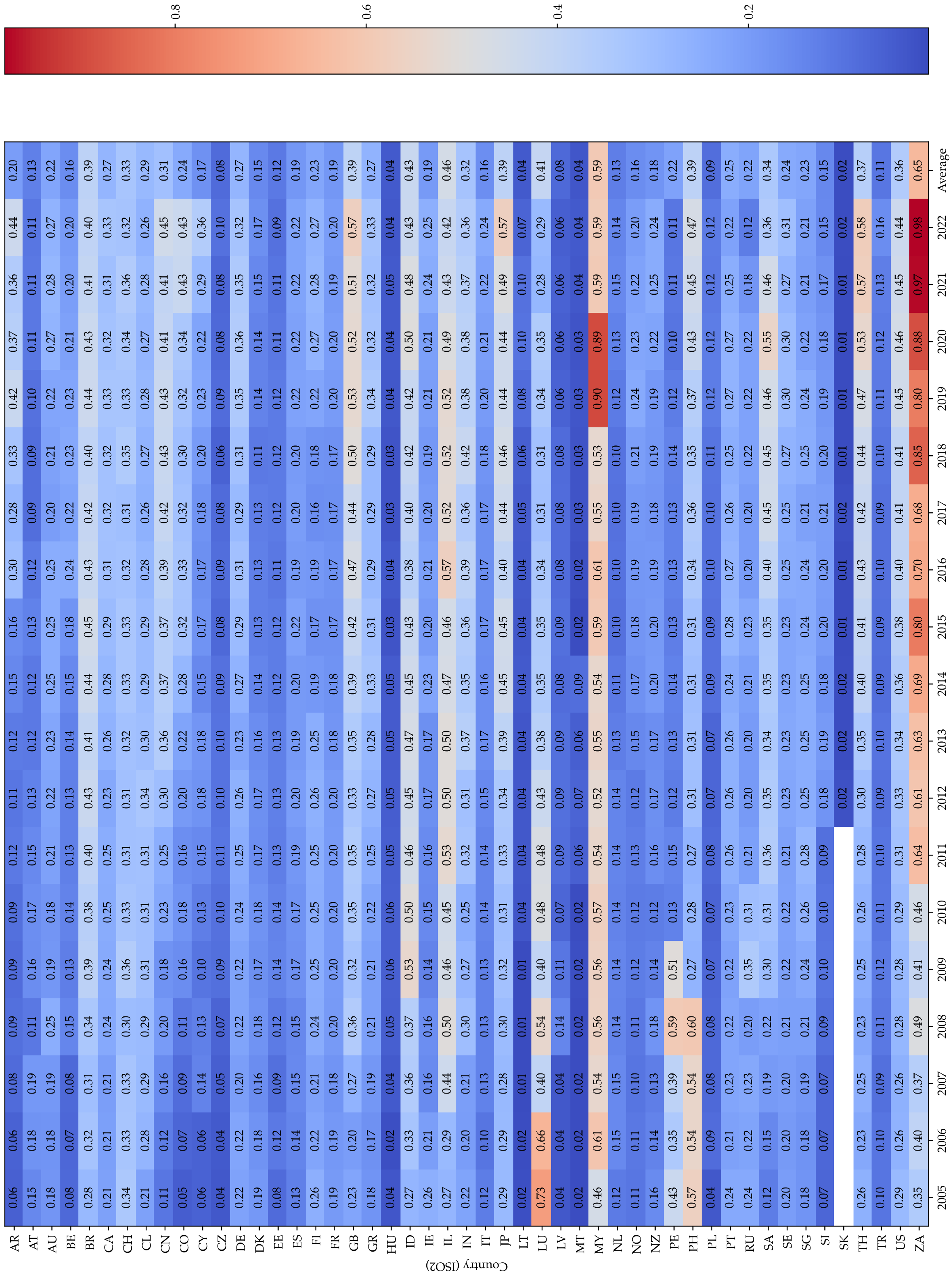
Credit rating data. The S&P Global Ratings Credit Ratings dataset provides comprehensive, issuer-level credit rating information. We use this dataset to categorize firms in our sample as investment-grade (IG) firms and non-investment-grade (non-IG) firms. Starting from daily credit rating data, we retain only the most recent rating in each firm-quarter. We then clean the data by consolidating firms using ultimate parent identifiers, retaining only entities that are their own parents. For duplicate firm-quarter observations, which account for less than 1% of the sample, we keep the lowest rating. We remove non-standard and preliminary ratings, and classify firms as investment-grade (BBB- and above), high-yield (BB+ and below), or unrated. This yields a consistent, unique credit rating per firm-quarter for analysis.

Headcount data. We rely on the S&P Headcount Analytics dataset to get a timely and representative estimate of the firms' number of employees. We use the S&P Capital IQ Pro companies screener to compile the headcount data. To be able to download the data in bulk from the screener, we had to restrict our sample to firms that reported a headcount value greater than 100 in December 2023.

A.5 Definitions of variables used in firm-level regressions

Table A.1 summarizes the definitions of variables used in our firm-level analysis in section 5.

Figure A.1: Coverage share of Capital IQ debt in IIF debt



Note: This figure show a heatmap of the coverage share of the debt structure data available for each individual country in the Capital IQ data compared to the corporate debt data from the IIF.

Table A.1: Firm balance sheet variables

Variables	Data Item ID	Description
Total assets	id1007	All assets owned by the firm.
Total debt	id4173	Total debt outstanding.
Total bonds and notes	–	Total bonds and notes outstanding amount. Computed based on data from Capital IQ capital structure dataset.
Total term loans	–	Total term loan outstanding amount. Computed based on the Capital IQ capital structure dataset.
Net PPE	id1004	The book value of a company's tangible assets (including land, buildings, machinery) after accounting for accumulated depreciation.
Number of employees	id4371	Total number of employees including full-time and part-time employees. Each part-time employee counts as half.
Headcount	–	Total headcount of employees. Extracted via the Capital IQ companies screener.
Interest expense	id82	Total interest expense.
Current assets	id1008	Sum of all a company's assets that are expected to be converted into cash, sold, or used up within one year or the normal operating cycle.
Dividends	id2022 + id2041	Sum of common & preferred stock dividends paid (id2022) and special dividends paid (id2041) . Missing values are set to zero.
Share repurchases	id2164 + id2172	Cash used for the repurchase of common stock (id2164) and preferred stock (id2172). Missing values are set to zero.
R&D expense	id100	Research and development expense. Missing values are set to zero.
Selling, General & Admin Expenses	id102	Operating costs not directly related to production—selling expenses, general business operations, and administrative functions.

Note: This table shows the financial variables we use in the firm outcome analysis. Column "Data item ID" stands for the data item ID in the Capital IQ financial statement dataset. We get the outstanding amount of bonds and notes, and term loans from Capital IQ capital structure dataset. We extracted the firm headcount information from Capital IQ screener and merged it and the total outstanding debt amounts by type with the Capital IQ financial statement data.

B Additional Figures and Tables

Figure B.1: Example of a question on the pace of Federal Reserve purchases from the Survey of Primary Dealers, December 2013

6) In the October FOMC statement, the Committee announced it will continue purchasing additional agency mortgage-backed securities at a pace of $40 billion per month and longer-term Treasury securities at a pace of $45 billion per month, and also stated that decisions about the pace, "will remain contingent on the Committee's economic outlook as well as its assessment of the likely efficacy and costs of such purchases."

a) Provide your estimate for the most likely monthly pace of purchases that will be in effect after each of the below FOMC meetings.

			Monthly Pace of Longer-Term Security Purchases ($ billions)	
			Treasuries	Agency MBS
2013	December 17-18:	25th Pctl	45	40
		Median	45	40
		75th Pctl	45	40
2014	January 28-29:	25th Pctl	35	35
		Median	45	40
		75th Pctl	45	40
	March 18-19:	25th Pctl	30	30
		Median	35	35
		75th Pctl	35	35
	April 29-30:	25th Pctl	25	25
		Median	30	30
		75th Pctl	35	35
	June 17-18:	25th Pctl	15	15
		Median	20	20
		75th Pctl	25	25
	July 29-30:	25th Pctl	10	5
		Median	15	15
		75th Pctl	20	20
	September 16-17:	25th Pctl	0	0
		Median	0	0
		75th Pctl	10	15
	October 28-29:	25th Pctl	0	0
		Median	0	0
		75th Pctl	5	10
	December 16-17: (1 year ahead)	25th Pctl	0	0
		Median	0	0
		75th Pctl	0	0

Please explain any changes to your assumptions behind the increments of pace reduction and any changes in the expected composition of Treasury and agency MBS purchases since the last survey on October 22.

(20 responses)

Some dealers made no change to their expectations for the most likely pace of purchases; however, several of these dealers noted they changed the distribution of probabilities they assigned to the timing of the first reduction in purchase pace. Several other dealers did move forward their expectation for the timing of the first cut in pace. Several dealers expected that the FOMC would reduce the pace of Treasury purchases more rapidly than MBS purchases.

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Note: During the December 2013 FOMC meeting, the Federal Reserve announced that it plans to "...reduce the pace of treasury purchases from 45 billion to 40 billion per month since January 2014...". The announcement was a shock to the primary dealers as they expected tapering to start in March 2014, per table above.

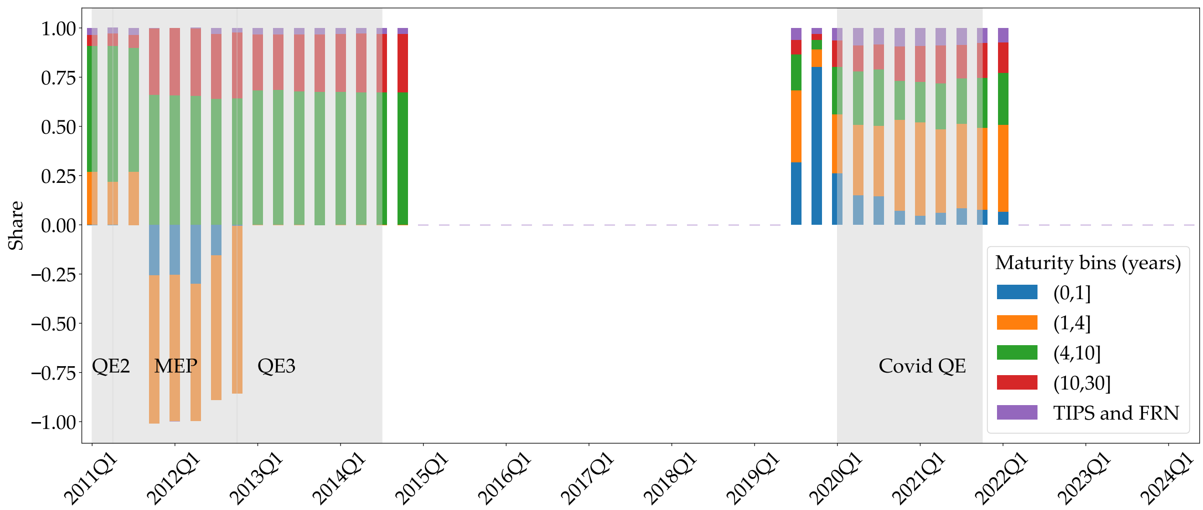
Figure B.2: Example of the maturity breakdown of the Federal Reserve's purchases of US Treasuries

Nominal Coupon Securities by Maturity Range*					
4 – 4¾ Years	4¾ – 5¾ Years	5¾ – 7 Years	7 – 10 Years	10 – 20 Years	20 – 30 Years
11%	12%	16%	29%	2%	27%

**The on-the-run 7-year note will be considered part of the 5¾- to 7-year sector, and the on-the-run 10-year note will be considered part of the 7- to 10-year sector.*

Note: This figure shows the maturity breakdown for securities set for purchase by the Federal Reserveon December 12, 2012. Retrieved on April 24, 2025, from `https://www.newyorkfed.org/markets/opolicy/operating_policy_121212.html`.

