Do Firms Cater to Corporate QE? Evidence from the Bank of Japan's Corporate Bond Purchases during the COVID-19 Pandemic*

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Abstract

The Federal Reserve and Bank of Japan corporate bond purchase programs in response to the COVID-19 crisis have primarily targeted bonds with five years or less remaining to maturity. This paper documents evidence suggesting that firms in Japan, but not in the U.S., have catered to the maturity-specific demand shock by shifting the maturity of new bond issues. Most strikingly, in Japan, there is a large and disproportionate reduction in issuance of bonds maturing in seven years, a previously popular maturity just above the maturity eligibility criterion. I argue that Japanese results are consistent with heterogeneous firms facing a trade-off between the gain from shortening maturities to match the positive demand shock and the cost of deviating from their intrinsically optimal maturities. An analysis of simultaneous issuances of multiple-maturity bonds further supports the catering explanation. Thus, this paper documents a novel unintended effect of corporate quantitative easing (QE) and has important policy implications.

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Keywords: Debt maturity, Pandemic, Gap-filling, Corporate bond purchase program.

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1 Introduction

In the wake of the novel coronavirus (COVID-19) pandemic, many central banks announced the large-scale purchase of corporate bonds. An interesting feature of some of the corporate bond purchase programs is an eligibility criterion on (remaining) maturities. In the case of the U.S., with the backing of the Treasury, the Federal Reserve launched two facilities to purchase corporate bonds: the Primary Market Corporate Credit Facility (PMCCF) for primary market purchases and the Secondary Market Corporate Credit Facility (SMCCF) for secondary market purchases. The PMCCF targeted bonds maturing in four years or less, and individual bonds purchased by the SMCCF were required to have remaining maturities of five years or less. Similarly, massive corporate bond purchases by the Bank of Japan (BOJ) have targeted only already issued bonds with five year or less remaining to maturity.

Theoretically, such a maturity-specific demand shock can produce a distortion of the maturity choice of bond suppliers; under market segmentation, firms may tilt the maturity of new bond issues toward a maturity segment with such a positive demand shock in order to take advantage of the favorable issuing conditions (Greenwood et al., 2010). This possible effect is also relevant to policy because firms' increasing reliance on shorter-term debt can constrain their investment decisions when the economic situation worsens (Almeida et al., 2011; Kalemli-Ozcan et al., 2020).

In line with contemporaneous papers such as Halling et al. (2020) and Boyarchenko et al. (2020), this paper finds no evidence of such a distortionary effect in the U.S. On the other hand, I also present evidence that the post-COVID-19 massive expansion of the BOJ's corporate quantitative easing (QE) led some firms to shorten bond maturities in the vicinity of the maturity eligibility threshold.

The BOJ had already implemented a corporate bond purchase program when the pandemic hit, and the bank expanded the size and scope of the existing program in response to the pandemic shock. Most importantly, the BOJ announced on April 27, 2020 that it would dramatically increase its corporate bond purchases and that the maximum eligible remaining maturity had been increased from three to five years.[1]

In the pre-pandemic period, maturities of Japanese corporate bonds clustered in some specific integer

[1] More institutional details are provided in Section 2.1. In response to the pandemic, the BOJ actually made another key announcement on March 16, 2020. Section 5.2.2 explains why my main analysis focuses on comparing the period before the March-16 announcement and the period after April 27.

years, namely, three, five, seven, and ten. Then, after the BOJ's corporate QE expansion, firms became more likely to choose maturities of five years or less and the share of seven years (i.e., the previously popular maturity just above the threshold) decreased disproportionately. To formally test these changes in firms' maturity choice, I employ the multinomial logit model where the dependent variable can take any of the following five maturity categories: [1,3], (3,5], (5,7], (7,10], and >10 years. This analysis shows that even after controlling for basic firm characteristics, firms significantly became less likely to choose the maturity bin just above the threshold, (5,7] years, as compared to both the neighboring shorter and longer maturity bins. The reduction is also economically significant: my baseline specification implies that the probability of maturities of (5,7] years being selected decreased from 17.7% to 7.7% (i.e., a 56.5% reduction).

I argue that these observed maturity changes near the eligibility threshold are consistent with a notion that firms face a trade-off in determining the maturity of new bond issues. By issuing a bond maturing in five years or less, a firm can benefit from a favorable issuance condition created by the positive demand shock. Shorting the maturity of newly issued bonds is, however, costly for firms whose intrinsically optimal debt maturities are greater than five years—e.g., due to the maturity-matching principle (Myers, 1977). Importantly, this cost should increase as the deviation increases. Therefore, it can be predicted that firms whose target maturities are greater than, but not too far from, five years should respond the most to the positive demand shock (by shortening maturities of new bond issues). This is because if a firm's target maturity is well above the threshold, the gain from catering to the demand shock is unlikely to outweigh the cost of doing so. Consequently, there should be an increase in eligible maturities and a disproportionate decrease in maturities just to the right of the eligibility threshold.

In stark contrast, in the U.S., the proportion of short-term bonds remained constant and that of bonds with (5,7] years of maturities somewhat *increased*. These observations are in line with Halling et al. (2020) and Boyarchenko et al. (2020). Notably, Halling et al. (2020, pp. 503–504) document that the average corporate bond maturity became *longer* in the post-COVID-19 period and state that this finding is "surprising" on the following grounds: (a) it is known that corporate bond maturities tend to be pro-cyclical (Chen et al., 2021; Erel et al., 2012) and (b) the Fed's purchase programs targeted only relatively shorter-term bonds.[2] Based on the logic of Halling et al. (2020), the Japanese evidence presented in this paper is not surprising.

Why are the U.S. and Japanese results so different? One possible reason is that the BOJ became a more significant buyer in the target maturity segment of the domestic corporate bond market than the Fed did in the U.S. market. While the BOJ's purchase cap was smaller on an absolute basis than that of the Fed, the relation is reversed once the difference in their market sizes is considered. It is estimated that the total purchase cap relative to the domestic corporate bond market size was 15.5% for Japan and 7.8% for the U.S.[3] In addition, the target bonds of the BOJ's purchases were strictly confined to individual eligible bonds, i.e., investment-grade bonds with remaining maturities of from one to five years. In contrast, the SMCCF was authorized to buy individual bonds and bond exchange traded funds (ETFs). The latter option enabled the SMCCF to indirectly buy a wider variety of corporate bonds. Other key institutional differences are also discussed in this paper.

Greenwood et al. (2010) predict that firms with greater financial flexibility should be more responsive to a maturity-specific demand/supply shock in the debt market because of the lower cost of deviating from the intrinsically optimal maturity structure. The empirical analysis of this paper does not, however, indicate strong heterogeneity. This stands in contrast to findings of previous studies such as Greenwood and Vayanos (2010), Badoer and James (2016), and Lugo and Piccillo (2019). There are three possible explanations for the divergence of the results. First, the primary corporate bond market in Japan is practically restricted to only highly creditworthy issuers, and as a result, the cross-sectional difference might be limited. For instance, *all* of the Japanese bonds included in my sample are investment grade and 95% of them are rated either AA or A. Second, firms might have different incentives during an acute crisis such as the COVID-19 pandemic. Specifically, firms might care more about raising and stockpiling cash as opposed to keeping their maturity structures close to the target ones. The former incentive might have been especially stronger for firms with weaker balance sheets. Lastly, as explained later, the protocol of the BOJ's reverse auctions implies that higher-yield bonds, and therefore bonds issued by riskier firms, were purchased first.

[2] Halling et al. (2020) offer a possible explanation based on capital demand-side desire. Specifically, Halling et al. (2020) argue that firms' desire to reduce the immediate rollover risk might have played a special role during the COVID-19 crisis.

[3] Section 2.2 has the details of these calculations.

Changes in firms' bond maturity choice in the post-COVID-19 period are not limited to the vicinity of the eligibility threshold (five years), although establishing the link between those changes and the BOJ's corporate QE is more challenging.[4] First, the proportions of bonds with maturities of both [1,3] years and (3,5] years increased. In other words, the increase in issuance of bonds eligible for the BOJ purchases was not limited to the maturity segment just meeting the eligibility criterion. This result can be viewed as consistent with the fact that the BOJ's corporate QE expansion was essentially two separate shocks for corporate bonds maturing in [1,3] and (3,5] years. Second, issuance of very long-term bonds (i.e., those with maturities longer than 10 years) decreased during the post-COVID-19 period. It is, however, hard to find a direct theoretical link between the positive demand shock in bonds maturing in [1,5] years and the decrease in issuance of bonds at the other end of the spectrum.

Special attention is devoted to changes in maturities in the neighborhood of the eligibility threshold because sharp predictions are provided by the previous theoretical discussion in this region, and because the main interest of this study lies not in the overall maturity changes but the changes induced by the BOJ corporate bond purchases. There still exist, however, two empirical concerns in interpreting significant changes in the maturity distribution near the eligibility threshold as evidence of a causal effect of the BOJ's corporate QE expansion on firms' maturity choice.

First, the disproportionate decrease in seven-year bonds and the increase in shorter-term bonds in Japan might have been driven by a shift in the maturity distribution caused by some COVID-19-induced shocks that were unrelated to the BOJ's corporate QE. Although apart from the BOJ's bond purchases I am not aware of any COVID-19-related institutional arrangements that provided bond issuers with a discontinuous incentive shift around the maturity of five years, more fundamental economic forces might have played a role.[5] Note, however, that a simple shift toward shorter or longer maturities cannot explain the observed

[4]This can possibly be achieved by employing a difference-in-differences method if the parallel trend assumption is satisfied. Unfortunately, the vast majority of corporate bond issuers in my sample period are eligible issuers based on the BOJ's eligibility criteria, meaning that there are not enough "control group" issuers. For instance, although the BOJ announced to only purchase bonds rated BBB or above, all newly issued bonds satisfied this condition. I thus employ an alternative empirical approach to investigate whether firms shifted maturities due to the policy—focusing on the discontinuous change around the maturity eligibility threshold.

[5]Given the dominant role of the U.S. monetary policy in international financial markets, an international spillover effect of the SMCFF, which also has a maturity eligibility criterion of five years, is a possible concern. The fact that it did not appear to induce shortening of maturities in its home country, nevertheless, indicates that this concern is not well-founded.

patterns, since the decrease in maturities of (5,7] years is significantly different from changes in the shorter neighboring maturity bin ((3,5] years) and the longer one ((7,10] years), in line with my theoretical predictions. Therefore, given the large magnitude of the changes around the threshold, it seems fair to argue that such a confounding factor is unlikely to have completely brought about the results. That being said, this issue should be kept in mind when interpreting the results.

Second, the COVID-19 shock and the corporate QE could have affected the observed maturity distribution not only through altering individual firms' maturity decisions but also through changing the composition of bond issuers. As my argument is based on the former channel, I show that individual issuers have indeed shifted maturities by exploiting simultaneous issuances of multiple-maturity bonds (Helwege and Turner, 1999). This sample of issuances provides a unique opportunity to analyze how individual firms select *sets* of different maturities. Specifically, I analyze multiple-maturity issuances including at least one maturity of five years or less and one maturity of ten years or more. These issuers, by construction, must have had similar desired maturity structures.[6] This paper shows that these issuances became much less likely to include a bond maturing in (5,7] years in the period following the corporate QE. This is consistent with the view that the demand shock decreased the attractiveness of maturities that were just above the maturity eligibility criterion.

Interestingly, firms' decision to issue multiple-maturity bonds itself might have been influenced by the BOJ's corporate QE. This paper documents that the proportion of multiple-maturity bond issuances increased from 51% in the period before the pandemic to 70% in the period after the BOJ's April-27 announcement. One natural explanation for this would be that firms became more inclined to disperse future rollover dates in response to the COVID-19-induced increase in uncertainty and rollover risk (Choi et al., 2018, 2021). Nevertheless, this paper's finding that this increase was entirely driven by multiple-maturity issuances including at least one bond maturing in five years or less suggests that firms might have employed multiple-maturity issuances to (partially) cater to the high demand in the shorter end of the maturity spec-

[6] The basic idea can be illustrated by the following example of SoftBank Corp. (9434), which is a publicly listed subsidiary company of SoftBank Group (9984) running the group's domestic telecommunications businesses. On March 12, the company issued four ¥10 billion-bonds maturing in 3, 5, 7, and 10 years. Then, on July 21, the company returned to the public debt market by issuing three new bonds maturing in 3, 5, and 10 years, which raised 10, 70, and 20 billion yen, respectively. Although both the of simultaneous issuances had identical maturity ranges and very similar average maturities, only the first issuance in the pre-crisis period included a 7-year bond.

trum without much changing their overall maturity structures.