Figure B.3: Quarterly active purchase shares by maturity bin



Note: This figure shows the shares of active purchases by maturity and TIPS & FRN in total purchases by the Federal Reserve in a given quarter.

Figure B.4: Sample of a TBAC Recommended Financing Table

US TREASURY FINANCING SCHEDULE FOR 2nd QUARTER 2015
BILLIONS OF DOLLARS

ISSUE	ANNOUNCEMENT DATE	AUCTION DATE	SETTLEMENT DATE	OFFERED AMOUNT 4-WK	3-MO	6-MO	12-MO	MATURING AMOUNT	NEW MONEY
4-WEEK AND	3/26	3/30	4/1	*35.00*	*26.00*	*24.00*	*25.00*	*88.00*	*22.00*
3&6&12 MO BILLS	4/2	4/6	4/8	*30.00*	*26.00*	*24.00*		*111.00*	*-31.00*
	4/9	4/13	4/15	*30.00*	*24.00*	*24.00*		*91.00*	*-13.00*
	4/16	4/20	4/22	*25.00*	*23.00*	*24.00*		*94.00*	*-22.00*
	4/23	4/27	4/29	*25.00*	*22.00*	*24.00*	*25.00*	*114.00*	*-18.00*
	4/30	5/4	5/6	*25.00*	*22.00*	*24.00*		*86.00*	*-15.00*
	5/7	5/11	5/13	*30.00*	*22.00*	*24.00*		*85.00*	*-9.00*
	5/14	5/18	5/20	*30.00*	*22.00*	*24.00*		*81.00*	*-5.00*
	5/21	5/25	5/27	*30.00*	*22.00*	*24.00*	*25.00*	*107.00*	*-6.00*
	5/28	6/1	6/3	*25.00*	*22.00*	*24.00*		*80.00*	*-9.00*
	6/4	6/8	6/10	*25.00*	*22.00*	*24.00*		*85.00*	*-14.00*
	6/11	6/15	6/17	*25.00*	*22.00*	*24.00*		*84.00*	*-13.00*
	6/18	6/22	6/24	*25.00*	*22.00*	*24.00*	*25.00*	*107.00*	*-11.00*
					1069.00			*1213.00*	*-144.00*
CASH MANAGEMENT BILLS									
							CMB Funds:		*0.00*

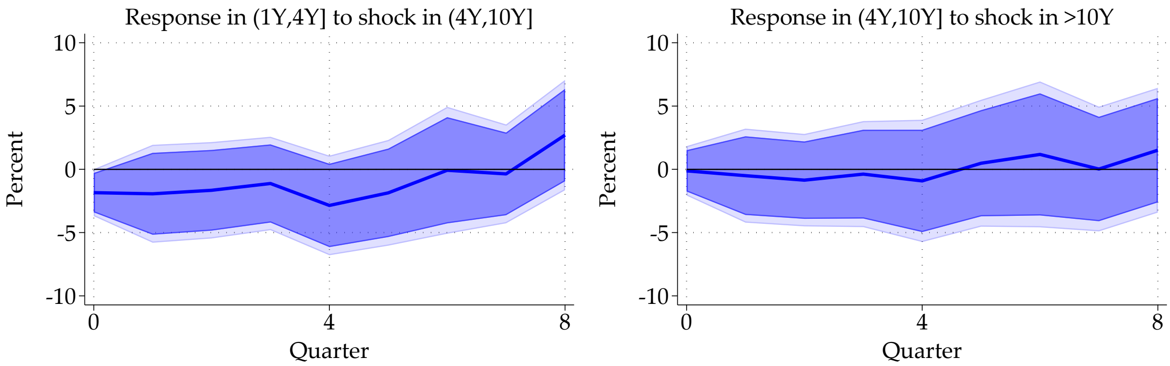
COUPONS				OFFERED AMOUNT	CHANGE	MATURING AMOUNT	NEW MONEY
3-year Note	*4/2*	*4/7*	*4/15*	*24.00*	*0.00*		
10-year Note ®	*4/2*	*4/8*	*4/15*	*21.00*	*0.00*		
30-year Bond ®	*4/2*	*4/9*	*4/15*	*13.00*	*0.00*	*61.09*	*-3.09*
5-year TIPS	*4/16*	*4/23*	*4/30*	*18.00*	*0.00*		
2-year note	*4/23*	*4/27*	*4/30*	*26.00*	*0.00*		
5-year note	*4/23*	*4/28*	*4/30*	*35.00*	*0.00*		
7-year note	*4/23*	*4/29*	*4/30*	*29.00*	*0.00*		
2-year FRN	*4/23*	*4/29*	*4/30*	*15.00*	*0.00*	*77.89*	*45.11*
3-year Note	*5/6*	*5/12*	*5/15*	*24.00*	*0.00*		
10-year Note	*5/6*	*5/13*	*5/15*	*24.00*	*0.00*		
30-year Bond	*5/6*	*5/14*	*5/15*	*16.00*	*0.00*	*68.47*	*-4.47*
10-year TIPS ®	*5/14*	*5/21*	*5/29*	*13.00*	*0.00*		
2-year FRN ®	*5/21*	*5/27*	*5/29*	*13.00*	*0.00*	*0.00*	*26.00*
2-year note	*5/21*	*5/26*	*6/1*	*26.00*	*0.00*		
5-year note	*5/21*	*5/27*	*6/1*	*35.00*	*0.00*		
7-year note	*5/21*	*5/28*	*6/1*	*29.00*	*0.00*	*75.86*	*14.14*
3-year Note	*6/4*	*6/9*	*6/15*	*24.00*	*0.00*		
10-year Note ®	*6/4*	*6/10*	*6/15*	*21.00*	*0.00*		
30-year Bond ®	*6/4*	*6/11*	*6/15*	*13.00*	*0.00*	*34.26*	*23.74*
2-year FRN ®	*6/18*	*6/24*	*6/26*	*13.00*	*0.00*	*0.00*	*13.00*
2-year note	*6/18*	*6/23*	*6/30*	*26.00*	*0.00*		
5-year note	*6/18*	*6/24*	*6/30*	*35.00*	*0.00*		
7-year note	*6/18*	*6/25*	*6/30*	*29.00*	*0.00*		
30-year TIPS ®	*6/11*	*6/18*	*6/30*	*7.00*	*0.00*	*74.13*	*22.87*
				529.00		*391.71*	*137.29*

Estimates are italicized. R = Reopening

NET CASH RAISED THIS QUARTER: -7

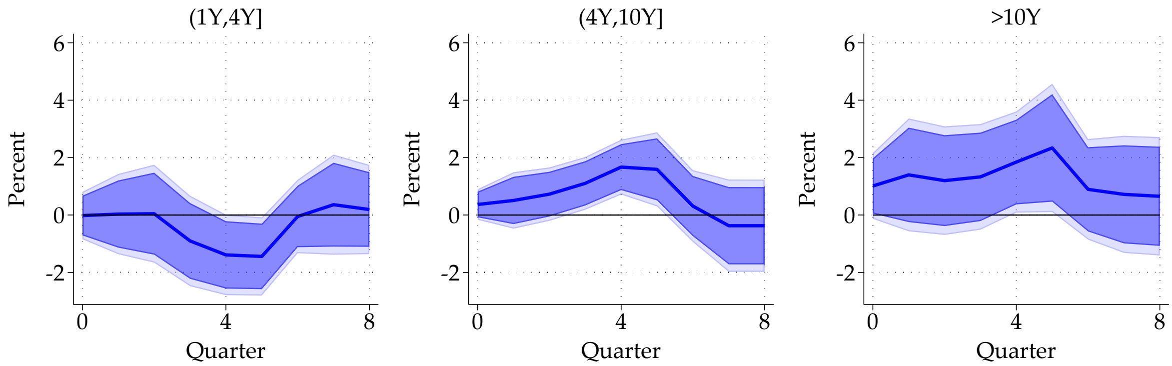
Note: This figure shows the maturity breakdown for Treasury securities to be issued as recommended by the TBAC on February 4, 2015 for the second quarter of 2015.

Figure B.5: Evidence on maturity compression of corporate bonds

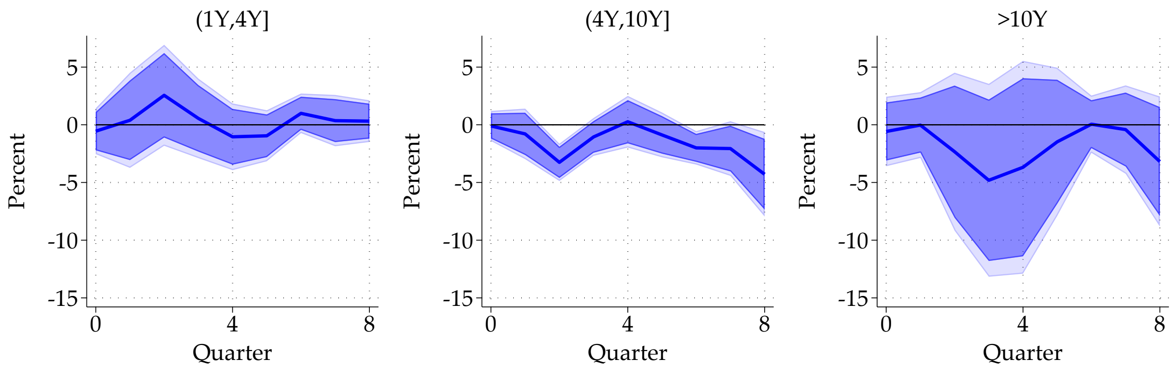


Note: The figures show estimates $\hat{\mu}_{m,h}$ obtained from a variant of the regression equation (5) over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. We modify this equation by replacing the subscript $m+1$ with $m-1$ to estimate the effect for shorter maturity corporate bonds of shocks to higher maturity Treasuries. The sample contains only US firms and debt denominated in dollars and runs between 2011Q1 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The lines correspond to our estimates $\hat{\mu}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. The first panel plots the response of firm bonds in the one-to-four years maturity bin to central bank balance sheet shocks in the four-to-ten years maturity bin. The second panel plots the response of firm bonds in the four-to-ten years maturity bin to central bank balance sheet shocks in the greater than ten years maturity bin.

Figure B.6: The effect of central bank balance sheet policies on bond prices of non-US firms



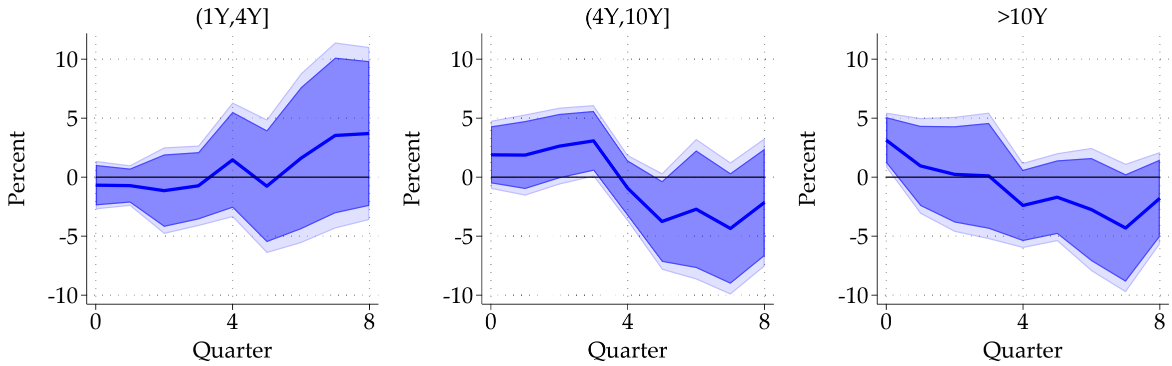
(a) The effect of shock m on IG bond prices of non-US firms at maturity bucket m



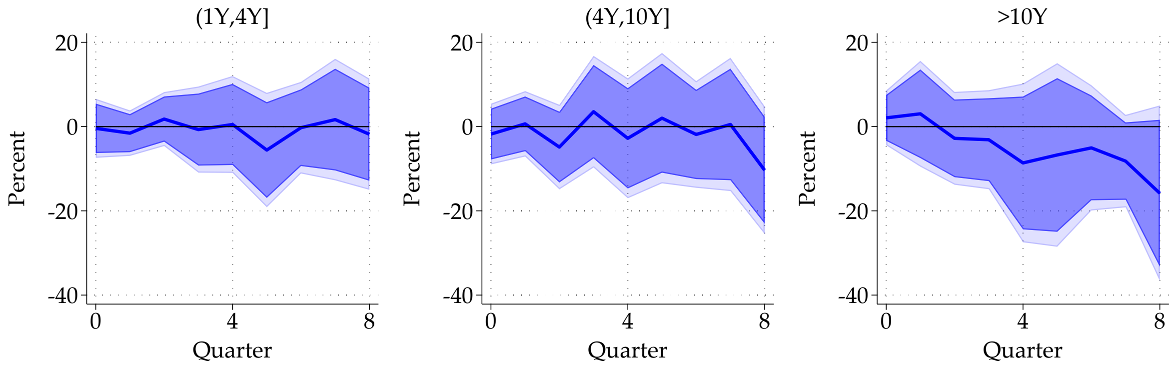
(b) The effect of shock m on HY bond prices of non-US firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (6) estimated for corporate bond prices and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The regression sample contains bonds issued in USD by non-US firms only. For investment-grade (IG) bonds, the regression sample runs between 2012Q2 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. For firms issuing high-yield (HY) bonds, the regression sample runs between 2013Q3 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for IG bond prices are reported in Figure B.6a and the estimates for HY bond prices are reported in Figure B.6b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding bond prices in the corresponding maturity bin changes by $\hat{\beta}_{m,h}$%.

Figure B.7: The effect of central bank balance sheet policies on non-US non-IG firms' debt



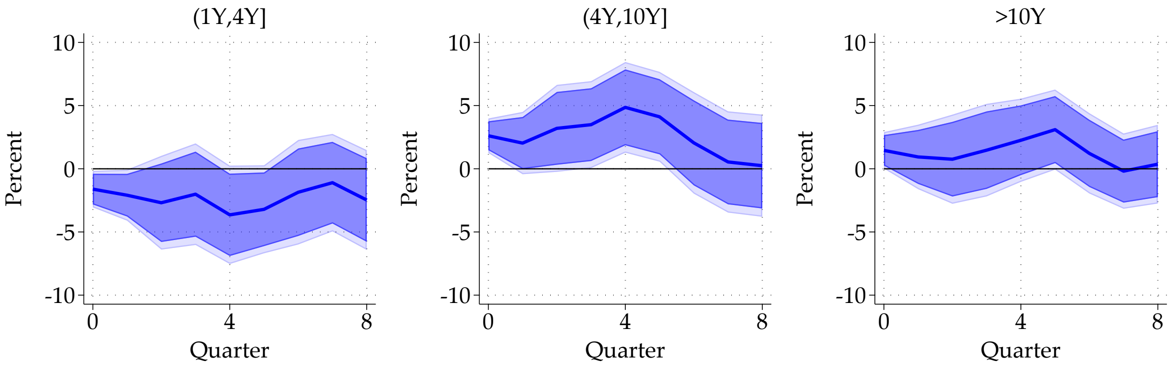
(a) The effect of shock m on bonds of non-US non-IG firms at maturity bucket m



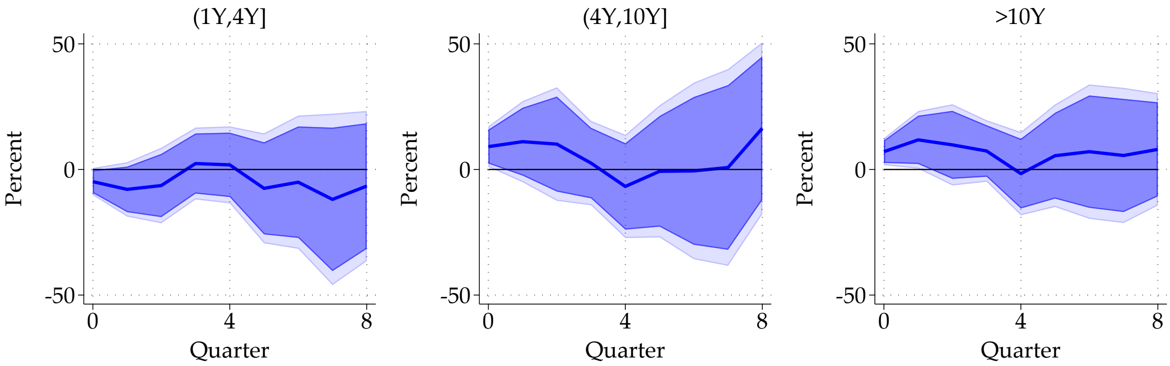
(b) The effect of shock m on term loans of non-US non-IG firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}^d_{m,h}$ obtained from the regression equation (4) estimated for each type of debt $d \in$ {Bonds, Term Loans} and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only non-US firms, which do not have an investment grade rating, and debt denominated in dollars and runs between 2011Q3 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for bonds are reported in Figure B.7a and the estimates for term loans are reported in Figure B.7b. The lines correspond to our estimates $\hat{\beta}^d_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt in the corresponding maturity bin changes by $\hat{\beta}^d_{m,h}$%.

Figure B.8: The effect of central bank balance sheet policies on US firms' debt when controlling for Swanson (2021) shocks



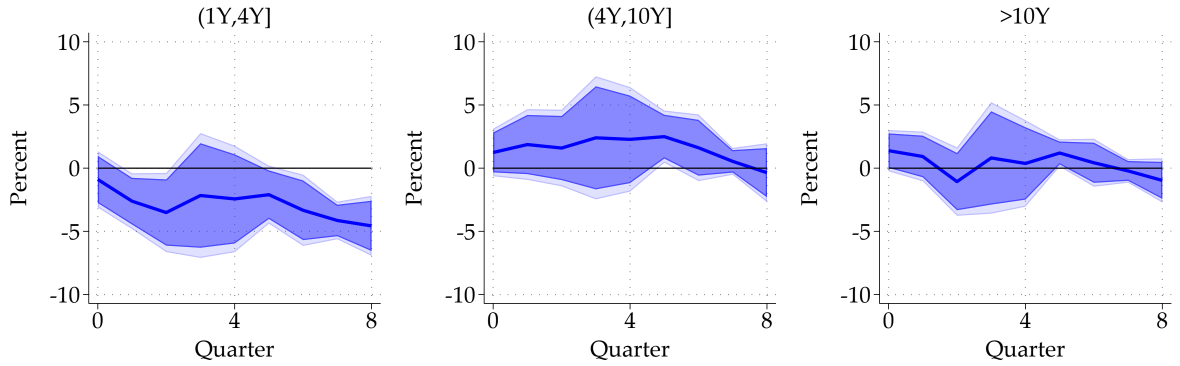
(a) The effect of shock m on bonds outstanding of US firms at maturity bucket m



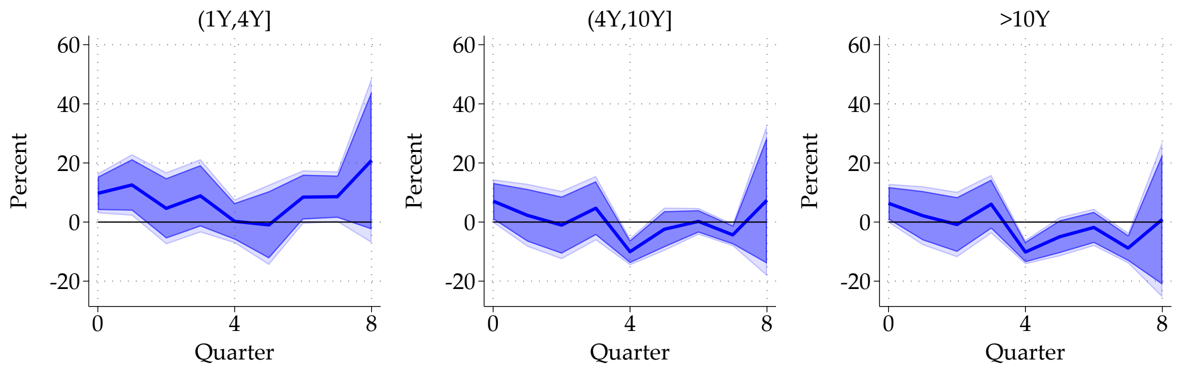
(b) The effect of shock m on term loans outstanding of US firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}^d_{m,h}$ obtained from the regression equation (4) to which we add the monetary policy shocks from Swanson (2021) as additional controls. The model is estimated for each type of debt $d \in \{\text{Bonds, Term Loans}\}$ and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms, and debt denominated in dollars and runs between 2011Q3 and 2019Q2. The estimates for bonds are reported in Figure B.8a and the estimates for term loans are reported in Figure B.8b. The lines correspond to our estimates $\hat{\beta}^d_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt in the corresponding maturity bin changes by $\hat{\beta}^d_{m,h}$%.