This paper contributes to two strands of literature. First, this paper contributes to the literature on the effect of corporate QE on firms' bond issuances. A number of papers analyze the effect of the Corporate Sector Purchase Programme (CSPP), a large-scale corporate bond purchase program implemented by the European Central Bank (ECB) since 2016.[7] In particular, Pegoraro and Montagna (2020) document that CSPP-eligible firms changed some bond characteristics to meet the eligibility criteria.[8][9] The effect of the CSPP's maturity eligibility criterion is not studied, however, for a valid reason: the restriction, 31 years or less remaining to maturity, should not matter for most issuers. Galema and Lugo (2021) analyze changes in the financing behavior of CSPP-eligible issuers around the first actual purchase of their bonds by the ECB and document that they started to substitute private debt with bonds and the maturity of the newly issued bonds became *longer*. They interpret that firms' motive to make the best use of favorable but transient issuing conditions drove the maturity change. This paper contributes to the literature by presenting evidence suggesting that a tight maturity eligibility criterion of corporate QE can lead to firms' gap-filling behavior.[10]

Second, this paper extends the literature pertaining to the determinants of the maturity of newly issued corporate debt, and especially, the influence of demand/supply conditions.[11] As mentioned earlier, on the theoretical side, the gap-filling theory is proposed by Greenwood et al. (2010). Nevertheless, empirical tests are challenging due to the difficulty in finding an exogenous demand/supply shock to a specific maturity segment. Therefore, in their empirical analysis, Greenwood et al. (2010), Badoer and James (2016), and Lugo and Piccillo (2019) rely on variations in *government bond supply*, based on the assumption that government

[7] Grosse-Rueschkamp et al. (2019), Zaghini (2019), Pegoraro and Montagna (2020), and Todorov (2020) show that the CSPP significantly increased firms' bond issuances.

[8] Specifically, the bond characteristics studies by Pegoraro and Montagna (2020) are exchange listing, use of central securities depository (CSD), seniority, collateral, and credit guarantee.

[9] Dathan and Davydenko (2020) and Calomiris et al. (2019) also document evidence that firms modify bond features to cater to bond ETFs and major indexes, respectively.

[10] I am not aware of any other studies examining changes in firms' maturity choice in response to the BOJ's corporate QE. At the same time, it is noted that the possibility that the post-COVID-19 expansion of the BOJ's corporate QE influenced Japanese firms' bond maturity choice has been suggested by the financial press. An article by Nikk ei on October 16, 2020 reported that the issuance amount of corporate bonds maturing in six to seven years was much lower during July–September 2020 relative to the same months in the previous year and explained that some firms shortened bond maturities to meet the BOJ's maturity criterion—Kohei Onishi (October 16, 2020) *Nichigin taishogai no shasai ni juyo toshika 6 nensai ni katsuro* (Demand for corporate bonds not targeted by the Bank of Japan increases—Investors moving to 6-year bonds). *Nikkei*.

[11] Classical explanations of firms' debt maturity choice are the so-called matching principle (Myers, 1977) and signaling explanations (Diamond, 1991; Flannery, 1986). The determinants of debt maturity have been empirically studied by Barclay and Smith Jr (1995), Stohs and Mauer (1996), Guedes and Opler (1996), and Badoer and James (2016).

and corporate bonds are regarded as (partial) substitutes by some preferred-habitat investors. On the other hand, I am aware of only the following two recent papers that analyze *demand* shocks. First, Butler et al. (2019) document that the demand from insurance companies, which have a strong appetite for long-term bonds, influences firms' decision to supply long-term bonds. Second, Lugo (2021) focuses on money market mutual funds, which are regulated to buy only very short-term (less than one year) bonds and shows that their demand affects firms' short-term debt issuances. This paper adds to this literature by studying a large and unique demand shock in the medium range of the maturity spectrum that resulted from corporate QE with an (arbitrary) eligibility criterion on maturities. Also, my analysis suggests a previously undocumented scheme used by firms: simultaneously issuing multiple-maturity bonds to partially cater to demand in a specific maturity segment without much changing their maturity structures.

The findings of this paper also have policy implications. Firms that shorten their maturities are also increasing their rollover risk, which can constrain their future investment when the economic prospects worsen (e.g., the arrival of bad news regarding the COVID-19 vaccine effectiveness or economic recovery in the present circumstances). Almeida et al. (2011) show that in the wake of the global financial crisis U.S. firms with greater proportions of long-term debt close to maturity contracted investment more than other similar firms did. Similarly, Kalemli-Ozcan et al. (2020) claim that the rollover risk originating from short-term debt deterred investment of European firms during the crisis. Moreover, the negative effects can be long-lasting as Duval et al. (2020) demonstrate, using international data, that firms that had been exposed to higher rollover risk during the global crisis exhibited not only lower TFP growth but also scarce innovation in the subsequent years. Thus, the results described in this paper suggest that having tight maturity criteria for the eligibility of corporate QE can make the financial system more vulnerable to a negative shock in the near future.[12] This effect is unintended by the BOJ[13] as the original motive of the maturity eligibility criterion was to limit the bank's risk exposure (Bank of Japan, 2009). Importantly, this

[12] At the same time, I note three features that are specific to this setting and could have mitigated this effect. First, most issuers in my sample were highly creditworthy, being rated AA or A. Second, by simultaneously issuing multiple-maturity bonds, which became more popular during the pandemic period, firms could contain the increase in their reliance on shorter-term debt while at the same time partly catering to the high demand for bonds eligible for the BOJ's purchases. Third, the BOJ had a purchase cap set for each bond issuer, limiting individual issuers' gap-filling incentive.

[13] The effect being unintended does not mean that it was unexpected. Rather, the fact that the BOJ increased the maximum eligible remaining maturity from three to five years seems to imply that the bank was aware of this possible effect on firms' maturity selection.

finding in Japan is in stark contrast to the U.S. experience, which is summarized by Boyarchenko et al. (2020, p. 3) as follows: "the existence of the facility does not distort issuance decisions, with issuers not changing maturity of issued bonds to target SMCCF eligibility." Given that Galema and Lugo (2021) show that the CSPP, a large-scale corporate QE *without* a tight maturity eligibility criterion, was followed by firms' lengthening of bond maturities, this paper's findings complement Galema and Lugo (2021) in terms of informing policy.

2 Institutional background

2.1 The BOJ's corporate bond purchase program

When the COVID-19 pandemic emerged, the BOJ had already implemented a corporate bond purchase program as part of its long-lasting quantitative easing policy. The original terms allowed the bank to purchase up to ¥2.2 trillion of commercial paper (CP) and up to ¥3.2 trillion of corporate bonds. The key eligibility criteria for corporate bonds were credit ratings of BBB or above (i.e., investment grade) and residual maturities of one to three years.[14] A brief history of the BOJ's corporate bond purchases is provided in Internet Appendix A.

During the COVID-19 pandemic, the BOJ's corporate bond purchase program was expanded, both in terms of size and scope. This came about through the following two announcements. First, the BOJ announced on March 16, 2020 that the caps on its CP and corporate bond purchases would be increased by ¥1 trillion each.[15] Then, on April 27, 2020, the bank unveiled a corporate bond purchase plan on an unprecedented scale.[16] Specifically, the size of the additional cap was increased from ¥1 trillion to ¥7.5 trillion for each of the CP and corporate bond purchases. As a result, the total cap on the BOJ's corporate bond purchases amounted to ¥10.7 trillion, an increase of 234 percent from the pre-pandemic level. There were also some material modifications to the eligibility criteria. One of the most significant changes was

[14]In addition, eligible bonds must have been denominated in Japanese yen and governed by Japanese law.

[15]Bank of Japan (2020, March 16) Enhancement of Monetary Easing in Light of the Impact of the Outbreak of the Novel Coronavirus (COVID-19). Retrieved from https://www.boj.or.jp/en/announcements/release_2020/k200316b.pdf.

[16]Bank of Japan (2020, April 27) Enhancement of Monetary Easing. Retrieved from https://www.boj.or.jp/en/announcements/release_2020/k200427a.pdf.

the extension of the maximum eligible remaining maturity from three years to five years.[17] Another noteworthy change was that the maximum bond purchase amount per issuer was increased from ¥100 billion to ¥300 billion. The April announcement said that the additional corporate debt purchases would continue until September 2020. Nevertheless, in May 2020, the date of termination was extended to March 2021.[18] The BOJ Governor Kuroda stated that the purpose of the bank's bond purchases during the COVID-19 was twofold: to stabilize the financial market through liquidity provision and to ease the raising of capital by firms (Kuroda, 2020).

Of course, measures taken by the BOJ were not limited to enhancing its corporate debt purchases. There were three other important policy tools: specifically, (a) loans to financial institutions through the Special Funds-Supplying Operations, (b) expanded Japanese government bond purchases, and (c) expanded equity ETF purchases. All these policies were also announced on March 16 and April 27, which were the dates of the bank's Policy Board meetings. Table 1 summarizes the information regarding the major policies announced by the BOJ on these dates.

The BOJ's monthly purchase amount significantly increased following these announcements. It should be noted that the BOJ employed reverse auctions to buy corporate bonds, and the auctions were conducted separately for bonds maturing in [1,3] and (3,5] years. Figure 1 shows that the monthly purchase amount of corporate bonds with remaining maturities of [1,3] years increased from ¥100 billion in February 2020 to ¥200 billion in March and further to ¥300 billion in the next month. Also, the BOJ began purchasing bond maturing in three to five years in May and had purchased ¥200 billion yen per month since then.[19]

Therefore, simply put, each of the maturity segments of [1,3] and (3,5] years experienced a ¥200 billion demand shock (on a monthly basis). This shock, however, could have led to a larger impact on the former segment because the BOJ's previous purchases plausibly had already made bonds with remaining maturities of [1,3] years scarce in the secondary market. Consistent with this view, in the auctions of bonds maturing in [1,3] years, the offer-to-cover ratio—the amount of (acceptable) offers divided by the purchase

[17] The minimum residual maturity continued to be one year.

[18] Bank of Japan (2020, May 22) Statement on Monetary Policy. Retrieved from `https://www.boj.or.jp/en/announcements/release_2020/k200522b.pdf`.

[19] The BOJ's corporate bond purchase volume was disclosed only at this level of granularity (i.e., bonds maturing in [1,3] years and (3,5] years). Unlike the Federal Reserve, the BOJ did not disclose individual bonds that they purchased. The SMCCF's target bond selection is studied by Flanagan and Purnanandam (2020).

amount at the auction—became unusually low after the purchase size increases.[20] For instance, in the May-8 auction, the first auction held after the BOJ's announcement on April 27, the offer-to-cover ratio was only marginally above one (1.05), with the lowest winning offer yield being −0.14%.[21] In contrast, in the case of auctions of bonds maturing in (3,5] years, more offers were submitted relative to the purchase size. When it was held for the first time on May 20, 2020, the offer-to-cover ratio was 2.96. These facts indicate that for the BOJ demand shock to be "absolved," more bond issuances were required in the maturity segment of [1,3] years than in that of (3,5] years.

2.2 Comparisons with other major central banks' corporate bond purchase programs

In response to the COVID-19 crisis, the Fed created its first-ever programs to purchase corporate bonds with financial support from the Treasury. Specifically, the Fed and the Treasury launched two facilities: the PMCCF to purchase newly issued corporate bonds and syndicated loans and the SMCCF to purchase already issued bonds and bond ETFs. Based on the Fed's announcement on April 9, their combined purchase size was $750 billion. More details about these programs are provided in Internet Appendix C.[22] Most importantly, the maturity eligibility criteria of these facilities were close to that of the BOJ's program. The SMCCF's criterion was five years or less remaining to maturity, whereas that of the PMCCF was slightly shorter—maturities of four years or less.

Figure 2 compares the corporate purchase caps of the Fed's facilities and the BOJ's program relative to the domestic corporate bond market sizes.[23] It is evident that although the absolute value of the Japanese cap was much smaller than its U.S. counterpart, the Japanese cap was larger once the difference in their target market sizes is considered. More specifically, while the purchase cap of the U.S. corporate QE is estimated to be 7.8% of the domestic bond market size, the percentage amounts to 15.5% for the BOJ's bond purchases. The Japanese figures can be broken into the additional purchase cap (10.8%) and the existing

[20]Outcomes of the BOJ's reverse auctions are summarized in Table IA.1 in Internet Appendix B.

[21]This ratio is much lower than those in the pre-COVID-19 period. In the auctions held on January 23 and February 20, 2020, the offer-to-cover ratios were 3.15 and 2.54, respectively.

[22]See Cheng et al. (2020) and Hanson et al. (forthcoming) for a summary of their wide variety of interventions in the wake of the pandemic.

[23]The data sources are the Japan Securities Dealers Association (JSDA) for Japan and SEC (2020) for the U.S. See Internet Appendix E for further details.

one (4.6%). Notably, the relative size of the additional purchase cap alone is bigger than the U.S. figure.

Central banks in other countries also launched corporate bond purchase programs, and most notably, the ECB announced on March 18 that it would launch the Pandemic Emergency Purchase Programme (PEPP).[24] It targeted both government and corporate bonds, and the total size was €750 billion. The main eligibility criteria for corporate bonds were the same as those for the ECB's existing corporate bond purchase program, the CSPP. Most importantly, in contrast to the Fed and the BOJ, the ECB sets a much less strict maturity eligibility criterion—(remaining) maturities of less than 31 years.[25] Therefore, it is highly unlikely that a significant proportion of Eurozone firms shortened the maturity of new bond issues to meet the ECB's maturity eligibility criterion.

3 Theoretical framework

Based on the gap-filling theory of Greenwood et al. (2010), the BOJ's massive purchase can be regarded as a sudden decrease in the "supply" of bonds available for private investors, and this could have encouraged firms to "fill the gap" in the targeted maturity segment. The driver of the gap-filling theory is the existence of a group of investors who predominantly invest in debt with specific maturities, i.e., preferred-habitat investors (Modigliani and Sutch, 1966, 1967; Vayanos and Vila, 2021). This is because if arbitrage capital is limited and if firms cannot change the maturity of new debt issues, a change in preferred-habitat investors' demand (or in the supply of bonds of their interest) leads to a violation of the expectations hypothesis. In reality, however, firms can change the maturity of new debt issues. Greenwood et al. (2010) therefore argue that firms have an incentive to alter the debt maturity toward a maturity segment in which the debt supply is low relative to the demand from preferred-habitat investors and that firms do so as long as the benefit outweighs the cost.