Figure B.9: The effect of central bank balance sheet policies on US firms' debt when including the COVID-19 crisis



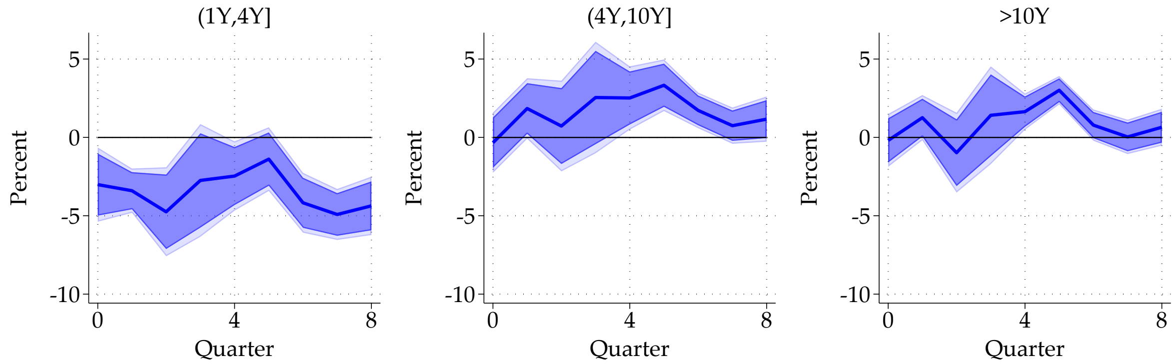
(a) The effect of shock m on bonds outstanding of US firms at maturity bucket m



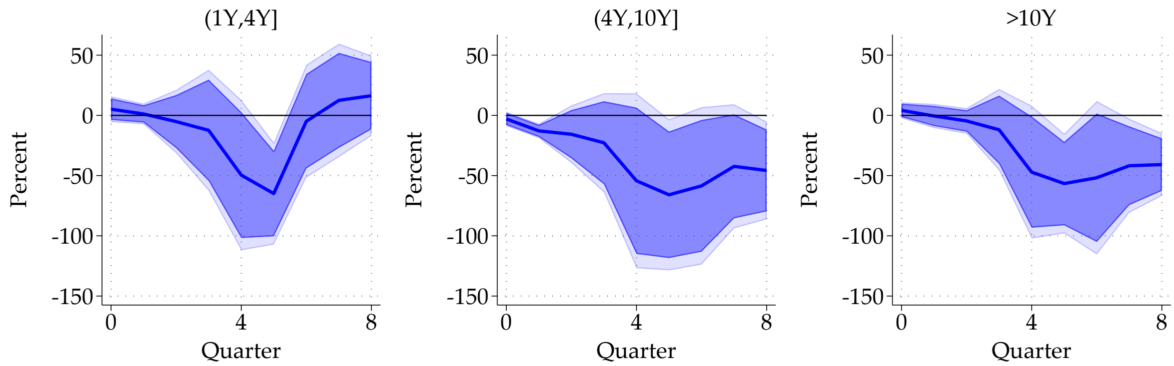
(b) The effect of shock m on term loans outstanding of US firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}^d_{m,h}$ obtained from the regression equation (4). The model is estimated for each type of debt $d \in$ {Bonds, Term Loans} and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms with debt denominated in dollars and runs between 2011Q3 and 2024Q2, including the COVID-19 crisis. The estimates for bonds are reported in Figure B.9a and the estimates for term loans are reported in Figure B.9b. The lines correspond to our estimates $\hat{\beta}^d_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt in the corresponding maturity bin changes by $\hat{\beta}^d_{m,h}$%.

Figure B.10: The effect of central bank balance sheet policies on US IG firms' debt when including the COVID-19 crisis



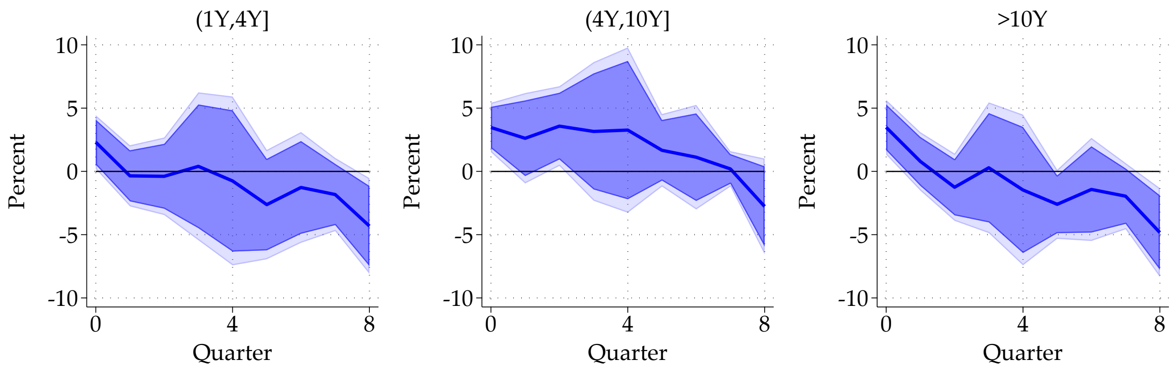
(a) The effect of shock m on bonds outstanding of US IG firms at maturity bucket m



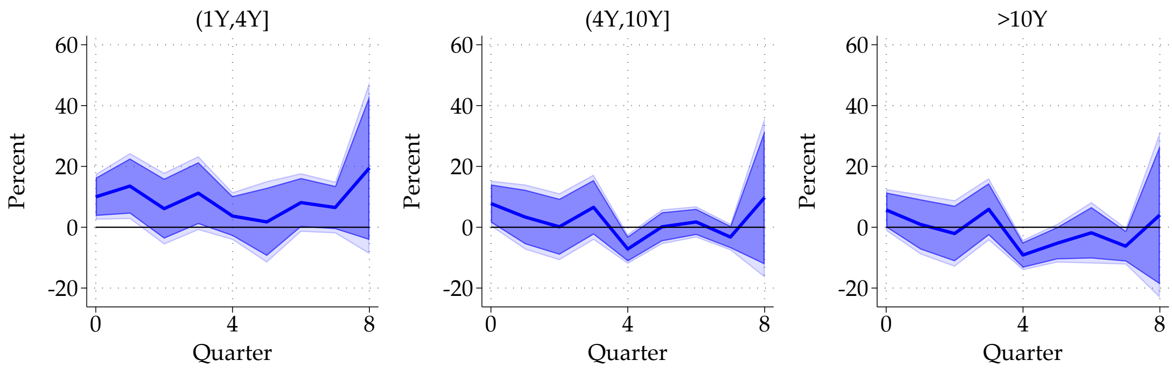
(b) The effect of shock m on term loans outstanding of US IG firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}^d_{m,h}$ obtained from the regression equation (4). The model is estimated for each type of debt $d \in \{\text{Bonds, Term Loans}\}$ and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US investment-grade (IG) firms with debt denominated in dollars and runs between 2011Q3 and 2024Q2, including the COVID-19 crisis. The estimates for bonds are reported in Figure B.10a and the estimates for term loans are reported in Figure B.10b. The lines correspond to our estimates $\hat{\beta}^d_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt in the corresponding maturity bin changes by $\hat{\beta}^d_{m,h}$%.

Figure B.11: The effect of central bank balance sheet policies on US non-IG firms' debt when including the COVID-19 crisis



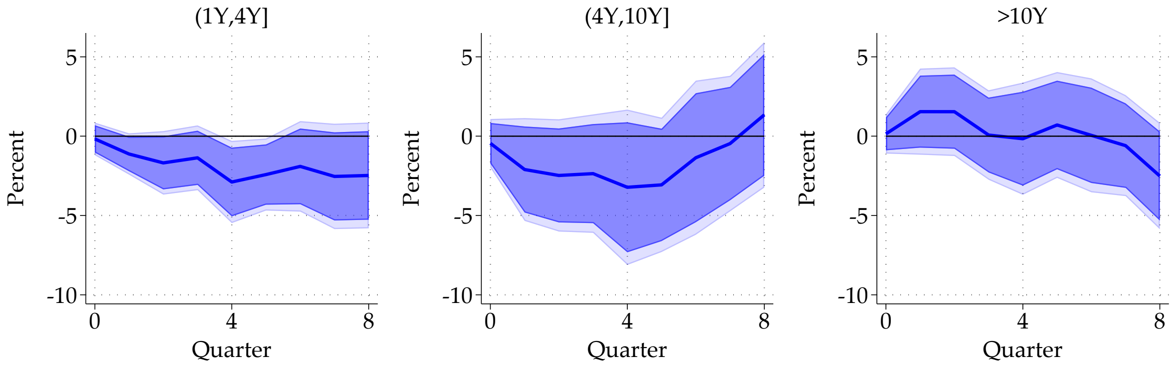
(a) The effect of shock m on bonds outstanding of US non-IG firms at maturity bucket m



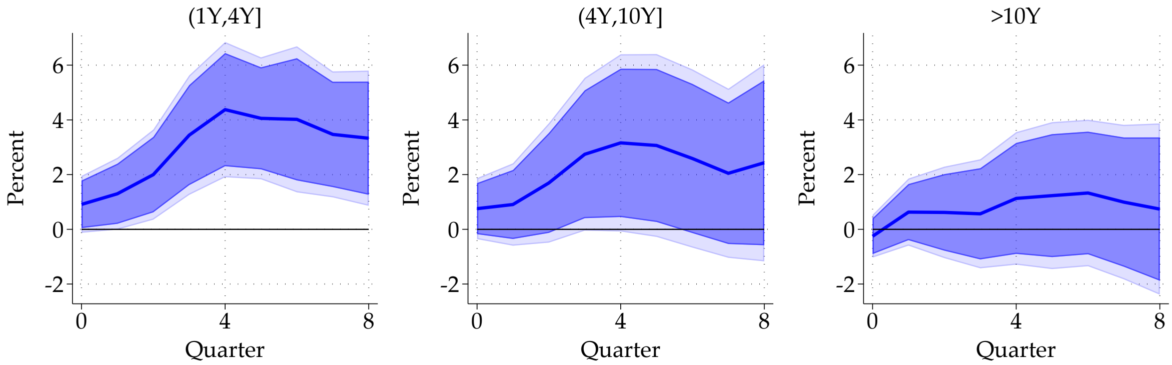
(b) The effect of shock m on term loans outstanding of non-US IG firms at maturity bucket m

Note: The figures show estimates $\hat{\beta}^{d}_{m,h}$ obtained from the regression equation (4). The model is estimated for each type of debt $d \in$ {Bonds, Term Loans} and over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US non-investment-grade (non-IG) firms with debt denominated in dollars and runs between 2011Q3 and 2024Q2, including the COVID-19 crisis. The estimates for bonds are reported in Figure B.11a and the estimates for term loans are reported in Figure B.11b. The lines correspond to our estimates $\hat{\beta}^{d}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the corresponding type of firm debt in the corresponding maturity bin changes by $\hat{\beta}^{d}_{m,h}$%.

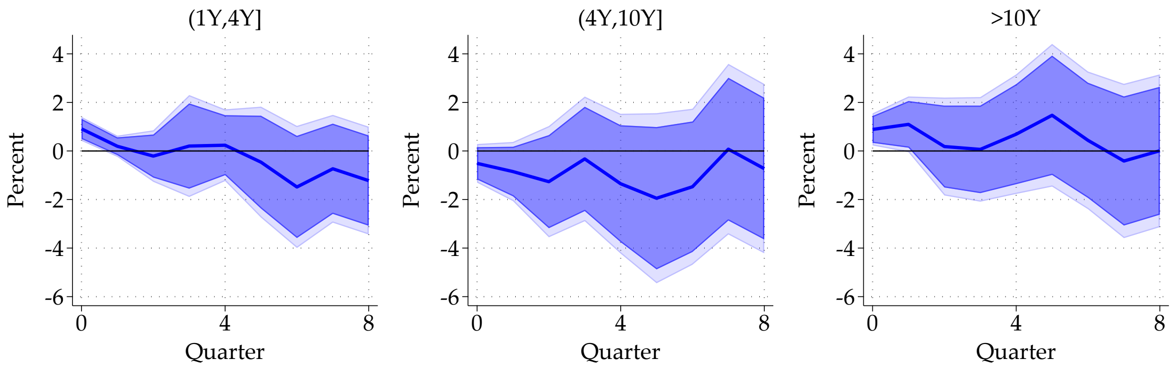
Figure B.12: The effects of central bank balance sheet shocks on US firms' outstanding bonds using an alternative specification (7)



(a) The effect of shocks at (1Y-4Y], (4Y-10Y], >10Y on bonds of US firms at maturity bin (1Y-4Y]



(b) The effect of shocks at (1Y-4Y], (4Y-10Y], >10Y on bonds of US firms at maturity bin (4Y-10Y]



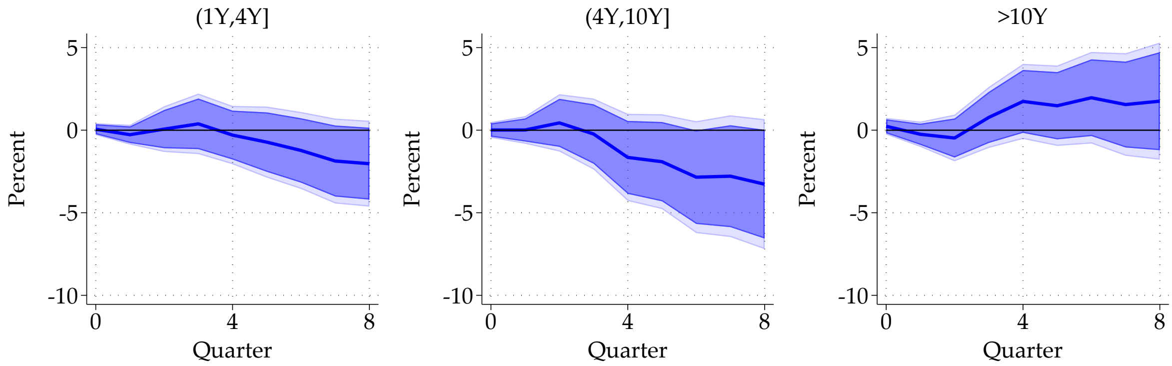
(c) The effect of shocks at (1Y-4Y], (4Y-10Y], >10Y on bonds of US firms at maturity bin >10Y

Note: The figures show estimates $\hat{\beta}_{n,m,h}$ obtained from

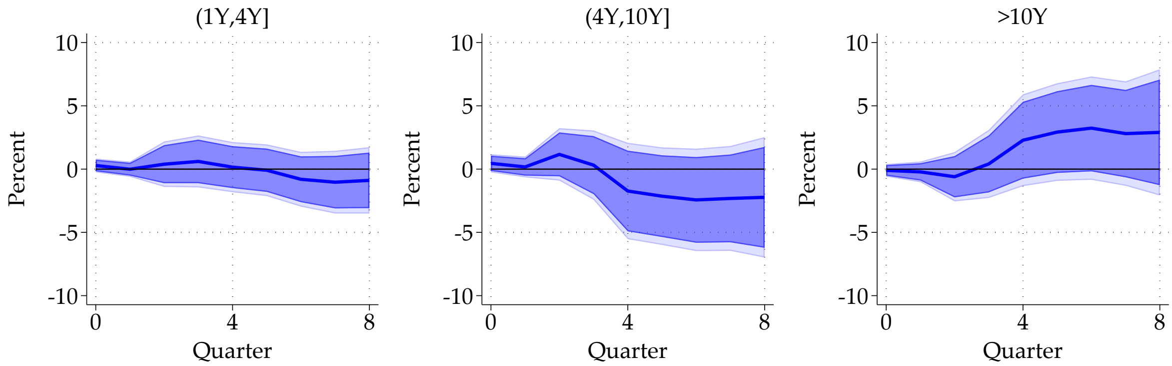
$$\Delta y_{n,i,t+h,t-1} = \sum_{m=2}^{4} \beta_{n,m,h} BSPshock_{m,t} + \sum_{j=1}^{4} \gamma_{n,j,h} \Delta y_{i,t-j,t-j-1} + \xi_{n,h} \cdot \mathit{Firm\ assets}_{i,t-6,h} + \nu_{n,h} \times \Delta \mathit{Macro\ controls}_{t,h} + \lambda_{i,h} + \varepsilon_{n,i,t,h}$$

The model estimates the responses of firms' bond outstanding at maturity bucket n to shocks in maturity bucket m over each horizon $h \in \{0, 1, 2, ..., 8\}$. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The lines correspond to our estimates $\hat{\beta}_{n,m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, bond outstanding at maturity bin n change by $\hat{\beta}_{n,m,h}$%.

Figure B.13: The effect of central bank balance sheet policies on US IG and non-IG firms' total debt outstanding



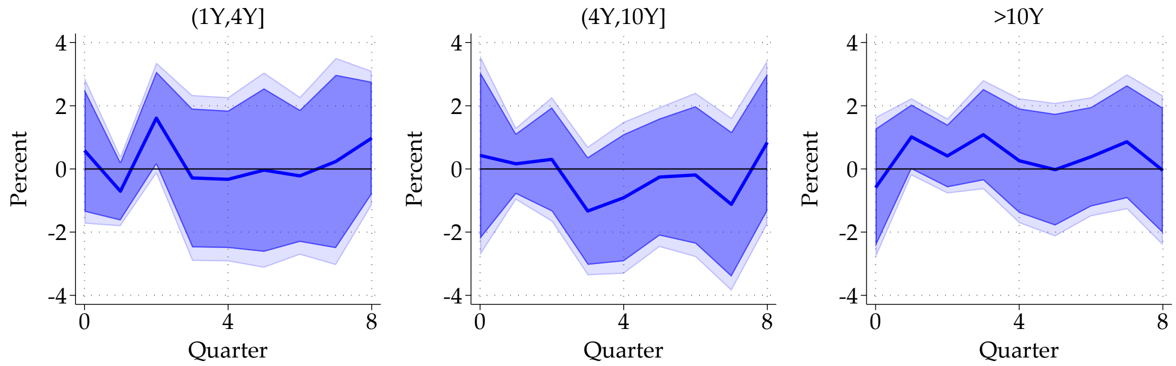
(a) The effect of shock m on total debt outstanding of IG firms



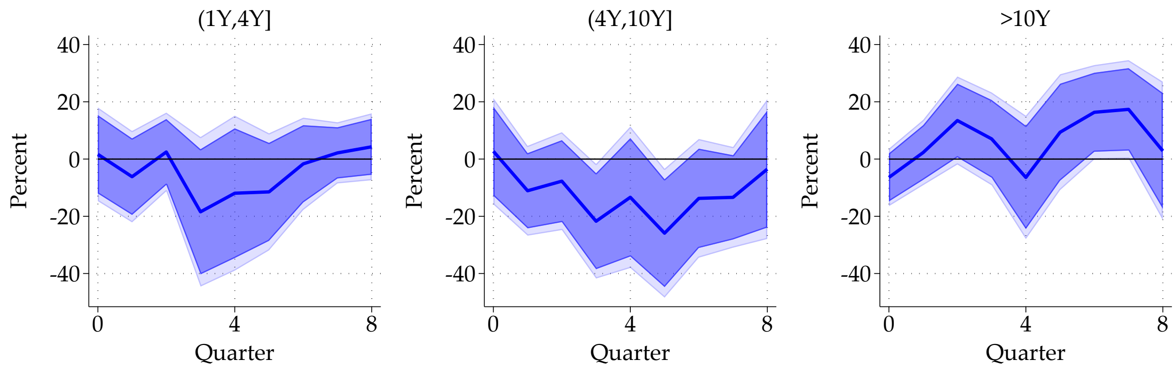
(b) The effect of shock m on total debt outstanding of non-IG firms

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for total debt outstanding over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for investment-grade (IG) firms are reported in Figure B.13a and the estimates for non-investment-grade (non-IG) firms are in Figure B.13b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, total debt outstanding changes by $\hat{\beta}_{m,h}$%.

Figure B.14: The effect of central bank balance sheet policies on US firms' dividend distributions and share repurchases



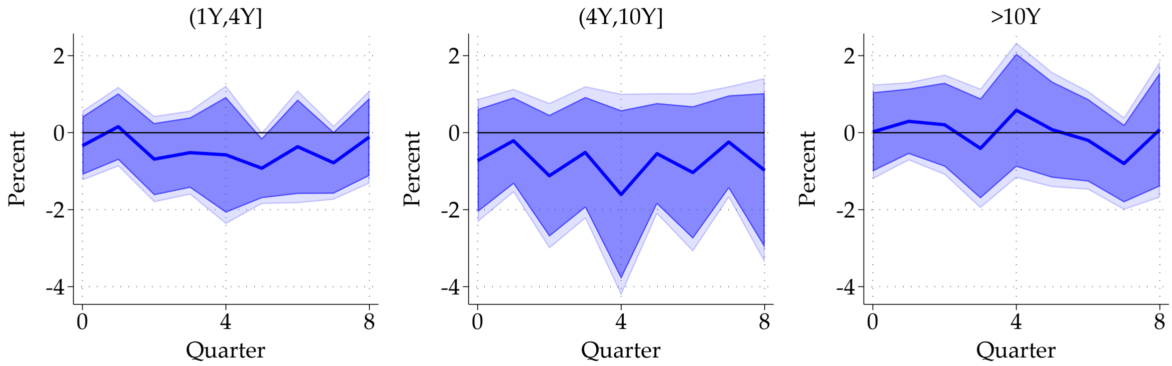
(a) The effect of shock m on dividend distributions



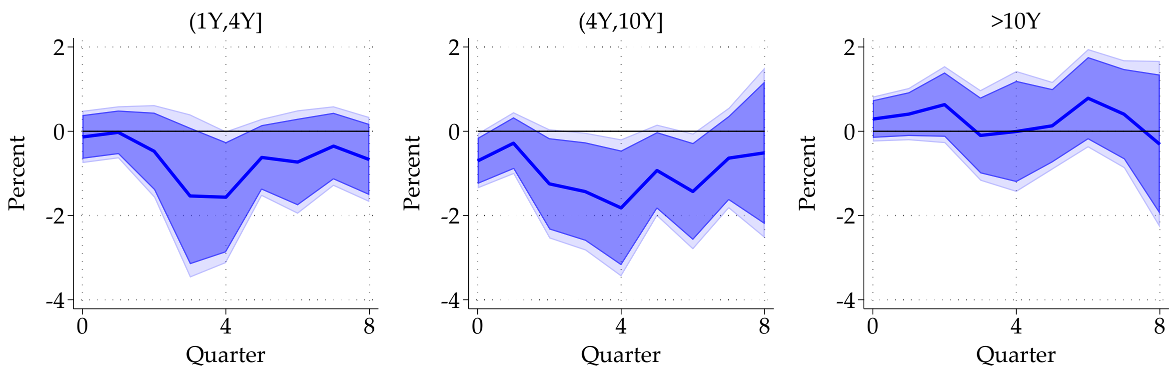
(b) The effect of shock m on share repurchases

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated with firm dividend distributions and share repurchases as dependent variables over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for dividend distributions are reported in Figure B.14a and the estimates for share repurchases are in Figure B.14b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, dividends or share repurchases change by $\hat{\beta}_{m,h}$%.