A unique nature of the demand shock examined by this paper is that it is clearly confined to a specific

[24]Other central banks that announced corporate bond purchases during the pandemic were the Bank of England (BoE), Bank of Canada, and Banco de Mexico, among others.

[25]https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/649397/EPRS_BRI(2020)649397_EN.pdf.

maturity segment.[26] Such a shock can lead to sharp changes in firms' maturity choice in the vicinity of the threshold. This is because firms face a trade-off in choosing bond maturity: by issuing bonds with maturities that are highly demanded by (preferred-habitat) investors, a firm can issue bonds at favorable terms, while doing so can be costly for a firm in the sense that its maturity structure is moved away from the target one (Greenwood et al., 2010). Importantly, the cost for a firm is expected to increase as the size of the deviation from its target maturity increases. Thus, in this paper's setting, where investors' demand for bonds maturing in five years or less suddenly increased, the following predictions can be made: the firms whose target maturities are five years or less keep issuing same-maturity bonds, those whose target maturities are only moderately above five years might find it optimal to shorten the maturity of new bond issues (to five years), and the firms with target maturities well above five years are unlikely to shorten the maturity to meet the demand shock because it would be too costly for them to do so. As a result, if we compare the distributions of the maturities of newly issued bonds in the periods before and after the expansion of the BOJ's corporate QE on April 27, 2020, there should be an increase in the share of maturities eligible to be bought by the BOJ and a disproportionate decrease in the share of maturities slightly exceeding five years.[27]

The above reasoning implies that, all other things being equal, the increase in the issuance of eligible maturities should be concentrated on the maturity that just meets the eligibility criterion (i.e., five years). This argument, nonetheless, ignores the following important fact—the BOJ held separate auctions of bonds with remaining maturities in [1,3] and (3,5] years and the bank behaved as if it had separate budgets for the two maturity ranges. Furthermore, in Section 2.1, I have noted that the demand shock to the shorter

[26] In this sense, one paper similar to mine is Lugo (2021) as it analyzes the effect of the demand from money market mutual funds, which can purchase only corporate debt maturing in one year or less.

[27] Notably, Calomiris et al. (2019) document discontinuous changes in issuance amounts, instead of maturities, around a threshold that they focus on and provide an explanation that somewhat resembles that of this paper. They analyze U.S. dollar-denominated corporate bonds issued by emerging country firms and document a disproportionate increase in clustering of issuance amounts exactly at $500 million in the period following the global financial crisis. Calomiris et al. (2019) argue that the driving force is a post-crisis increase in the demand for emerging country corporate bonds that can be included in major indexes. Importantly, a key index eligibility criterion of major bond indexes is the minimum issuance size of $500 million. Thus, according to the authors, firms whose target issuance sizes are below the threshold face a trade-off. By "stretching" to $500 million, they can issue bonds at more favorable conditions. At the same time, raising more than the target amount is costly because individual firms have limited investment opportunities whose (risk-adjusted) expected returns are at least as great as the interest rate. As a result, only emerging country issuers whose target sizes are moderately below $500 million would change their issuance amount to $500 million after the demand shock.

maturity segment could have been larger in effect due to the BOJ's purchases in the preceding period. Thus, the demand shock looks more like two separate shocks that occurred in the two maturity segments, and each shock could have encouraged firms to shift the maturity toward the segment.

4 Data

The BOJ's corporate bond purchases did not explicitly exclude specific firms or sectors with only one exception. Specifically, the BOJ committed not to buy bonds issued by financial institutions holding current accounts at the BOJ (i.e., "counterpart financial institutions") and their parent holding companies. Internet Appendix I provides a summary of the counterpart financial institutions and an overview of bond issuances by them and other firms in the financial sector. Internet Appendix I also explains why a (small) sample of bonds issued by counterpart financial institutions *cannot* be used as a control group in a difference-in-differences framework. Importantly, the BOJ reserves the right to reject offers at its discretion in its reverse auctions. Media reports have suggested that auction participants have learned that the BOJ excludes offers for certain (eligible) corporate bonds, largely from their own auction experiences.[28] Unfortunately, because the identities of the purchased (and unpurchased) corporate bonds have not been disclosed, those purchased and rejected by the BOJ cannot be separated.

Following previous papers such as Halling et al. (2020), my main analysis considers corporate straight bonds issued by public companies in non-financial and non-utility industries.[29] However, it is worth noting that the inclusion of financial firms and utilities does not qualitatively change the main result of this paper (see Internet Appendix K). An overview of the Japanese corporate bond market including discussions of bond issuances by financial firms and utilities is presented in Internet Appendix F.

Japanese corporate bond issuance data were obtained from the Japan Securities Dealers Association (JSDA).[30] I collected "corporate straight bonds" with fixed interest rates (bond code 40). This group in-

[28] *Shasai "nichigin tredo" ihen taishogai meigara uwanose kinri ni myoumi* (Change in corporate bond "BOJ trade": Attractiveness of higher yields of non-targeted bonds) (in Japanese). *Nikkei*. Retrieved from `https://www.nikkei.com/article/DGXZQOGD25C1L0V20C21A3000000/?unlock=1`.

[29] I also excluded firms under government control such as Japan Tobacco Inc. (JT) and companies in the Japan Railway (JR) group as did Tanaka (2014).

[30] `https://www.jsda.or.jp/en/statistics/bonds/index.html`

cludes callable bonds and they are excluded. I also removed permanent bonds, secured (asset-backed) bonds, equity-like bonds (e.g., bonds with an optional interest deferral clause), and investment corporation bonds.[31] The data included information on issuance amounts, coupon rates, yields, maturities, and credit ratings, among others. Maturities were rounded to the nearest half-year. Offering spreads were calculated by subtracting the yields of the closest-maturity Japanese government bonds (JGBs) from offer yields. JGB yield data were obtained from the website of the Ministry of Finance[32] and JGB yields were linearly interpolated when necessary.

This bond issuance data set was then merged with firm-level data obtained from the Worldscope. As Japanese public companies are required to file annual financial reports (equivalent to U.S. 10-K reports) within three months after the end of a fiscal year, the bond issuance data were merged with the most recent annual accounting information ending at least three months before the issuance date.

The sample period is divided into three sub-periods. As the BOJ announced expansions of its corporate bond purchases on March 16 and April 27, 2020, I refer to the period between the two announcements as the QE1 period, and the period starting from the date of the second announcement the QE2 period. The sample period ends on September 30, 2020. One full year leading up to the first announcement (March 16, 2019–March 15, 2020) is called the "pre-period" in my baseline analysis.[33]

For the sake of comparison, U.S. bond issuance data were also collected from the SDC Platinum. To obtain a sample similar to that used by Halling et al. (2020), I kept only public firms in non-financial and non-utility industries that could be matched to the Compustat.

One salient feature of the Japanese corporate bond market is illustrated in Panel A of Table 2: the

[31] The BOJ has no explicit restrictions on non-straight bonds. The bank, however, had discretion in selecting which eligible bonds to buy, and it might have taken special clauses attached to bonds into account when doing so. This issue remains unclear due to non-identification of bonds purchased by the BOJ.

[32] https://www.mof.go.jp/english/jgbs/reference/interest_rate/index.htm

[33] The empirical results remain similar, however, even if the pre-period includes only six months before March 16, 2020.

Japanese primary market is practically limited to highly creditworthy issuers.[34] All of the sample bonds are investment grade, and the vast majority of them (94.7%) are rated A or above.[35] Notably, this result is not driven by less creditworthy firms' greater difficulty in accessing the public debt market during the COVID-19 crisis. Bonds rated AA or A occupied 93.3% even in the pre-period.

Panel B of Table 2 shows that the distribution of maturity by credit rating. Although both AA- and A-rated bonds are dispersed across a wide maturity spectrum, BBB-rated bonds exhibit a high concentration (50%) in the maturity of five years. This observed pattern is largely consistent with the finding of Guedes and Opler (1996) in the U.S. that less credit-worthy firms are more likely to issue medium-term debt.

The summary statistics of basic bond- and firm-level variables are provided in Table 3. Of the 495 newly issued bonds, 486 could be merged with all of the firm-level data in the Worldscope that will be employed in the subsequent empirical analysis. Variable definitions are provided in Internet Appendix D. Bond- and issuer-characteristics in the three sub-periods are compared in Table 4. Most notably, it shows that the average log maturity is greater (smaller) in the QE1 (QE2) period than in the pre-period. The average maturities, however, can be greatly influenced by long-term issues, and my main interest lies in changes in maturities in the neighborhood of the BOJ's maturity eligibility criteria.

5 Results

Firms' bond issuance activity is empirically studied in this section. For discussions of the pandemic's effects on the stock market and the secondary corporate bond market in Japan, see Internet Appendix G. On the one hand, it shows that the Japanese stock market behaved similarly to the U.S. stock market. On the

[34] The Japanese corporate bond market is rated by four major credit rating agencies: two global institutions, Standard & Poor's (S&P) and Moody's, and two domestic ones, Rating and Investment Information (R&I) and Japan Credit Rating Agency (JCR). Most bond issuers obtain credit ratings only from the domestic agencies. In the interest of comparability, the highest ratings are employed for bonds rated by multiple agencies. This is because the global credit agencies tend to provide lower ratings (Packer, 2002) and because bigger, and therefore likely safer, firms are apt to be rated by the global agencies in addition to the domestic ones. Consequently, the use of the lowest (or even average) ratings could deflate the creditworthiness of relatively safer issuers. See Han et al. (2012) and Byoun et al. (in press) for recent developments in the Japanese credit rating industry.

[35] The first-ever speculative-grade (BB) bond was issued by Aiful in June 2019; however, this bond is not included in the sample as the issuer is a financial firm. For background information, see Finbarr Flynn and Komaki Ito (2019, May 28) Japan's First Junk Bond Would Break Barriers in Wary Market. *Bloomberg.* Retrieved from `https://www.bloomberg.com/news/articles/2019-05-28/japan-s-first-junk-bond-would-break-down-barriers-in-wary-market`.

other hand, the data presented in Internet Appendix G suggest that Japan's secondary corporate bond market remained more stable than that in the U.S., where a liquidity crisis was observed in the wake of the pandemic (O'Hara and Zhou, forthcoming).

5.1 Changes in bond issuances

Figure 3 shows the number of newly issued bonds and their total proceeds. They appear to move closely with each other in both countries. Interestingly, while in the U.S. corporate bond issuances surged in March 2020 and remained high in the following two months, a significant increase in corporate bond issuances in Japan occurred only in June and July 2020.

5.2 Changes in bond maturities

5.2.1 Preliminary observations

Two striking observations can be made from Figure 4, which displays the distributions of bond maturities for the three sub-periods.[36] First, corporate bond maturities in Japan exhibit clustering on some specific integer years, specifically, 3, 5, 7, and 10, across the sub-periods. This finding might reflect that these maturities are a part of a norm (Weld et al., 2009). Second, the distributions seem to differ by sub-period. As the interpretation of the results in the QE1 period requires caution for the reasons discussed later, the focus is on comparing the pre- and QE2 periods. The most salient difference is the decrease in the share of the maturity of seven years, which was a previously popular maturity marginally exceeding the maximum (remaining) maturity of the BOJ purchases.

In the following analysis, maturities are grouped into maturity buckets, as was done in the previous studies (Badoer and James, 2016; Galema and Lugo, 2021; Guedes and Opler, 1996). The choice of maturity buckets for this study is motivated by the observed maturity distribution and the research question. First, it is natural to have maturity bins each of which embraces only (at most) one of the popular maturity years (i.e., 3, 5, 7, and 10 years). Second, because the maximum maturity for the BOJ's purchases was originally

[36] The same observations are obtained from a graph that is similarly constructed but using proceeds as weights (see Figure IA.4 in Internet Appendix K).

three years and then increased to five years, the tests of firms' maturity choice around the maturity eligibility criteria require that these years are used as cut-off values. Based on these considerations, maturities are classified into the following five maturity categories: (1,3] years, (3,5] years, (7,10] years, and greater than 10 years.

The upper graph in Figure 5 shows the dynamics of maturities of newly issued bonds in Japan using the maturity bins. Two key observations can be made based on the Japanese graph. First, the cumulative proportion of one- to five-year maturity bonds appears to have started to increase in May 2020. In July 2020, it reached a peak of 60%. Second, the proportion of maturities of (5, 7] years became almost negligible after April 2020. These two observations suggest that the BOJ's corporate bond purchase plan during the COVID-19 pandemic encouraged firms to shorten maturities in the vicinity of the threshold (five years). This hypothesis will be more formally tested later.

A similarly constructed U.S. graph in Figure 5 tells a completely different story. First, the cumulative proportion of one- to five-year maturity bonds remained constant at around 20% throughout the period of analysis. This finding is consistent with the finding by Halling et al. (2020) that bond maturities were not shortened during the COVID-19 pandemic, despite the purchases of bonds maturing in five years or less by the Fed's facilities. Second, it appears that the proportion of maturities of (5, 7] years *increased* after the pandemic. Notably, these U.S. results do not depend on credit ratings.[37] Figure IA.5 in Internet Appendix K shows no signs that U.S. issuers, whether rated at least A or not, disproportionately increased issuances of shorter-term bonds in the post-corporate QE period. Collectively, the U.S. results are in line with the conclusion of Boyarchenko et al. (2020) that U.S. firms did not shorten the maturity of newly issued bonds due to the existence of the Fed's facilities.