Figure B.15: The effect of central bank balance sheet policies on US firms' R&D expenses and SGA expenses



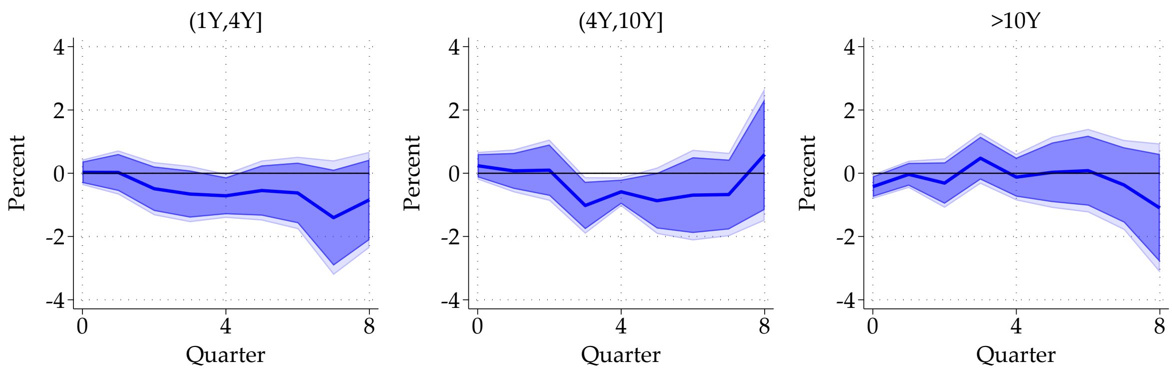
(a) The effect of shock m on R&D expenses



(b) The effect of shock m on SGA expenses

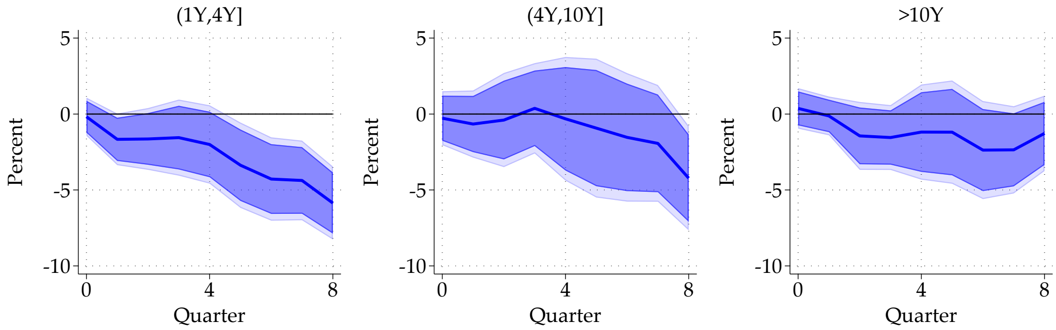
Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated with firm research and development (R&D) expenses and selling general and administrative expenses (SGA) as dependent variables over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for R&D expenses are reported in Figure B.15a and the estimates for share repurchases are in Figure B.15b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, R&D expenses or SGA expenses change by $\hat{\beta}_{m,h}$%.

Figure B.16: The effect of central bank balance sheet policies on US firms' employment

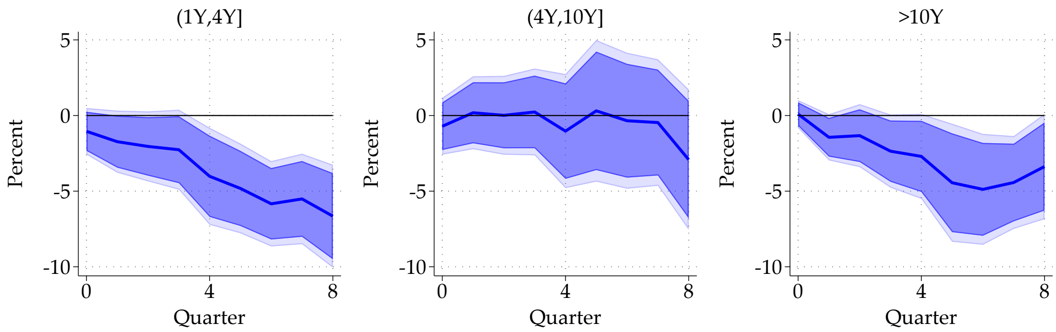


Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for firm employment over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, firm employment changes by $\hat{\beta}_{m,h}$%.

Figure B.17: The effect of central bank balance sheet policies on interest expenses of US IG and non-IG firms



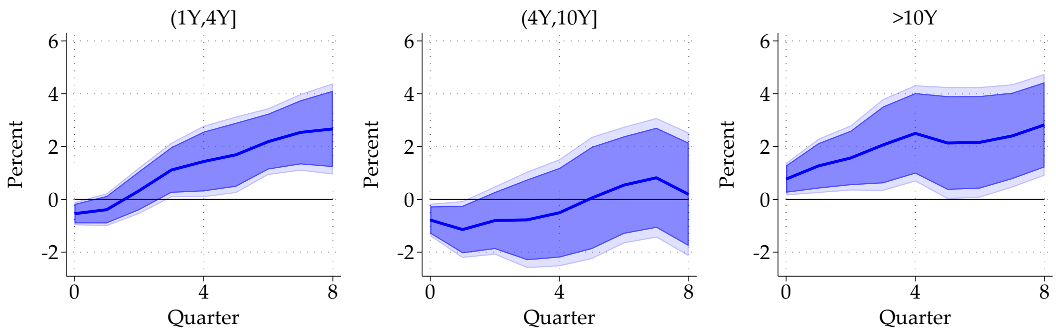
(a) The effect of shock m on interest expenses of IG firms



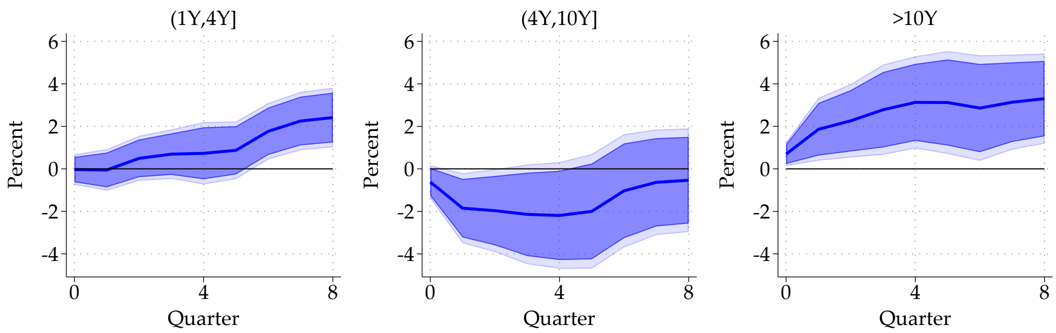
(b) The effect of shock m on interest expenses of non-IG firms

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for firm interest expenses over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for investment-grade (IG) firms are reported in Figure B.17a and the estimates for non-investment-grade (non-IG) firms are in Figure B.17b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, firm's interest expenses change by $\hat{\beta}_{m,h}$%.

Figure B.18: The effect of central bank balance sheet policies on current assets of US IG and non-IG firms



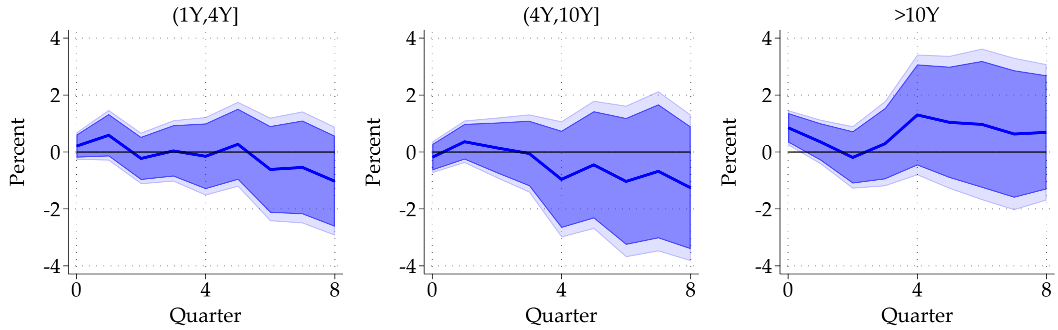
(a) The effect of shock m on interest expenses of IG firms



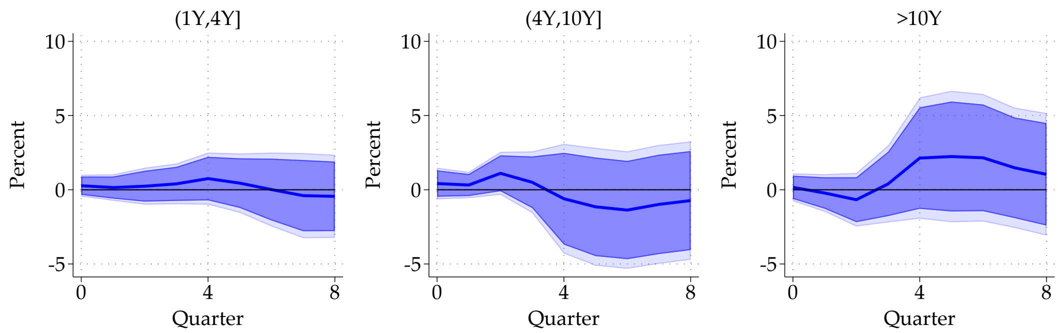
(b) The effect of shock m on current assets of non-IG firms

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for firm current assets over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for investment-grade (IG) firms are reported in Figure B.17a and the estimates for non-investment-grade (non-IG) firms are in Figure B.17b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, firm's current assets change by $\hat{\beta}_{m,h}$%.

Figure B.19: The effect of central bank balance sheet policies on the physical capital of US IG and non-IG firms



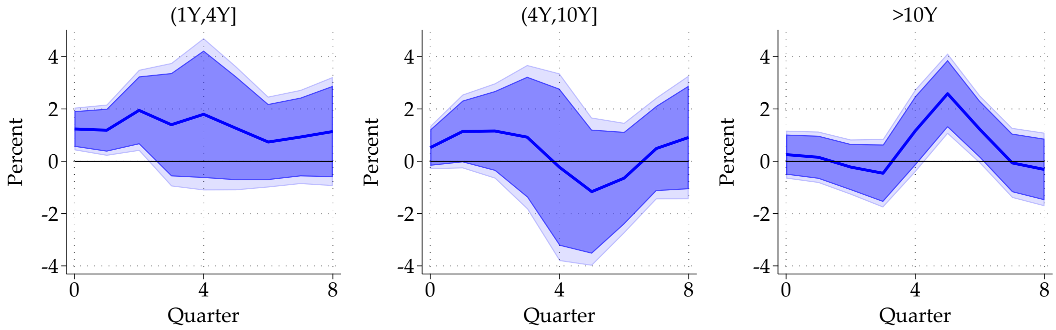
(a) The effect of shock m on physical capital of IG firms



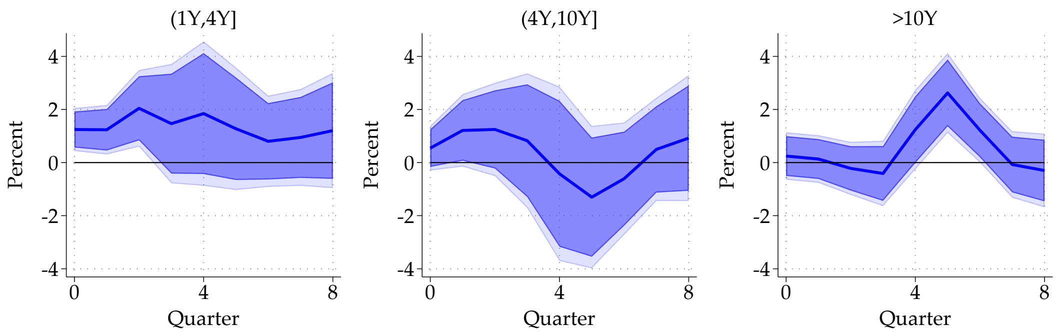
(b) The effect of shock m on physical capital of non-IG firms

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for firm capital over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. Capital is defined as net property, plant and equipment. The sample contains only US firms and runs between 2011Q4 and 2024Q2 excluding the COVID-19 crisis, i.e. 2020Q1-2020Q2. The estimates for investment-grade (IG) firms are reported in Figure B.19a and the estimates for non-investment-grade (non-IG) firms are in Figure B.19b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, firm's capital changes by $\hat{\beta}_{m,h}$%.