In summary, the preliminary observations indicate that the massive central bank corporate bond purchases influenced firms' bond maturity choice not in the U.S. but in Japan.

[37]Examining U.S. corporate bond issuances conditional on credit rating is important for two reasons. First, as Table 2 shows, the vast majority of Japanese bonds in my sample are rated at least A, suggesting that bond issuer compositions are materially different in Japan and the U.S. Second, the PMCCF and the SMCCF mainly targeted only investment-grade bonds.

5.2.2 Multinomial logit analysis of firms' bond maturity choice

To more formally test changes in the bond maturity choice of Japanese firms, this paper employs the multinomial logit model (MNLM), as did the previous studies on this topic (Badoer and James, 2016; Guedes and Opler, 1996). Guedes and Opler (1996) are not particularly interested in a specific maturity segment and their motivation for employing the MNLM is to address non-linearity in the relationship between firm characteristics and debt maturity. In contrast, the interest of Badoer and James (2016) lies in understanding the determinants of issuances of very long-term debt. In this paper, the primary purpose of using the MNLM is to investigate changes in firms' bond maturity choice in the vicinity of the maturity eligibility threshold of five years (e.g., (3,5] versus (5,7] years and (5,7] versus (7,10] years).

To estimate changes in firms' bond maturity choice following the BOJ's corporate QE announcements, the MNLMs include two indicator variables, $QE1$ and $QE2$, which indicate whether the bond was issued during the QE1 or QE2 period. Both the variables take a value of zero if a bond was issued during the pre-period. Issuer control variables and industry fixed effects are also included to control for compositional changes in issuers. The baseline models include a dummy variable for BBB-rated bonds, the natural logarithm of total assets, net book leverage, profitability, and asset tangibility. Industry classifications are based on the Industry Classification Benchmark (ICB) 11 industries. It should be noted that some of the variables cause the problem of complete or quasi-complete separation,[38] and in such a case, the maximum likelihood estimates do not exist (Albert and Anderson, 1984). Therefore, I use the bias-corrected multinomial logit model of Kosmidis and Firth (2011), which can handle the problem of separation.[39]

Note that the coefficients of the MNLM correspond to the effects on the "log odds ratio" of choosing the maturity bin relative to the reference maturity bin. My baseline analysis uses the maturity bin of (7,10] years as the reference category as it was the most popular maturity bin. Different reference categories are, however, also used to test changes around the maturity eligibility threshold. For instance, it is possible to

[38] Complete separation occurs when the outcome variable is perfectly predicted by a set of explanatory variables. A similar situation but with some overlaps is called quasi-complete separation. See Albert and Anderson (1984) for a fuller explanation. In the context of this study, for instance, no health care firms (ICB industry code 20) in my sample issued bonds with maturities greater than 10 years, and this means that the industry's dummy variable creates a separation problem because it almost perfectly predicts whether a firm chooses the maturity bin of $>$10 years or not.

[39] The MNLM of Kosmidis and Firth (2011) is based on the penalized likelihood method of Firth (1993), which has been shown to be effective at solving the problem of separation (Heinze and Schemper, 2002). I used an R package `brglm2` (Kosmidis, 2020) for the estimation.

test whether firms became disproportionately less likely to choose the maturity bin just above the threshold by taking a look at the effect of the QE2-period dummy ($QE2$) on the log odds ratio of choosing maturities of (3,5] versus (5,7] years and (5,7] versus (7,10] years. Note, however, that while the choice of the reference category determines the parameterization of regression coefficients, it does *not* affect the estimated predicted probabilities nor the marginal effects (Long and Freese, 2014).

Before moving on to the estimation results, it should be emphasized, nevertheless, that it appears to be nearly impossible to reliably estimate the changes induced purely by the BOJ's March-16 announcement and that the results of $QE1$ should be taken with great caution. This is because the QE1 period was quite short, spanning only 41 days, and it appears likely that the massive expansion announced on April 27 had been strongly anticipated. The April-27 announcement was made immediately after a pre-scheduled Policy Board meeting on that day, and some of the topics to be discussed had been already reported by newspapers.[40] Furthermore, the SMCCF, whose maximum eligible remaining maturity was five years, was announced only a week after the BOJ's March-16 announcement, possibly giving the public a clue as to how the BOJ's corporate bond purchases would be expanded. These anticipations are likely to be an important issue since bond issuances during the QE1 period were concentrated in the later period. For instance, 21 out of the 23 bonds (91.3%) issued during the QE1 period were issued on or after April 16.[41] As such, most of the attention is directed to comparing the pre- and QE2 periods.

The MNLM results are reported in Table 5. Panel A shows the baseline result where the reference category is the maturity bucket of (7,10] years, while alternative reference categories are used in Panel C. To gauge the economic significance, I also compute the average marginal effects (AMEs) of $QE1$ and $QE2$. These marginal effects are measured as the changes in the predicted probabilities by changing the values of the dummy variables from zero to one. Because they can be viewed as dummy variables for a categorical variable with three levels (i.e., the pre-, QE1, and QE2 periods), the marginal effects of *QE1* (*QE2*) are computed by using only observations in the pre- and QE1 (QE2) periods, as recommended by

[40] A Reuters exclusive on April 14 said that the meeting would discuss options to expand its CP and corporate bond purchases. Then, four days before the meeting, Nikkei, Japan's leading business newspaper, reported that the BOJ was planning to expand both the size and scope of the purchases. Internet Appendix J provides further details.

[41] In the U.S., the SEC requires bond issuers to file a registration statement and then a pricing document, and Butler et al. (2019) report that the median number of days between the two filings is six for the 100 bonds randomly selected from their sample. Such an exercise is not possible for Japanese bond issuers as they are required to file only one document that includes full issuance information.

(Bartus, 2005). Panel B of Table 5 reports the AMEs of $QE1$ and $QE2$ (computed from the MNLM result of Panel A) together with their standard errors obtained by using the delta method.

The estimated coefficients of $QE2$ strongly support the view that, during the QE2 period, some firms shifted maturities in the vicinity of the eligibility threshold (five years). In Panel A of Table 5, the significant and negative coefficient of $QE2$ for the maturity bin of (5,7] years means that the maturity bin became less likely to be selected as compared to the reference maturity bin of (7,10] years when we compare the pre- and QE2 periods, holding issuer characteristics constant. Likewise, Column 2 of Panel C of Table 5 indicates that firms also became less likely to choose (5,7] year maturity bin when compared with the maturity bin of (3,5] years. Therefore, these results collectively indicate that the maturity bin of (7,10] years became less likely to be selected by bond issuers in the QE2 period than in the pre-period and this decrease is unique in that its neighboring maturity bins did not experience similar changes. This is consistent with the theoretical prediction that firms whose target maturities are only moderately above the eligibility threshold (five years) are the most likely to shorten maturities to meet the criterion. Moreover, the last two columns of Panel C show that firms were significantly less likely to choose the maturity bin of (5,7] years in the QE2 period than in the pre-period even when compared with the shorter maturity bins combined (Column 3) or the longer maturity bins combined (Column 4).

Panel B of Table 5 documents that the changes from the pre- to QE2 period are also economically significant. The AME of $QE2$ is -0.107 for the maturity bin of (5,7] years, implying that the probability of a bond issuer choosing a maturity of (5,7] years was lower by 10.7 percentage points in the QE2 period than in the pre-period, holding issuer characteristics fixed. At the same time, the AMEs of $QE2$ for the shorter maturity bins, which were eligible for the BOJ purchases, are positive and significant. Notably, the 9.1 percentage-point increase in the maturity segment just meeting the eligibility criterion ((3,5] years) is fairly comparable in size to the decrease of the neighboring maturity segment to the right. To put these marginal effects into perspective, Figure 6 displays the predicted probabilities for the pre-, QE1, and QE2 periods. It shows that the 10.7 percentage-point decrease of the maturity bin of (5,7] years translates into a 60.5% decrease relative to the predicted probability of this maturity segment in the pre-period (17.7%).

It should be noted, however, that the changes in firms' bond maturity choice from the pre- to QE2 periods were not limited to the maturity segments close to the eligibility threshold (five years). First, the increase in the eligible maturities occurred not only in (3,5] years but also in [1,3] years.[42] In Section 3, it is argued that the BOJ's expanded purchases following the April-27 announcement were like two separate shocks to bonds with remaining maturities in [1,3] years and (3,5] years, with the shock to the former segment possibly being greater. The MNLM result can be seen as consistent with the view that firms catered to each of the demand shocks.

On the other hand, it is certainly possible that other factors pushed firms to issue bonds in the shortest end of the maturity spectrum. Erel et al. (2012) find that the maturity of newly issued debt tends to be shorter during a downturn and argue that both capital demand- and supply-side factors can contribute to this phenomenon. First, in the framework of Myers and Majluf (1984), if adverse selection costs are higher during an economic downturn, issuers have an incentive to issue less information-sensitive securities due to the increased informational dilution cost (Bolton and Freixas, 2000). Second, capital suppliers might become more risk averse during a crisis (Caballero and Krishnamurthy, 2008; Vayanos, 2004), leading to a decrease in the demand for riskier securities. As longer maturity debt is both more information-sensitive and riskier, these arguments predict that the debt maturity decreases during a period of crisis. Therefore, it is possible that these economic forces, instead of the BOJ's corporate bond purchases, encouraged firms to issue shorter-term bonds. It is worth repeating that possible confounding effects of COVID-19-driven shocks is the main reason why I focus on changes in the maturity of new bond issues around the maturity eligibility threshold.

Second, the longest maturity segment became less popular in the QE2 period than in the pre-period. The discussion in Section 3, however, suggests that it is unlikely that this decrease was directly related to the demand shock generated by the BOJ. The reason is that those firms whose intrinsically optimal maturities are well above five years should respond the least to the demand shock as it would be prohibitively costly for them to shorten the maturity to five years. There are two possible alternative explanations for this result. First, the decrease in very long-term bond issuances might reflect a general tendency for maturities

[42]While Column 1 of Panel C of Table 5 shows that the coefficient of *QE2* is positive and significant (at the 5% level), meaning that firms became more likely to choose maturities in [1,3] years relative to (3,5] years in the QE2 period, the interpretation requires a caution. This is because the AMEs of *QE*2 are positive and significant for *both* of the maturity bins. The increases in the predicted probabilities of these maturity bins are also visually evident in Figure 6.

to be shortened during a "typical" crisis time. As very long-term bonds are the most information-sensitive and the riskiest, the capital demand- and supply-side factors pointed out by Erel et al. (2012) might have particularly discouraged firms from issuing very long-term bonds during the COVID-19 crisis in Japan.

A second possible reason can be a rise in very long-term yields observed during the QE2 period. The dynamics of the yield curves of JGBs and U.S. Treasuries are shown in Figure 7. Most importantly, the left graph of Figure 7 documents that during the QE2 period, yields of JGBs with very long maturities (20 or 30 years) kept increasing and that these movements are in contrast to those of shorter-term rates, which remained stable during the period.[43] This distinct rise in the very long end of the term structure in Japan might have discouraged firms from choosing those segments when issuing a bond. Notably, this type of effect is indeed suggested by some papers. For instance, Graham and Harvey (2001, pp. 224–225) document that more than a third of CFOs answered that issuing "short-term when short-term interest rates are low compared to long-term rates" is "important" or "very important." Likewise, Guedes and Opler (1996) find that firms tend to choose shorter maturities when the yield curve is steeper (i.e., when short-term rates appear to be relatively low).[44]

On the surface, the results of $QE1$ do not seem to be well aligned with the view that the changes in the maturity of new bond issues were driven by the BOJ's corporate QE. For instance, although the maximum eligible maturity was not five but three years in this period, Panel B of Table 5 shows that the AME of $QE1$ is negative and (marginally) significant for the maturity bin of (5,7] years. Nevertheless, the $QE1$ results are neither reliable nor statistically strong. Fist, as already discussed in detail, most of the bonds issued during the QE1 period were issued when market participants were likely aware of the great chance of a more dramatic announcement coming on April 27. Thus, the results of $QE1$ can be influenced, and possibly driven, by the anticipation of the BOJ's second corporate QE expansion, which turned out to be much larger than the first one. Furthermore, none of the coefficients of $QE1$ are statistically significant at the conventional levels in Panels A and C of Table 5.

[43]Figure 7 also shows that long-term rates increased in mid-March 2020 in both Japan and the U.S. This rise (fall) in long-term U.S. Treasury yields (prices) attracted much attention because long-term Treasuries tend to *appreciate* during a period of crisis presumably because of their special status as safe haven. This somewhat surprising phenomenon has been studied in detail by Duffie (2020), He et al. (forthcoming), and Schrimpf et al. (2020).

[44]Of course, under the expectations hypothesis firms cannot benefit from this kind of timing behavior. This behavior might result from managers' desire to inflate near-term earnings or their speculation on future interest rate changes(Chernenko and Faulkender, 2011; Faulkender, 2005; Greenwood et al., 2010).

The results of *QE*2 are robust to various changes in the model settings. First, controlling for possible seasonality in firms' bond maturity choice does not alter the results. For instance, Murfin and Petersen (2016) document seasonal variations in interest rates and loan volumes using data from the U.S. They suggest that one way to control for possible seasonality is by adding month-by-year fixed effects. I thus estimated the baseline MNLM with month-by-year fixed effects on the extended sample covering full four years (October 2016–September 2020). The result reported in Table IA.9 in Internet Appendix K are similar to those presented in Table 5.[45] Second, using an alternative pre-period of six months before the BOJ's first announcement did not qualitatively change the MNLM result. Lastly, the *QE*2 results remain qualitatively similar even when control variables and industry fixed effects are removed (see Tables IA.6 and IA.7 in Internet Appendix K). This guarantees that the MNLM results are not driven by the separation problem resulting from these explanatory variables.

I employ the MNLM to analyze changes in firms' bond maturity choice after controlling for bond- and issuer-characteristics. This model, however, has a limitation of not being able to analyze changes in issuance amounts. Therefore, to complement the MNLM results, I analyze changes in proceeds by collapsing the bond issuance data into a weekly time series for each of the five maturity bins. The details of this exercise are provided in Internet Appendix H. The results are largely consistent with those of the MNLM.

5.2.3 Cross-sectional differences

The next logical step is to investigate the heterogeneity in the maturity changes from the pre- to QE2 period. Greenwood et al. (2010) predicts that firms with greater financial flexibility respond to demand/supply shocks more strongly. The reason is that deviating from the intrinsically optimal maturity is expected to be less costly for them. The existing literature on this subject largely supports this prediction. Greenwood et al. (2010) state that their empirical analysis supports this prediction "largely, though not entirely." Badoer and James (2016) report from their analysis of very long-term debt issuance that only firms rated A or above exhibited gap-filling behavior.

To study the heterogeneity, I employ the MNLM model to compute the AMEs of *QE2* for sub-samples

[45]The results of applying the model with month-by-year fixed effects to alternative sample periods (covering full three and five years) turn out to be qualitatively similar.

divided by proxies of financial strength. The results are reported in Table 6.[46] No strong cross-sectional differences are, however, indicated in the table. In Panel A, bonds are divided into AA-rated and A/BBB-rated, with the vast majority (92%) of the latter category being rated A. The signs of the AMEs of *QE2* are the same for the two groups, except for the maturity bin of (7,10] years whose AMEs of *QE2* are close to zero for both groups, and none of the differences are statistically significant at the conventional levels. Similar analyses using market capitalization (Panel B) and net book leverage (Panel C) also do not indicate any clear differences.[47] I also repeated the exercise using other variables possibly related to financial strength, such as Tobin's Q (measured as total assets plus market value of equity minus book value of equity divided by total assets), cash holdings to assets, book leverage, and profitability. These exercises do not show any statistically significant differences, either.

In light of the fact that Japan has long been viewed as a bank-centered economy,[48] one might think that a close relationship with a bank might affect firms' financial flexibility and therefore bond maturity choice. Specifically, a strong banking relationship might decrease the firm's rollover risk by providing an option to rely on private debt in a situation in which the firm needs to roll over its debt under a bond market freeze. (Obviously, however, this is possible only if the bank is solvent and willing to help its client firms during the bond market freeze.) I therefore obtained data on the ratio of bank debt to total debt from the Capital IQ Capital Structure database and used this variable to divide the sample.[49] Internet Appendix K provides details of the data construction process and the estimation result (Table IA.12). This exercise also found no statistically significant cross-sectional differences.

Therefore, in contrast to previous studies, I do not find strong cross-sectional differences in firms' cater-

[46]This cross-sectional analysis is performed in the following manner. First, for each measure of financial strength, I create a dummy variable separating the sample. I then estimate the MNLM where the dependent variable is the same as before but the independent variables are *QE1*, *QE2*, the dummy variable about financial strength, and the interaction term of *QE2* and the dummy. Finally, the AMEs of *QE2* are computed for two separate cases: when the dummy variable takes a value of zero and one. The differences in the AMEs between the two cases are also tested. I use Stata's `margins` command to calculate standard errors of theses differences based on the delta method.

[47]More specifically, in Panel B (C) issuers are divided into two sub-samples based on the value of market capitalization (net book leverage) at the beginning of the sample period.

[48]The "main bank" system of Japan has been studied by Aoki (1990), Hoshi et al. (1990, 1991), Weinstein and Yafeh (1998), and Morck and Nakamura (1999). An overview of the banking relationship in Japan in a more recent period is provided by Hirota (2015, pp. 187–221).

[49]Note, however, that it is also possible to argue that some financial strength proxies that have been studied are also related to firms' bank dependence. For example, Kahle and Stulz (2013) and Kirti (2020) regard low (no) credit rating and small firm size, in addition to high reliance on bank debt, as indicative of bank dependence.

ing behavior. There are three specificities in this research setting that can possibly lead to the null result. First, the cross-sectional variation in the financial flexibility of Japanese bond issuers might be limited. Specifically, as already mentioned, access to the Japanese primary bond market has been virtually restricted only to highly creditworthy firms. I had to use a cutoff point of AA versus A/BBB in the cross-sectional analysis because 94.8% of the sample bonds are rated AA or A (and none of them are rated below BBB). In contrast, Badoer and James (2016) divide their sample bonds into those rated AAA/AA/A and those rated B or below. Thus, setting aside possible cross-country differences in rating standards, if the classification method of Badoer and James (2016) is mechanically applied to my Japanese data, the vast majority of the sample issuers would be classified as financially strong firms. Likewise, in one of their cross-sectional analysis, Greenwood et al. (2010) compares dividend payers (financially strong issuers) and non-payers (financially weak issuers) and find that the former more strongly exhibits gap-filling behavior. In my sample, nearly all (99.6%) bonds were issued by dividend payers.

Second, this study's sample period, the crisis period of COVID-19, might have altered firms' incentives. During such an acute crisis, the most important corporate finance matter is likely to be the securing of liquidity to keep businesses running. Notably, this is likely to be especially true for firms with weaker balance sheets. The greater need to raise external capital might have encouraged less financially strong firms to more aggressively take advantage of the positive demand shock coming from the BOJ's corporate QE.

Last but not least, the BOJ employs reverse auctions to purchase corporate bonds, and the auction protocol prioritizes bonds with higher yields, i.e., bonds issued by riskier firms. Specifically, perhaps surprisingly, in those auctions offers with the highest yields, irrespective of the market yields of the associated corporate bonds, are accepted first.[50] The auction mechanism implies that bonds issued by relatively riskier firms, presumably with higher yields, would have been preferred among those issued by eligible firms. Thus, the preferential treatment might have encouraged relatively riskier firms especially strongly to cater

[50] A more natural way to compare offers of different securities would be to compare each offer's difference between the offer yield and the market yield of the associated security. This approach is indeed commonly taken in QE auctions. In the reverse auctions to repurchase JGBs, the BOJ compares offers of different JGBs by ranking the spread between the offer yield and the "benchmark yield" of the JGB in question. (See `https://www.boj.or.jp/en/mopo/measures/mkt_ope/ope_f/opetori4.htm/`.) Similar methods have been also employed in the QE operations by the BoE (Breedon, 2018) and the Fed (Song and Zhu, 2018).

to the corporate QE-driven demand shock. Perhaps, this effect counterbalanced the opposite effect coming from the notion that deviating from the target maturity structures is costlier for financially weaker, and therefore riskier, firms. The auction mechanisms by the BOJ and other central banks are further explained in Internet Appendix B.

5.2.4 Discussion

So far, the massive expansion of the BOJ's corporate QE has been regarded as only a positive demand shock. As explained earlier, such a shock fits within the theoretical framework of Greenwood et al. (2010).

In reality, however, it is also possible that the BOJ's corporate QE affected firms' bond maturity choice through a rather unique channel. Specifically, observers have suggested that the BOJ's purchases of already issued bonds could have propagated to the primary market by encouraging the so-called "BOJ trade." In short, this trading strategy aims to profit from the BOJ's quantitative easing operations. As explained in detail in Internet Appendix B, the BOJ has purchased JGBs and corporate bonds through reverse auctions. According to the financial press, the accepted offer yields in these auctions tended to be lower than the at-issuance and secondary market yields of the associated securities. The BOJ trade tries to exploit this difference by predicting securities that could later be sold to the BOJ and purchasing them in the primary or secondary market.[51] Media reports suggest that the massive expansion of the BOJ's corporate QE provided a great opportunity for the BOJ trade, and thus escalated private investors' demand for eligible corporate bonds.[52] From the viewpoint of bond issuers, the above discussion implies that they could have catered to BOJ-trade-driven demand from private investors by choosing a maturity of five years or less.

Therefore, strictly speaking, the BOJ's purchases could have influenced firms' bond maturity not only by inducing a maturity-specific demand shock but also by creating a greater opportunity for the BOJ trade.

[51]For media coverage, see Ayai Tomisawa and Issei Hazama (2019, October 16) Record-Low 0.0000000091% Yield on Japan Bond Shows BOJ Effect. *Bloomberg*. Retrieved from `https://www.bnnbloomberg.ca/record-low-0-0000000091-yield-on-japan-bond-shows-boj-effect-1.1332580`.

[52]For instance, in July 2020, an article by Nikkei stated that an anonymous fund manager told the newspaper that her/his fund had been deciding which corporate bonds to purchase based on whether they could be later bought by the BOJ rather than credit ratings. Satoshi Matsui, Shugo Yamada, and Taichiro Sunaga (2020, July 23) *Nichigin kanwa 3kagetsu shasai CP shijou ni onkei senmei* (Easing of the Bank of Japan for 3 months—clear benefits to the corporate bond/CP market) (in Japanese). *Nikkei*. Retrieved from `https://www.nikkei.com/article/DGXLASFL22I19_S0A720C2000000/`.

Unfortunately, this paper is unable to isolate the two possible channels.[53]

It is noteworthy, however, that these two possible channels are not mutually exclusive; the alleged market distortion leading to the BOJ trade might be an unavoidable byproduct of massive purchases of already issued corporate bonds. The corporate bond market is characterized by infrequent trading and low liquidity, and this should be especially true outside the U.S., which has the most developed corporate bond market. As a result, if the BOJ, like the SMCCF, had conducted direct secondary market purchases—instead of purchases through reverse auctions—on the current scale, such purchases could have caused significant price impact. Thus, even in this case, private investors could have profited from selling (eligible) corporate bonds to the BOJ.

5.3 Simultaneous issuances of bonds with varying maturities

One important feature of corporate bond issuances is that firms often issue bonds of different maturities simultaneously (Helwege and Turner, 1999; Houston and Venkataraman, 1994). So far, my analyses have ignored this feature as they were performed at the individual bond level. In contrast, in the analysis of this section, bonds issued on the same day are grouped together.

5.3.1 Proportion of multiple-maturity bond issuances

Interestingly, multiple-maturity bond issuances (i.e., issuing multiple bonds of different maturities at the same time) became more popular in the post-pandemic period. In Table 7, bond issuances on the same day are grouped together, and the unit of observation is the unique issuance event. Panel A of Table 7 shows that while in the pre-period around half (50.8%) of unique bond issuance events were multiple-maturity issuances, this percentage increased to 70.1% in the QE2 period. This is a large increase, and the Fisher's exact test of the distributions being different in the two periods is statistically significant (p-value < 0.01).

Why did the proportion of multiple-maturity bond issuances increase? On the one hand, the increase appears to be consistent with the main finding of Choi et al. (2018, 2021). These authors show, both theoreti-

[53]Table IA.1 in Internet Appendix B summarizes the BOJ's corporate bond auction outcomes, based on publicly available information. This analysis in fact indicates that the accepted offer yields (prices) are generally lower (higher) than the secondary market yields (prices) of the associated bonds. Nevertheless, my ability to examine the BOJ trade in depth is limited. This is in part because the BOJ has not disclosed the identities of the individual bonds purchased.

cally and empirically, that when the rollover risk increases, firms increase the dispersion of their debt maturities. Based on this *maturity dispersion view*, the COVID-19 pandemic encouraged firms to choose multiple-maturity bond issuances because of the heightened economic uncertainty and the resulting rollover risk increase. On the other hand, it is also possible that the BOJ's corporate QE played a role in this increase. This is because multiple-maturity bond issuances can be viewed as a means to *partially* cater to the demand shock: by issuing a bond whose maturity is short enough for the BOJ purchases and another bond with a longer maturity, the firm was able to partially cater to the high demand at the shorter end of the maturity spectrum without much increasing its reliance on shorter-term debt. I call this a *partial catering view*.

Maturity compositions of multiple-maturity bond issuances have changed in manners consistent with the partial catering view, although these findings by no means discredit the maturity dispersion view. Panel B of Table 7 shows that the increase in multiple-maturity bond issuances was concentrated on those including maturities meeting the BOJ's maturity eligibility criterion. Conditional on being a multiple-maturity issuance, the probability of including a bond maturing in [1,3] years ((3,5] years) increased from 18.3% (59.1%) in the pre-period to 46.3% (92.6%) in the QE2 period.[54] At the same time, the probability of including a bond maturing in (5,7] years decreased from 44.1% to 16.7%. Furthermore, the last row of the panel shows that there was a significant increase in the proportion of multiple-maturity issuances including an eligible maturity bond *and* a bond maturing in ten years or more. The proportion increased from 50.5% in the pre-period to 74.1% in the QE2 period. Arguably, this type of multiple-maturity bond issuances appears to particularly fit well in the partial catering view.