Figure B.20: Response of firm-level total bond and notes outstanding when controlling for Swanson (2021) shocks



(a) Without Swanson (2021) shocks



(b) With Swanson (2021) shocks

Note: The figures show estimates $\hat{\beta}_{m,h}$ obtained from the regression equation (7) estimated for total bonds and notes outstanding over each horizon $h \in \{0, 1, 2, ..., 8\}$ separately. The sample contains only US firms and runs between 2011Q3 and 2019Q2, as the Swanson (2021) end in 2019Q2. The estimates of the regression without Swanson (2021) shocks are reported in Figure B.20a and the estimates with Swanson (2021) shocks are reported in Figure B.20b. The lines correspond to our estimates $\hat{\beta}_{m,h}$ and the darker and lighter bands correspond to 90% and 95% confidence intervals, respectively, using standard errors double clustered at firm and time level. In each panel, when the central bank share in maturity bin m is shocked by one standard deviation, the total bonds and notes outstanding change by $\hat{\beta}_{m,h}$%.

Table B.1: Timeline of major events of the Federal Reserve quantitative easing and tightening programs

Region	Major Event	FOMC Date	Most Recent SPD	Announced Operation Period
QE2	QE2 start	Nov 3, 2010		Nov 2010 - Jun 2011
	QE2 completion	Jun 22, 2011	SPD Jun 2011	
MEP	MEP start	Sep 21, 2011	SPD Sep 2011	Oct 2011 - Jun 2012
	MEP extension	Jun 20, 2012	SPD Jun 2012	Jul 2012 - Dec 2012
QE3	QE3 MBS purchase start	Sep 13, 2012	SPD Sep 2012	Oct 2012 -
	QE3 UST purchase start	Dec 12, 2012	SPD Dec 2012	Jan 2013 -
	QE3 tapering	Dec 18, 2013	SPD Dec 2013	Jan 2014 -
	QE3 tapering	Jan - Jul 2014	SPD Jan - Jul 2014	Jan 2014 -
QT1	QT1 communication	Jun 14, 2017	SPD Jun 2017	
	QT1 start	Sep 12, 2017	SPD Sep 2017	Oct 2017 -
	QT1 tapering	Mar 20, 2019	SPD Mar 2019	Apr 2019 - Sep 2019
COVID QE	COVID QE start	Mar 15, 2020	SPD Mar 2020	Apr 2020 -
	COVID QE extension	Jun 15, 2020	SPD Jun 2020	Jul 2020 -
	COVID QE extension	Dec 16, 2020	SPD Dec 2020	Jan 2021 -
	COVID QE tapering	Nov 03, 2021	SPD Nov 2021	Dec 2021 -
	COVID QE tapering	Dec 15, 2021	SPD Dec 2021	Jan 2021 -
QT2	QT2 communication	Mar 16, 2022	SPD Mar 2022	
	QT2 start	May 4, 2022	SPD May 2022	Jun 2022 -
	QT2 tapering	May 1, 2024	SPD May 2024	Jun 2024 -

Note: This table presents the timeline of major events during the Federal Reserve QE and QT programs from 2010 to 2024. “FOMC Dates” stands for the dates that Federal Reserve made announcements. “Most Recent SPD" stands for the most recent wave of the SPD before each announcement from which we collect the market expectation regarding the Federal Reserve balance sheet policies. “Announced Operation Period” stands for the announced length of corresponding QE, QT or tapering episodes. Starting from 2012, the Federal Reserve tilted to open-ended programs and did not announce the ending date for each program during program announcements, except for the QT1 tapering period.

Table B.2: Summary statistics for firm-level variables of US firms

	Obs	Mean	SD	Median	P10	P90
All U.S. firms						
Total assets	117,370	5,999.91	21,292.42	750.7	21.44	12,077.91
Total debt	117,370	1,994.35	8,095.52	180.01	1.44	4,066.36
Total bonds and notes	68,125	1,978.41	5,092.34	401.63	1.14	4,959.17
Total term loans	56,442	323.15	772.53	49.13	0.40	844.54
Net PPE	116,574	2,032.09	8,776.22	125.31	1.62	3,468.81
Number of employees	36,866	13,368.11	58,399.79	1,805.50	46.00	27,200.00
Headcount	73,388	6,111.18	20,735.33	1,170.00	156.00	11,893.00
Interest expenses	104,583	20.61	63.11	2.86	0.04	47.29
Current assets	117,344	1,751.05	6,934.39	255.71	9.53	3,288.23
Dividends	117,363	32.08	170.78	0.00	0.00	44.86
Share repurchases	117,370	43.39	364.16	0.00	0.00	46.13
R&D expenses	117,370	32.95	290.71	0.00	0.00	28.15
Selling, general & admin exp.	117,370	154.73	761.17	19.89	0.76	270.68
U.S. IG firms						
Total assets	18,014	27,216.53	44,900.32	12,004.58	3,030.47	62,151.57
Total debt	18,014	8,410.73	14,800.26	3,516.50	655.35	20,217.68
Total bonds and notes	17,474	5,491.87	8,487.03	2,463.60	468.65	13,504.02
Total term loans	5,724	630.91	1,182.16	259.51	7.42	1,590.12
Net PPE	17,918	9,461.32	19,955.04	2,702.25	399.79	24,722.20
Number of employees	5,531	50,265.22	134,847.09	18,108.00	2,982.00	114,500.00
Headcount	15,891	18,457.29	38,738.66	6,040.00	683.00	48,187.00
Interest expenses	17,566	74.05	125.31	32.05	6.39	176.63
Current assets	18,014	7,602.17	14,241.77	2,975.89	606.42	17,452.10
Dividends	18,013	180.25	394.70	49.27	0.00	474.01
Share repurchases	18,014	229.58	887.66	12.01	0.00	510.41
R&D expenses	18,014	159.90	706.69	0.00	0.00	279.93
Selling, general & admin exp.	18,014	688.95	1,811.88	201.79	0.00	1,553.05
U.S. non-IG firms						
Total assets	99,356	2,153.17	8,581.81	457.56	17.32	4,573.84
Total debt	99,356	831.01	5,374.83	85.72	1.04	1,741.15
Total bonds and notes	50,651	766.31	2,074.10	210.89	0.61	1,826.87
Total term loans	50,718	288.42	703.25	36.24	0.36	778.07
Net PPE	98,656	682.78	2,616.69	69.55	1.18	1,391.08
Number of employees	31,335	6,855.33	22,817.95	1,127.00	37.00	14,600.00
Headcount	57,497	2,698.97	8,959.67	819.00	140.00	5,667.00
Interest expenses	87,017	9.82	30.40	1.44	0.03	23.71
Current assets	99,330	689.92	3,562.22	172.18	7.38	1,437.71
Dividends	99,350	5.22	38.83	0.00	0.00	9.51
Share repurchases	99,356	9.63	79.85	0.00	0.00	12.59
R&D expenses	99,356	9.93	76.41	0.00	0.00	18.76
Selling, general & admin exp.	99,356	57.87	167.66	14.89	0.89	134.64

Note: This table presents summary statistics for firm-level variables of US firms. Debt amount, net PPE, interest expenses, current assets, dividends, share repurchases, research and development (R&D) expenses, and selling, general & administrative expenses are in million USD and adjusted using US CPI index.

Table B.3: Summary statistics for firm-level variables of non-US firms

	Obs	Mean	SD	Median	P10	P90
All non-U.S. firms						
Total asset	63,281	8,867.93	28,102.09	932.6	41.22	19,370.90
Total debt	63,281	2,760.50	8,538.23	275.62	5.06	6,110.44
Total bonds and notes	25,981	1,344.55	2,851.52	385.39	6.03	3,535.31
Total term loans	38,838	253.98	852.06	30.14	0.69	592.44
Net PPE	62,929	3,451.91	13,458.53	261.96	6.96	6,228.00
Number of employees	22,574	21,702.32	49,616.59	3,700.00	173.00	61,499.00
Headcount	31,056	5,397.01	19,569.98	773.00	119.00	11,662.00
Interest expense	59,566	33.95	140.38	4.15	0.11	72.68
Current assets	63,280	2,837.40	10,195.03	282.13	12.88	5,356.53
Dividends	63,268	47.51	347.12	0.00	0.00	59.24
Share repurchases	63,281	14.26	134.96	0.00	0.00	1.33
R&D expenses	63,281	24.39	151.61	0.00	0.00	10.51
Selling, general & admin exp.	63,281	126.52	488.80	8.90	0.30	266.15
Non-U.S. IG firms						
Total assets	8,549	42,864.43	58,599.17	20,434.43	4,034.89	112,088.12
Total debt	8,549	12,334.78	17,762.02	5,612.87	1,131.88	32,360.42
Total bonds and notes	7,499	3,053.47	4,267.28	1,298.85	265.37	8,282.52
Total term loans	3,458	912.53	1,641.94	307.02	32.24	2,371.85
Net PPE	8,545	16,839.84	29,097.17	5,583.90	867.74	47,538.71
Number of employees	4,187	73,723.66	88,726.45	42,000.00	6,997.00	168,000.00
Headcount	7,180	15,702.58	36,637.09	4,503.00	391.50	43,637.00
Interest expense	8,237	136.07	322.85	54.55	9.86	285.20
Current assets	8,549	13,036.03	21,741.10	4,887.53	870.16	32,124.84
Dividends	8,547	228.22	545.36	31.18	0.00	630.32
Share repurchases	8,549	84.62	346.67	0.00	0.00	205.66
R&D expenses	8,549	135.51	370.86	0.00	0.00	454.36
Selling, general & admin exp.	8,549	606.58	1,145.34	212.17	0.00	1,921.95
Non-U.S. non-IG firms						
Total assets	54,732	3,557.76	12,963.28	612.31	34.39	8,027.54
Total debt	54,732	1,265.02	4,296.51	168.85	3.92	2,903.50
Total bonds and notes	18,482	651.16	1,541.68	224.48	2.52	1,352.90
Total term loans	35,380	189.62	697.86	22.58	0.60	448.18
Net PPE	54,384	1,348.36	6,632.51	166.45	5.19	2,793.57
Number of employees	18,387	9,856.28	21,759.57	2,235.00	132.00	26,000.00
Headcount	23,876	2,297.92	7,280.49	528.00	103.00	4,629.00
Interest expense	51,329	17.56	64.81	2.62	0.09	38.17
Current assets	54,731	1,244.37	5,250.20	196.84	9.98	2,426.04
Dividends	54,721	19.29	294.91	0.00	0.00	22.33
Share repurchases	54,732	3.27	37.36	0.00	0.00	0.15
R&D expenses	54,732	7.03	53.51	0.00	0.00	4.29
Selling, general & admin exp.	54,732	51.54	172.48	6.79	0.34	109.95

Note: This table presents summary statistics for firm-level variables of non-US firms. Debt amount, net PPE, interest expenses, current assets, dividends, share repurchases, research and development (R&D) expenses, and selling, general & administrative expenses are in million USD and adjusted using US CPI index. Local currency values are converted into US dollars using the official exchange rate at the end of each quarter.