5.3.2 Analysis of changes in maturity compositions of multiple-maturity bond issuances

By analyzing maturity compositions of multiple-maturity issuances, it is possible to address the mechanisms underlying the previously documented maturity distribution changes around the maturity eligibility criterion (five years). My explanation for these changes is that some firms shortened maturities to cater to the demand shock coming from the massive purchases by the BOJ (*catering channel*). Nevertheless, one possible alternative explanation is that those changes simply resulted from changes in the composition of bond

[54]Note that all the changes mentioned in this paragraph are statistically significant at the conventional levels based on Fisher's exact tests.

issuers (*composition change channel*). For instance, the observed maturity distribution changes around the eligibility threshold could arise if, for some reason, firms with target maturities of five years or less became more active in issuing bonds during the QE2 period and the opposite was true for firms with target maturities that were only moderately longer than five years. Note that in this hypothetical case *no* individual issuers shortened maturities to meet the demand shock. The MNLM analysis partially addressed the effect of the composition change channel, by including issuer control variables and industry fixed effects. However, multiple-maturity issuances allow an analysis of how individual firms vary bond maturities. This analysis can provide further support for the catering channel.

Panel C of Table 7 shows maturity compositions of multiple-maturity issuances including maturities of [1,5] years and $\geq$10 years. The panel provides a new piece of evidence suggesting that the firms indeed altered maturities due to the BOJ's massive corporate bond purchases. For instance, in the pre-period, there were no simultaneous issuances of bonds maturing in 3, 5, and 10 years, and there was only one simultaneous issuance of bonds maturing in 3, 7, and 10 years. In the QE2 period, while the former increased to 15 (37.5%), the latter decreased to zero. These contrasting changes can hardly be explained by the COVID-19-induced economic uncertainty or the consequent rise in rollover risk. Those two types of multiple-maturity issuances consisted of the same number of different maturities (three), covered the same maturity range (from three to ten years), and had very similar average maturities (6 years for the former and 6.7 years for the latter). In contrast, this observation is consistent with the view that the BOJ's corporate QE made the maturity of seven years, which marginally exceeds the eligibility threshold, disproportionately less appealing for bond issuers.

I then perform a more formal test using this sample (i.e., multiple-maturity issuances reported in Panel C of Table 7). The logit model is employed to estimate the change in the probability of maturities of (5,7] years being included from the pre- to QE1 or QE2 period, after controlling for issuer- and issuance-characteristics. The dependent variable is an indicator variable that takes a value of one if the simultaneous bond issuance includes a maturity of (5,7] years. The variables for issuer-characteristics are the same as those used for the MNLM. The issuance-characteristics included are the natural log of proceeds-weighted average maturity and a dummy variable that takes a value of one if the multiple-maturity issuance includes three different maturities or more. The bias-corrected logit model of Kosmidis and Firth (2009) is employed as it can obtain maximum likelihood estimates even when quasi-complete or complete separation is present.

The result reported in Table 8 shows that the sample issuers were less likely to include (5,7] year maturities in the QE2 period than in the pre-period. Column 1 shows that the coefficient of $QE2$ is negative and significant at the 1% level. The economic significance is also large. The AME of $QE2$ is estimated to be −22.1 percentage points, which equals the difference between the predicted probability of the pre-period (41.7%) and that of the QE2 period (19.6%). Therefore, the 22.1 percentage point decrease corresponds to a 53.0% reduction relative to the pre-period. In addition, this result seems to be robust. Columns 2 and 3 of Table 8 show that the coefficient of $QE2$ increases in size when more independent variables are included to control for issuance- and issuer-characteristics. In columns 4–6, I further restrict the sample multiple-maturity issuances to those with three different maturities (e.g., maturity combinations of 3, 5, and 10 years and 3, 7, and 10 years). Thus, this pool of issuers likely had very similar desired maturity structures. Although this restriction halves the sample size, the coefficients of $QE2$ are also negative and remain significant at the 1% level. The magnitude of the effect seems greater for this sub-sample. In column 4, the estimated AME is −57.4 percentage points as the predicted probability decreases from 81.3% to 24.0% when moving from the pre- to QE2 period.

Although Table 8 also shows that the coefficients of $QE1$ are significant and highly negative, their magnitudes are unlikely to be reliable. The seemingly strong results of $QE1$ come from the fact that there were only five sample issuances (i.e., multiple-maturity issuances including maturities of [1,5] years and $\geq$10 years) during the QE1 period and none of them included a bond maturing in (5,7] years (see panel C of Table 7). Thus, the sample is very limited and quasi-complete separation is present, meaning that the maximum likelihood estimate does not exist and the coefficient is estimated thanks to the penalized likelihood approach of Kosmidis and Firth (2009).

5.4 Offering yields and spreads

Having documented changes in firms' bond maturity choice, I now move on to examine changes in issuing costs. The key questions in this regard are: Did the BOJ's corporate QE decrease at-issuance yields (spreads) of corporate bonds? Did firms benefit from choosing maturities eligible for BOJ purchases (i.e., five years or less) in the form of a lower interest rate?

To begin with, two notable features regarding corporate bond issuance conditions in Japan are discussed. Note that the summary statistics of offering yields and spreads have been provided in Table 3. First, the average offering spread is *higher* than the average offering yield. This is so because the short end of the JGBs yield curve was negative during the sample period. Second, offering yields and spreads tend to be very low. The median offer yield is 28 basis points and the minimum after being winsorized at the 1% level is only one basis point. The lowest yields come from bonds in the shortest maturity bin,[55] and the financial press suggests that the existence of the BOJ trade, which is explained in Section 3, is likely the root cause.[56] Coupon rates were of second-order importance to BOJ-trade-oriented investors because they did not intend to hold bonds until maturity.

I first analyze how corporate bond issuance conditions changed over the initial course of the pandemic. To do so, offering yields and spreads were regressed on issuer control variables and fixed effects for maturity bins, credit ratings, industries, and issuance months for the period from April 2019 to September 2020. The coefficients of monthly dummies are reported in Figure 8. Note that the reference month is set to December 2019 and the capped spikes represent 90% confidence intervals of the dummy variables based on the heteroskedasticity-robust standard errors.

The dynamics of the average offering yields can be seen as consistent with the view that the BOJ's corporate bond purchases eased funding conditions. Figure 8 shows that the average offering yield increased during the first two months of the pandemic. It started to increase in March 2020 and peaked in the next month. Then, the average offering yield moderately decreased in May 2020 and stayed around the same during the months that followed. The decrease in May 2020 could be a result of the BOJ's announcement on April 27, 2020. Nevertheless, identifying this effect is challenging due to the existence of other policy interventions and is beyond the scope of this paper.

[55]During my main sample period, five bonds, all with maturities of three years, were issued at the offering yield of 0.033 basis points.

[56]Ayai Tomisawa and Issei Hazama (2019, October 16) Record-Low 0.0000000091% Yield on Japan Bond Shows BOJ Effect. *Bloomberg.* Retrieved from `https://www.bnnbloomberg.ca/record-low-0-0000000091-yield-on-japan-bond-shows-boj-effect-1.1332580`.

In contrast, interpreting the dynamics of offering spreads is more challenging. On the one hand, offering spreads continued to increase during the first four months of 2020. On the other hand, even the peak of the offering spreads in the post-COVID-19 period (April 2020) was lower than or comparable to those in August–October 2020. These seemingly puzzling movements of offering spreads appear to reflect complications arising from negative interest rates (i.e., negative yields of JGBs with corresponding remaining maturities). The subsequent analysis thus mainly focuses on offering yields.

Figure 9 plots coefficients of maturity bin dummies against the baseline category of [1,3] years. They are estimated separately for the pre- and QE2 periods with issuer control variables and fixed effects for credit ratings and industries.[57] Although offering yields increase with maturity, offering spreads decrease as they move from the bin of (5,7] years to that of (7,10] years. Of course, the differences between yields and spreads at issuance come from JGB yields.

Table 9 presents the underlying regression results of offer yields together with the tests of differences in coefficients in the two periods.[58] The result implies that the relationship between yields at issuance and maturities changed only weakly at best. In Table 9, all the maturity bin dummies have greater coefficient values in the QE2 period (i.e., the curve became steeper), though the difference is statistically significant only for the bin of (7,10] years. In addition, there is no sign of a discontinuous change around the eligible maturity threshold.[59] Notably, no statistically significant changes are found when a similar analysis is performed on offering spreads (Table IA.14 in Internet Appendix K).

It should be noted, however, that the theoretical analysis of Greenwood et al. (2010) does not make a strong prediction about the effect of demand/supply conditions on the (observed) term structure of cor-

[57]I caution that the individual credit yield/spread curves displayed in Figure 9 do not necessary reflect the causal effects of maturities on credit yields/spreads. The reason for this is the self-selected nature of bond maturities. For instance, relatively high credit quality issuers, even within the same credit rating category, might tend to select longer maturities (Helwege and Turner, 1999). Therefore, Figure 9 provides limited information as to how much a firm could lower its bond offering yield/spread by changing the bond maturity. On the other hand, note that the interest here is not in the slopes of individual curves but in the *changes* in the curves between the pre- and QE2 period. This is because the main purpose of this exercise is to investigate the possibility that the BOJ's expanded corporate bond purchases disproportionately lowered offering yields and spreads of newly issued bonds whose maturities were five years of less.

[58]They are tested using Wald tests obtained by the "stacking" method of Stata's `suest` command (Weesie et al., 2000).

[59]Table 9 shows that the difference in coefficients of the maturity bin of (3,5] years and that of the maturity bin of (5,7] years is 10.88 for the pre-period and 11.61 for the QE2 period. Therefore, the gap widened by 0.73 basis points only.

porate debt.[60] This is because firms as a whole are expected to (very) elastically respond to any demand-driven yield differences across the maturity spectrum—in the most extreme case of a frictionless capital market where the maturity choice is irrelevant, until all the differences are eliminated.[61] This line of reasoning applies to the present paper's context as the BOJ's purchase size was dramatically expanded but still not unlimited.

To sum up, the analysis in this section documents two key findings: First, the average offering yield moved in a manner consistent with the view that the worsening of corporate bond issuance conditions in Japan was mitigated by the BOJ's corporate QE expansion (Figure 8). Second, the change in the relationship between yields (spreads) and maturities between the pre- and QE2 periods is found to be weak at best (Table 9). Thus, these results collectively indicate that BOJ's massive corporate bond purchases might have changed the *level* of the credit yield curve that bond issuers faced but not the *slope* of the curve. These observations appear to be puzzling given that the BOJ purchased only bonds with remaining maturities of five years or less. The theoretical discussion of Greenwood et al. (2010), however, suggests that firms' catering behavior, which has been documented in this paper, can be the key to bridge the two findings. Specifically, the increase in the supply of bonds maturing in five years or less might have largely offset the disproportionate effect that the positive demand shock could have had on offering yields in this maturity segment if firms had not changed bond maturities.

6 Discussion and conclusions

The results of this paper suggest that some firms shortened the maturities of newly issued bonds to meet the maturity eligibility criterion of the BOJ's massive corporate QE in the post-COVID-19 period. As the COVID-19 shock itself should have influenced firms' debt maturity choice, this paper focuses on maturity

[60] Greenwood et al. (2010) state, "[W]e should stress that our model's implications for returns are neither as fundamentals nor as robust as its implications for quantities" (p. 997).

[61] Nevertheless, this logic does not rule out a possible announcement effect of corporate QE for target-maturity bonds in the secondary market. That is because bond supply cannot immediately respond to a demand shock. Gilchrist et al. (2020) show that the Fed's corporate QE announcements on March 23 and April 9 disproportionately decreased the yields of corporate bonds eligible for the SMCCF (i.e., investment-grade bonds with remaining maturities of five years or less) in the secondary market. In the case of the Japanese corporate bond market, Suganuma et al. (2018) study a period preceding the pandemic, and therefore before the dramatic increase of the BOJ corporate bond purchase, and argue that the bank's corporate QE decreased credit spreads.

distribution changes in the vicinity of the eligibility criterion of five years. Consistent with theoretical predictions, the shares of eligible, shorter-term maturity segments increased, while the share of the maturity segment just above the threshold, (5,7] years, decreased relative to the neighboring maturity bins. In addition, I take advantage of multiple-maturity bond issuances to show that issuers indeed shifted maturities away from maturities just above the eligibility threshold at the intensive margin.

In contrast, no evidence suggests that U.S. firms shortened bond maturities to meet the maturity eligibility criteria of the PMCCF/SMCCF. Therefore, the distortionary effect was found in Japan, but not in the U.S. This might be because the BOJ's program was larger as a proportion of the target market size (Section 2.2). It should be noted, however, that there were also at least two important differences in the implementation of the programs. First, while the Fed created the PMCCF and the SMCCF to purchase newly issued and already issued bonds, respectively, the BOJ's program targeted only already issued bonds. Second, the purchase methods were different. The Fed's programs directly purchased bonds from the the primary and secondary markets with help from BlackRock. In contrast, the BOJ purchased corporate bonds through reverse auctions.[62] It has been argued that the BOJ's massive reverse auctions have distorted the market in an unintended manner, creating an opportunity for the "BOJ trade." Its possible effect on firms' bond maturity choice is discussed in Section 5.2.4. Consequently, it is also possible that these institutional differences, rather than the difference in program sizes, led to the different results.

It is worth emphasizing that this paper's results have implications for policymakers not only in Japan but also in other countries. Many central banks have employed corporate QE as a monetary policy response to the COVID-19 pandemic. Also, persistent low interest rates in many high-income countries, which Blanchard and Summers (2020) call "Japanification," suggest the increasing importance of unconventional monetary policies. Although no evidence suggests that the U.S. corporate bond purchase program distorted firms' bond maturity choice, the Japanese evidence suggests that policymakers should still be concerned about the possible distortionary effect of a tight maturity eligibility criterion when designing corporate QE.

[62] More details are provided in Internet Appendix B.

References

Albert, A., Anderson, J. A., 1984. On the existence of maximum likelihood estimates in logistic regression models. Biometrika 71, 1–10.

Almeida, H., Campello, M., Laranjeira, B., Weisbenner, S., 2011. Corporate debt maturity and the real effects of the 2007 credit crisis. Critical Finance Review 1, 3–58.

Aoki, M., 1990. Toward an economic model of the Japanese firm. Journal of Economic Literature 28, 1–27.

Badoer, D. C., James, C. M., 2016. The determinants of long-term corporate debt issuances. The Journal of Finance 71, 457–492.

Bank of Japan, 2009. Outright purchases of corporate financing instruments. Announcement on January 22, 2009.

Barclay, M. J., Smith Jr, C. W., 1995. The maturity structure of corporate debt. The Journal of Finance 50, 609–631.

Bartus, T., 2005. Estimation of marginal effects using margeff. The Stata Journal 5, 309–329.

Blanchard, O. J., Summers, L. H., 2020. Automatic stabilizers in a low-rate environment. AEA Papers and Proceedings 110, 125–30.

Bolton, P., Freixas, X., 2000. Equity, bonds, and bank debt: Capital structure and financial market equilibrium under asymmetric information. Journal of Political Economy 108, 324–351.

Boyarchenko, N., Kovner, A., Shachar, O., 2020. It's what you say and what you buy: A holistic evaluation of the corporate credit facilities. FRB of New York Staff Report, No. 935.

Breedon, F., 2018. On the transactions costs of UK quantitative easing. Journal of Banking & Finance 88, 347–356.

Butler, A. W., Gao, X., Uzmanoglu, C., 2019. Clientele effects explain the decline in corporate bond maturities. Available at SSRN 3315551 .

Byoun, S., Han, S. H., Shin, Y. S., in press. Does the nationally recognized statistical rating organization certification matter for japanese credit rating agencies? Journal of Financial Markets, in press .

Caballero, R. J., Krishnamurthy, A., 2008. Collective risk management in a flight to quality episode. The Journal of Finance 63, 2195–2230.

Calomiris, C. W., Larrain, M., Schmukler, S. L., Williams, T., 2019. Search for yield in large international corporate bonds: Investor behavior and firm responses. NBER Working Paper, No. 25979.

Chen, H., Xu, Y., Yang, J., 2021. Systematic risk, debt maturity, and the term structure of credit spreads. Journal of Financial Economics 139, 770–799.

Cheng, J., Skidmore, D., Wessel, D., 2020. What's the Fed doing in response to the COVID-19 crisis? What more could it do? Brookings Report pp. 6–12.

Chernenko, S., Faulkender, M., 2011. The two sides of derivatives usage: Hedging and speculating with interest rate swaps. Journal of Financial and Quantitative Analysis 46, 1727–1754.

Choi, J., Hackbarth, D., Zechner, J., 2018. Corporate debt maturity profiles. Journal of Financial Economics 130, 484–502.

Choi, J., Hackbarth, D., Zechner, J., 2021. Granularity of corporate debt. Journal of Financial and Quantitative Analysis 56, 1127–1162.

Dathan, M., Davydenko, S. A., 2020. Debt issuance in the era of passive investment. Available at SSRN 3152612.

Diamond, D. W., 1991. Debt maturity structure and liquidity risk. The Quarterly Journal of Economics 106, 709–737.

Driscoll, J. C., Kraay, A. C., 1998. Consistent covariance matrix estimation with spatially dependent panel data. Review of Economics and Statistics 80, 549–560.

Duffie, D., 2020. Still the world's safe haven? Redesigning the US Treasury market after the COVID-19 crisis. *Brookings Institution* Hutchins Center Working Paper No. 62.

Duval, R., Hong, G. H., Timmer, Y., 2020. Financial frictions and the great productivity slowdown. The Review of Financial Studies 33, 475–503.

Erel, I., Julio, B., Kim, W., Weisbach, M. S., 2012. Macroeconomic conditions and capital raising. The Review of Financial Studies 25, 341–376.

Faulkender, M., 2005. Hedging or market timing? Selecting the interest rate exposure of corporate debt. The Journal of Finance 60, 931–962.

Firth, D., 1993. Bias reduction of maximum likelihood estimates. Biometrika 80, 27–38.

Flanagan, T., Purnanandam, A., 2020. Corporate bond purchases after COVID-19: Who did the fed buy and how did the markets respond? Available at SSRN: http://dx.doi.org/10.2139/ssrn.3668342.

Flannery, M. J., 1986. Asymmetric information and risky debt maturity choice. The Journal of Finance 41, 19–37.

Galema, R., Lugo, S., 2021. When central banks buy corporate bonds: Target selection and impact of the European Corporate Sector Purchase Program. Journal of Financial Stability 54, 100881.

Gilchrist, S., Wei, B., Yue, V. Z., Zakrajšek, E., 2020. The fed takes on corporate credit risk: An analysis of the efficacy of the smccf. NBER Working Paper, No. 27809.

Graham, J. R., Harvey, C. R., 2001. The theory and practice of corporate finance: Evidence from the field. Journal of Financial Economics 60, 187–243.

Greenwood, R., Hanson, S., Stein, J. C., 2010. A gap-filling theory of corporate debt maturity choice. The Journal of Finance 65, 993–1028.

Greenwood, R., Vayanos, D., 2010. Price pressure in the government bond market. American Economic Review 100, 585–90.

Grosse-Rueschkamp, B., Steffen, S., Streitz, D., 2019. A capital structure channel of monetary policy. Journal of Financial Economics 133, 357–378.

Guedes, J., Opler, T., 1996. The determinants of the maturity of corporate debt issues. The Journal of Finance 51, 1809–1833.

Halling, M., Yu, J., Zechner, J., 2020. How did COVID-19 affect firms' access to public capital markets? The Review of Corporate Finance Studies 9, 501–533.

Han, S. H., Pagano, M. S., Shin, Y. S., 2012. Rating agency reputation, the global financial crisis, and the cost of debt. Financial Management 41, 849–884.

Hanson, S., Stein, J., Sunderman, A., Zwick, E., forthcoming. Business credit programs in the pandemic era. Brookings Papers of Economic Activity, forthcoming .

He, Z., Nagel, S., Song, Z., forthcoming. Treasury inconvenience yields during the COVID-19 crisis. Journal of Financial Economics, forthcoming .

Heinze, G., Schemper, M., 2002. A solution to the problem of separation in logistic regression. Statistics in Medicine 21, 2409–2419.

Helwege, J., Turner, C. M., 1999. The slope of the credit yield curve for speculative-grade issuers. The Journal of Finance 54, 1869–1884.

Hirota, S., 2015. Corporate finance and governance in stakeholder society: Beyond shareholder capitalism. Routledge, London.

Hoechle, D., 2007. Robust standard errors for panel regressions with cross-sectional dependence. The Stata Journal 7, 281–312.

Hoshi, T., Kashyap, A., Scharfstein, D., 1990. The role of banks in reducing the costs of financial distress in Japan. Journal of Financial Economics 27, 67–88.

Hoshi, T., Kashyap, A., Scharfstein, D., 1991. Corporate structure, liquidity, and investment: Evidence from Japanese industrial groups. The Quarterly Journal of Economics 106, 33–60.

Houston, J. F., Venkataraman, S., 1994. Optimal maturity structure with multiple debt claims. Journal of Financial and

Quantitative Analysis pp. 179–197.

Kahle, K. M., Stulz, R. M., 2013. Access to capital, investment, and the financial crisis. Journal of Financial Economics 110, 280–299.

Kalemli-Ozcan, S., Laeven, L., Moreno, D., 2020. Debt overhang, rollover risk, and corporate investment: Evidence from the European crisis. NBER Working Paper, No. 24555.

Kirti, D., 2020. Why do bank-dependent firms bear interest-rate risk? Journal of Financial Intermediation 41, 100823.

Kosmidis, I., 2020. brglm2: bias reduction in generalized linear models. R package version 0.7.0.

Kosmidis, I., Firth, D., 2009. Bias reduction in exponential family nonlinear models. Biometrika 96, 793–804.

Kosmidis, I., Firth, D., 2011. Multinomial logit bias reduction via the Poisson log-linear model. Biometrika 98, 755–759.

Kuroda, H., 2020. Novel coronavirus (COVID-19): Economic and financial developments and the responses taken by the Bank of Japan. Speech via Webcast Hosted by the Naigai Josei Chosa Kai (Research Institute of Japan) in Tokyo, May 14, 2020.

Long, J. S., Freese, J., 2014. Regression models for categorical outcomes using Stata (3rd ed.). Stata Press, College Station , TX.

Lugo, S., 2021. Short-term debt catering. Journal of Corporate Finance 66, 101817.

Lugo, S., Piccillo, G., 2019. The relation between corporate and government debt maturity in Europe. Journal of Financial and Quantitative Analysis 54, 2119–2140.

Modigliani, F., Sutch, R., 1966. Innovations in interest rate policy. American Economic Review 56, 178–197.

Modigliani, F., Sutch, R., 1967. Debt management and the term structure of interest rates: An empirical analysis of recent experience. Journal of Political Economy 75, 569–589.

Morck, R., Nakamura, M., 1999. Banks and corporate control in Japan. The Journal of Finance 54, 319–339.

Murfin, J., Petersen, M., 2016. Loans on sale: Credit market seasonality, borrower need, and lender rents. Journal of Financial Economics 121, 300–326.

Myers, S. C., 1977. Determinants of corporate borrowing. Journal of Financial Economics 5, 147–175.

Myers, S. C., Majluf, N. S., 1984. Corporate financing and investment decisions when firms have information that investors do not have. Journal of Financial Economics 13, 187–221.

Nozawa, Y., Qiu, Y., forthcoming. The corporate bond market reaction to the COVID-19 crisis. Journal of Banking & Finance, forthcoming .

O'Hara, M., Zhou, X. A., forthcoming. Anatomy of a liquidity crisis: Corporate bonds in the COVID-19 crisis. Journal of Financial Economics, forthcoming .

Packer, F., 2002. Credit ratings and the Japanese corporate bond market. In: Levich, R. M., Majnoni, G., Reinhart, C. M. (eds.), *Ratings, Rating Agencies and the Global Financial System*, Springer, pp. 139–158.

Pegoraro, S., Montagna, M., 2020. Issuance and valuation of corporate bonds with quantitative easing. Available at SSRN: http://dx.doi.org/10.2139/ssrn.3791730.

Schrimpf, A., Shin, H. S., Sushko, V., et al., 2020. Leverage and margin spirals in fixed income markets during the Covid-19 crisis. BIS Bulletin 2.

SEC, 2020. U.S. credit markets: Interconnectedness and the effects of the COVID-19 economic shock. A staff report of the Division of Economic and Risk Analysis of the U.S. Securities and Exchange Commission, October 2020.

Song, Z., Zhu, H., 2018. Quantitative easing auctions of Treasury bonds. Journal of Financial Economics 128, 103–124.

Stohs, M. H., Mauer, D. C., 1996. The determinants of corporate debt maturity structure. Journal of Business pp. 279–312.

Suganuma, K., Ueno, Y., et al., 2018. The effects of the Bank of Japan's corporate and government bond purchases on credit spreads. Institute for Monetary and Economic Studies, Bank of Japan, Discussion Paper No. 2018-E-4.

Tanaka, T., 2014. Corporate governance and the cost of public debt financing: Evidence from Japan. Journal of the Japanese and International Economies 34, 315–335.

Todorov, K., 2020. Quantify the quantitative easing: Impact on bonds and corporate debt issuance. Journal of Financial Economics 135, 340–358.

Vayanos, D., 2004. Flight to quality, flight to liquidity, and the pricing of risk. NBER Working Paper, No. 10327.

Vayanos, D., Vila, J.-L., 2021. A preferred-habitat model of the term structure of interest rates. Econometrica 89, 77–112.

Weesie, J., et al., 2000. Seemlingly unrelated estimation and the cluster-adjusted sandwich estimator. Stata Technical Bulletin 9.