Table B.4: Summary statistics of firms' debt outstanding

	Obs	Mean	SD	Median	P10	P90
All Firms						
Bond and Note 1Y-4Y	57,270	619.92	1,294.68	224.95	0.85	1,514.32
Bond and Note 4Y-10Y	62,927	1,111.32	1,934.71	482.81	18.49	2,707.60
Bond and Note >10Y	30,330	1,875.96	3,815.89	570.96	22.00	4,675.07
Term Loan 1Y-4Y	53,921	170.03	447.38	21.16	0.25	453.33
Term Loan 4Y-10Y	42,454	326.36	736.53	78.67	1.53	852.15
Term Loan >10Y	9,806	351.93	954.61	39.09	0.51	871.83
U.S. IG Firms						
Bond and Note 1Y-4Y	13,674	1,415.78	2,093.52	715.48	147.25	3,330.49
Bond and Note 4Y-10Y	16,278	2,011.68	2,719.70	1,132.32	269.67	4,568.42
Bond and Note >10Y	12,860	3,046.22	5,060.51	1,219.27	212.84	8,007.86
Term Loan 1Y-4Y	3,391	469.21	817.63	242.48	6.27	1,093.11
Term Loan 4Y-10Y	1,868	544.06	1,066.77	216.04	6.25	1,185.56
Term Loan >10Y	698	701.93	1,208.04	170.00	18.48	2,807.61
U.S. non-IG Firms						
Bond and Note 1Y-4Y	28,273	286.63	637.22	77.53	0.25	740.39
Bond and Note 4Y-10Y	31,110	722.39	1,452.25	319.18	3.33	1,623.89
Bond and Note >10Y	10,722	675.23	1,517.45	183.51	2.90	1,877.26
Term Loan 1Y-4Y	28,160	160.11	395.21	16.79	0.11	444.41
Term Loan 4Y-10Y	24,745	339.03	651.17	91.38	1.24	933.41
Term Loan >10Y	4,990	287.67	765.91	12.69	0.13	752.84
Non-U.S. IG Firms						
Bond and Note 1Y-4Y	4,838	995.36	1,259.09	558.66	103.43	2,468.21
Bond and Note 4Y-10Y	5,773	1,431.01	1,689.95	877.66	202.27	3,343.23
Bond and Note >10Y	3,890	2,236.67	3,409.09	1,110.49	222.16	4,730.90
Term Loan 1Y-4Y	1,959	529.25	1,035.94	187.20	10.71	1,311.61
Term Loan 4Y-10Y	1,711	744.59	1,313.78	254.12	17.51	2,005.04
Term Loan >10Y	705	814.87	1,502.18	237.40	40.48	2,054.70
Non-US non-IG Firms						
Bond and Note 1Y-4Y	10,485	307.46	570.45	145.20	1.54	719.01
Bond and Note 4Y-10Y	9,766	660.55	1,134.59	331.85	24.36	1,487.82
Bond and Note >10Y	2,858	623.85	1,237.89	259.31	17.60	1,456.68
Term Loan 1Y-4Y	20,411	99.55	258.69	15.37	0.49	260.74
Term Loan 4Y-10Y	14,130	224.73	700.03	45.16	1.69	508.58
Term Loan >10Y	3,413	278.68	957.35	45.98	0.78	552.69

Note: This table presents summary statistics for our debt structure data. Investment grade (IG) firms stands for firms with a credit rating equal to investment grade. The maturity bucket denotes the remaining maturity of outstanding debt. The unit is million USD.

Table B.5: Summary statistics for corporate and government bonds

	Obs	Mean	SD	Median	P10	P90
All Corporate Bonds						
Duration	265,664	6.35	4.84	4.85	1.42	14.62
Price (1Y-4Y)	72,147	81.44	12.80	83.89	65.27	95.62
Price (4Y-10Y)	123,134	82.18	14.46	85.13	61.26	97.18
Price (>10Y)	65,977	85.09	20.95	87.52	55.09	111.12
US IG Bond and Note						
Duration	138,334	7.81	5.32	6.30	1.81	15.78
Price (1Y-4Y)	35,070	82.78	11.18	84.29	65.90	97.02
Price (4Y-10Y)	51,229	83.48	14.31	85.78	61.92	100.59
Price (>10Y)	49,316	85.53	21.03	88.07	55.08	111.69
US HY Bond and Note						
Duration	65,356	3.74	2.52	3.54	0.77	6.54
Price (1Y-4Y)	17,863	78.20	15.33	82.27	63.08	93.19
Price (4Y-10Y)	43,169	80.13	14.62	84.07	60.26	94.76
Price (>10Y)	3,817	77.36	18.11	80.56	54.10	96.82
Non-US IG Bond and Note						
Duration	47,417	6.49	4.51	5.35	1.73	14.10
Price (1Y-4Y)	14,318	83.85	10.82	85.45	66.11	96.91
Price (4Y-10Y)	20,336	84.90	13.30	86.62	64.17	100.10
Price (>10Y)	11,717	86.71	20.73	88.95	56.01	112.65
Non-US HY Bond and Note						
Duration	14,557	3.69	2.45	3.41	0.90	6.39
Price (1Y-4Y)	4,896	76.65	15.14	80.53	61.33	92.18
Price (4Y-10Y)	8,400	78.13	14.88	82.28	58.91	93.15
Price (>10Y)	1,127	75.48	20.68	78.94	49.76	99.60
US Gov't Bond and Note						
Duration	13,454	5.81	5.38	3.85	1.23	16.09
Price (1Y-4Y)	5,872	84.36	10.78	85.52	66.72	96.29
Price (4Y-10Y)	4,131	89.27	17.15	87.85	65.93	111.17
Price (>10Y)	2,698	93.57	25.93	95.85	55.37	126.19

Note: This table presents summary statistics for corporate and government bond data. The corporate bonds are separated into four groups by issuer's country (US versus non-US), and bond credit rating (investment-grade (IG) versus high-yield (HY)). Durations are in years and bond prices are in USD.

Table B.6: Central bank balance sheet shocks and macro-financial predictors

VARIABLES	(1) $BSPshock_{1Y-4Y;t}$	(2) $BSPshock_{4Y-10Y;t}$	(3) $BSPshock_{>10Y;t}$
$NFP\ surprise_{t-1}$	-0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)
$Emp.\ growth\ (12m)_{t-1}$	-0.0133	0.0124	-0.0332
	(0.0213)	(0.0233)	(0.0251)
$\Delta log\ S\&P500\ (3m)_{t-1}$	0.0044	0.0006	0.0071
	(0.0069)	(0.0052)	(0.0088)
$\Delta Slope\ (3m)_{t-1}$	0.0020	-0.0010	-0.0003
	(0.0070)	(0.0061)	(0.0099)
$Treasury\ skewness_{t-1}$	-0.0000	-0.0004	-0.0021
	(0.0018)	(0.0016)	(0.0027)
$\Delta log\ Comm.\ price\ (3m)_{t-1}$	0.0014	-0.0008	-0.0013
	(0.0035)	(0.0023)	(0.0043)
Observations	51	51	51
R-squared	0.0342	0.0276	0.0862
$Corr(Shock, Error)$	0.968	0.947	0.824

Note: This table presents the regression our central bank balance sheet shocks $BSPshock_{m,t}$ for each $m \in \{(1Y\text{-}4Y], (4Y\text{-}10Y], >10Y\}$ on several macro-financial predictors as in Bauer and Swanson (2023). These include the latest non-farm payroll shock $NFP\ shock_{t-1}$, year-on-year employment growth in the preceding quarter $Emp.\ growth\ (12m)_{t-1}$, S&P 500 returns in the last quarter $\Delta log\ S\&P500\ (3m)_{t-1}$, changes in the slope of the yield curve in the last quarter $\Delta Slope\ (3m)_{t-1}$, changes in commodity prices in the last quarter $\Delta log\ Comm.\ price\ (3m)_{t-1}$, and the Treasury skewness at the end of the last quarter $Treasury\ skewness_{t-1}$. Newey-West standard errors with four lags are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B.7: Shocks and the pre-FOMC announcement week S&P 500 returns

VARIABLES	(1) $BSPshock_{1Y-4Y;FOMC}$	(2) $BSPshock_{4Y-10Y;FOMC}$	(3) $BSPshock_{>10Y;FOMC}$
$Pre-FOMC\ SP500\ weekly\ return$	0.0260	0.0307	0.0365
	(0.0296)	(0.0310)	(0.0352)
Observations	51	51	51
R-squared	0.0046	0.0056	0.0079

Note: This table presents the regression our central bank balance sheet shocks $BSPshock_{m,t}$ for each $m \in \{(1Y\text{-}4Y], (4Y\text{-}10Y], >10Y\}$ following the FOMC announcement dates on weekly returns of the S&P 500 the week before the corresponding FOMC announcement date. Newey-West standard errors with four lags are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B.8: Comparison of our $BSPshock_{1Y-4Y}$ shock to monetary policy shocks from the literature

VARIABLES	(1) $BSPshock_{1Y-4Y}$	(2) $BSPshock_{1Y-4Y}$	(3) $BSPshock_{1Y-4Y}$	(4) $BSPshock_{1Y-4Y}$
Swanson FFR	-0.0011			
	(0.0015)			
Swanson FG	-0.0001			
	(0.0004)			
Swanson LSAP	0.0008			
	(0.0008)			
JK MP		0.0014		
		(0.0047)		
JK CBI		-0.0265		
		(0.0161)		
Nakamura-Steinsson			0.0001	
			(0.0004)	
BRW				0.5875
				(0.3750)
Observations	34	52	45	52
R-squared	0.0531	0.0765	0.0011	0.0281

Note: This table presents the regression our central bank balance sheet shocks $BSPshock_{(1Y-4Y],t}$ on various monetary policy shocks identified in the literature. Column (1) presents the results using measures in Swanson (2021). Column (2) presents the results using measures in Jarociński and Karadi (2020). presents the results using measures in Nakamura and Steinsson (2018). presents the results using measures in Bu et al. (2021). Newey-West standard errors with four lags are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table B.9: Comparison of our $BSPshock_{4Y-10Y}$ shock to monetary policy shocks from the literature

VARIABLES	(1) $BSPshock_{4Y-10Y}$	(2) $BSPshock_{4Y-10Y}$	(3) $BSPshock_{4Y-10Y}$	(4) $BSPshock_{4Y-10Y}$
Swanson FFR	0.0008			
	(0.0012)			
Swanson FG	-0.0000			
	(0.0004)			
Swanson LSAP	-0.0011			
	(0.0008)			
JK MP		-0.0007		
		(0.0046)		
JK CBI		0.0250		
		(0.0152)		
Nakamura-Steinsson			0.0002	
			(0.0003)	
BRW				-0.4248
				(0.3956)
Observations	34	52	45	52
R-squared	0.1087	0.0868	0.0067	0.0194

This table presents the regression our central bank balance sheet shocks $BSPshock_{(4Y-10Y],t}$ on various monetary policy shocks identified in the literature. Column (1) presents the results using measures in Swanson (2021). Column (2) presents the results using measures in Jarociński and Karadi (2020). presents the results using measures in Nakamura and Steinsson (2018). presents the results using measures in Bu et al. (2021). Newey-West standard errors with four lags are shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table B.10: Comparison of our $BSPshock_{>10Y}$ to MP shocks from the literature

VARIABLES	(1) $BSPshock_{>10Y}$	(2) $BSPshock_{>10Y}$	(3) $BSPshock_{>10Y}$	(4) $BSPshock_{>10Y}$
Swanson FFR	0.0017			
	(0.0019)			
Swanson FG	-0.0000			
	(0.0006)			
Swanson LSAP	-0.0015			
	(0.0015)			
JK MP		-0.0061		
		(0.0103)		
JK CBI		0.0270		
		(0.0270)		
Nakamura-Steinsson			0.0002	
			(0.0007)	
BRW				0.1920
				(0.6154)
Observations	34	52	45	52
R-squared	0.0724	0.0519	0.0022	0.0014

Note: This table presents the regression our central bank balance sheet shocks $BSPshock_{>10Y,t}$ on various monetary policy shocks identified in the literature. Column (1) presents the results using measures in Swanson (2021). Column (2) presents the results using measures in Jarociński and Karadi (2020). presents the results using measures in Nakamura and Steinsson (2018). presents the results using measures in Bu et al. (2021). Newey-West standard errors with four lags are shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

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