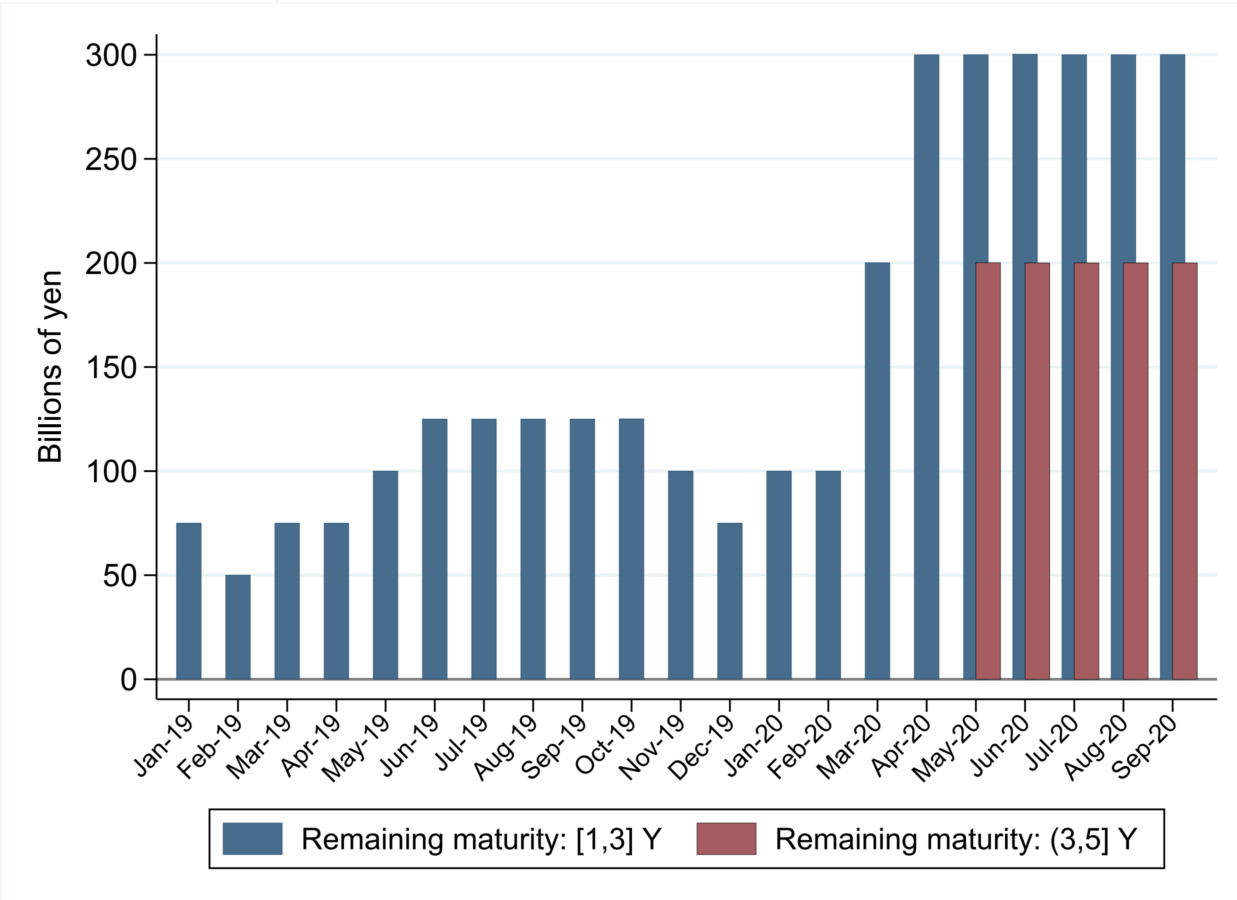
Weinstein, D. E., Yafeh, Y., 1998. On the costs of a bank-centered financial system: Evidence from the changing main bank relations in Japan. The Journal of Finance 53, 635–672.

Weld, W. C., Michaely, R., Thaler, R. H., Benartzi, S., 2009. The nominal share price puzzle. Journal of Economic Perspectives 23, 121–42.

Zaghini, A., 2019. The CSPP at work: yield heterogeneity and the portfolio rebalancing channel. Journal of Corporate Finance 56, 282–297.

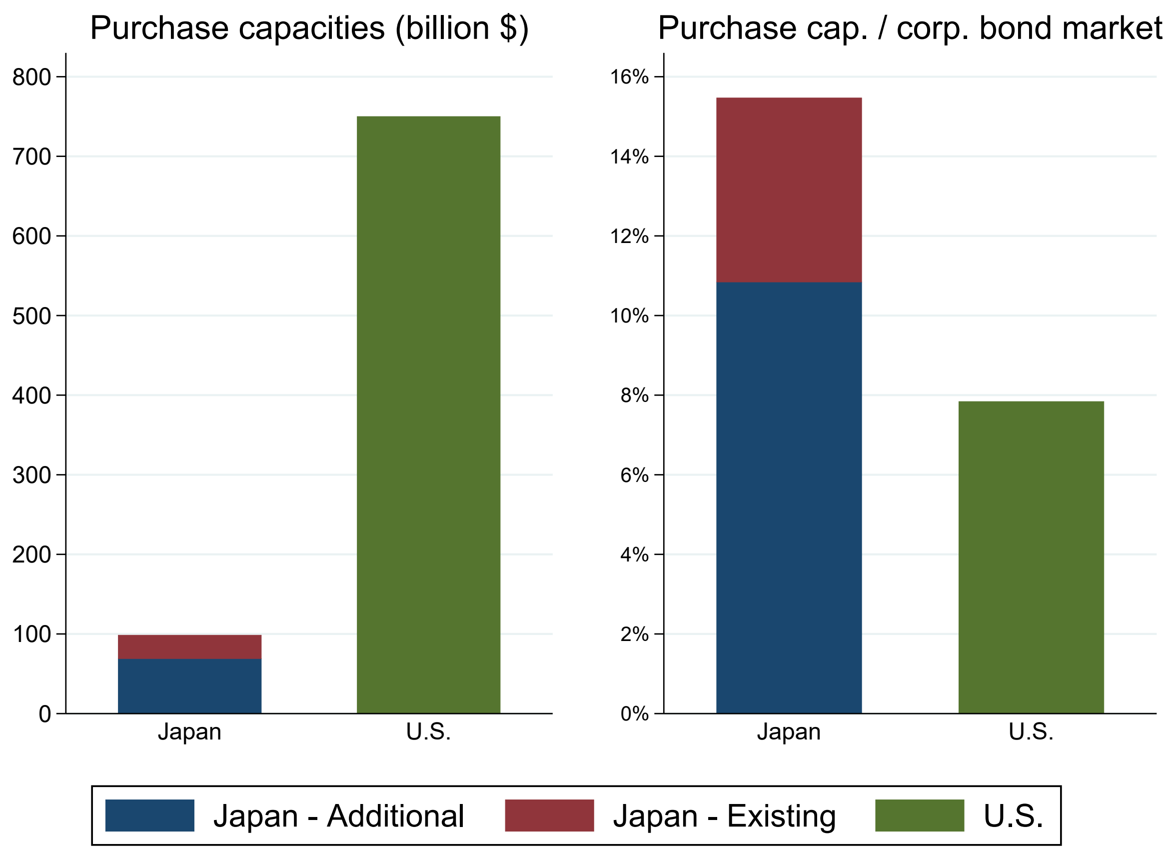
7 Figures

Figure 1: The BOJ's new corporate bond purchase amounts



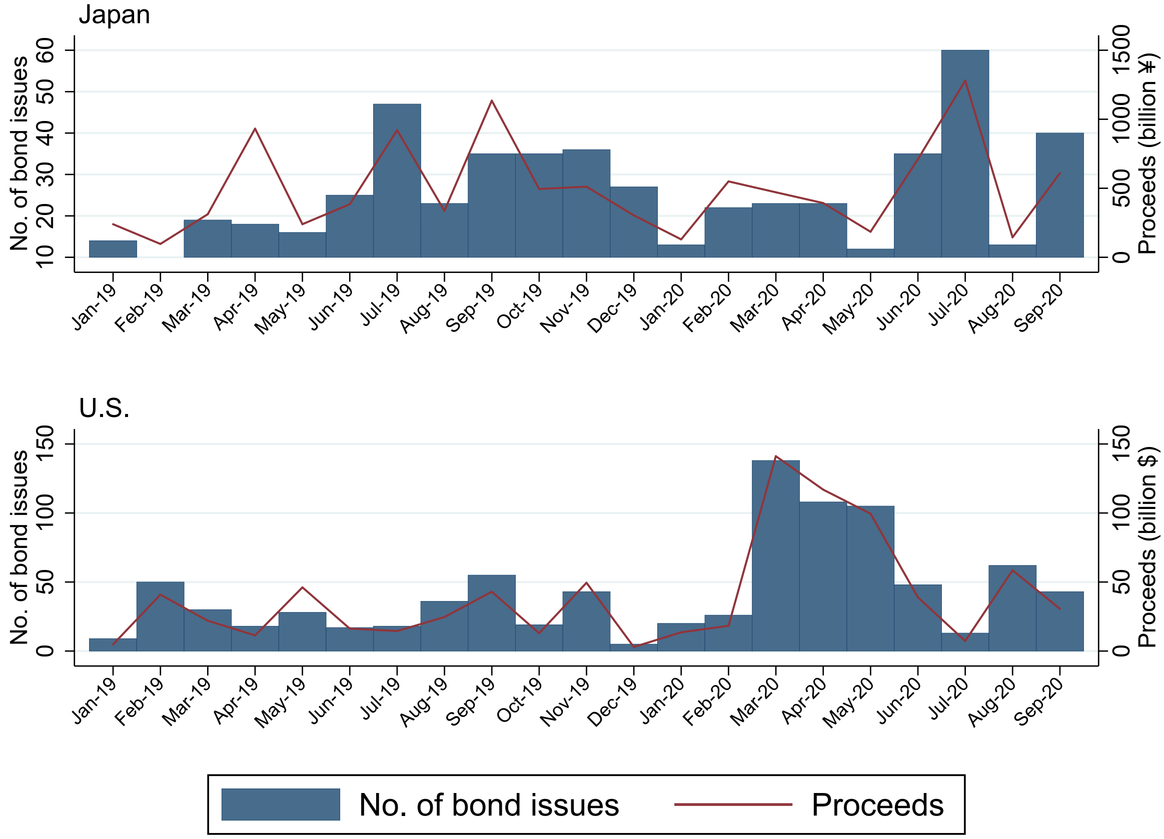
This figure shows the amounts of the BOJ's new corporate bond purchases (in billions of yen) on a monthly basis. The data were obtained from the BOJ's website regarding its market operations (`https://www.boj.or.jp/en/statistics/boj/fm/ope/index.htm/`).

Figure 2: Comparison of the corporate bond purchase capacities of the BOJ and the Fed



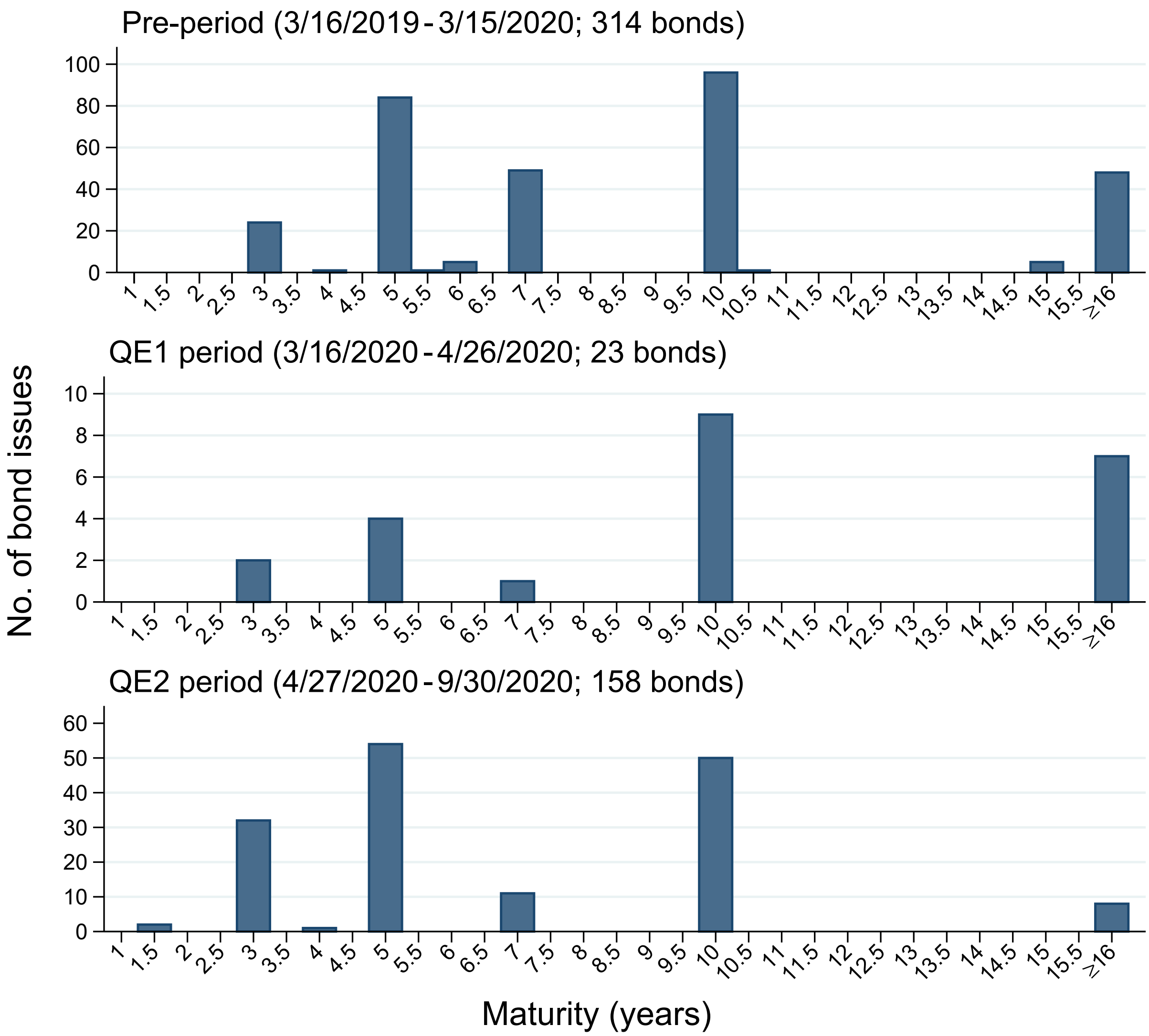
This figure shows the corporate bond purchase capacities of the BOJ and the Fed (i.e., the PMCCF and the SMCCF) during the COVID-19 pandemic. The BOJ's capacities are divided into the preexisting amounts (Japan - Existing) and the additional amounts announced on April 9, 2020 (Japan - Additional). In the graph to the right, purchase capacities are normalized by the domestic corporate bond market sizes. See Section 2.2 for data sources.

Figure 3: Corporate bond issues in Japan and the U.S.



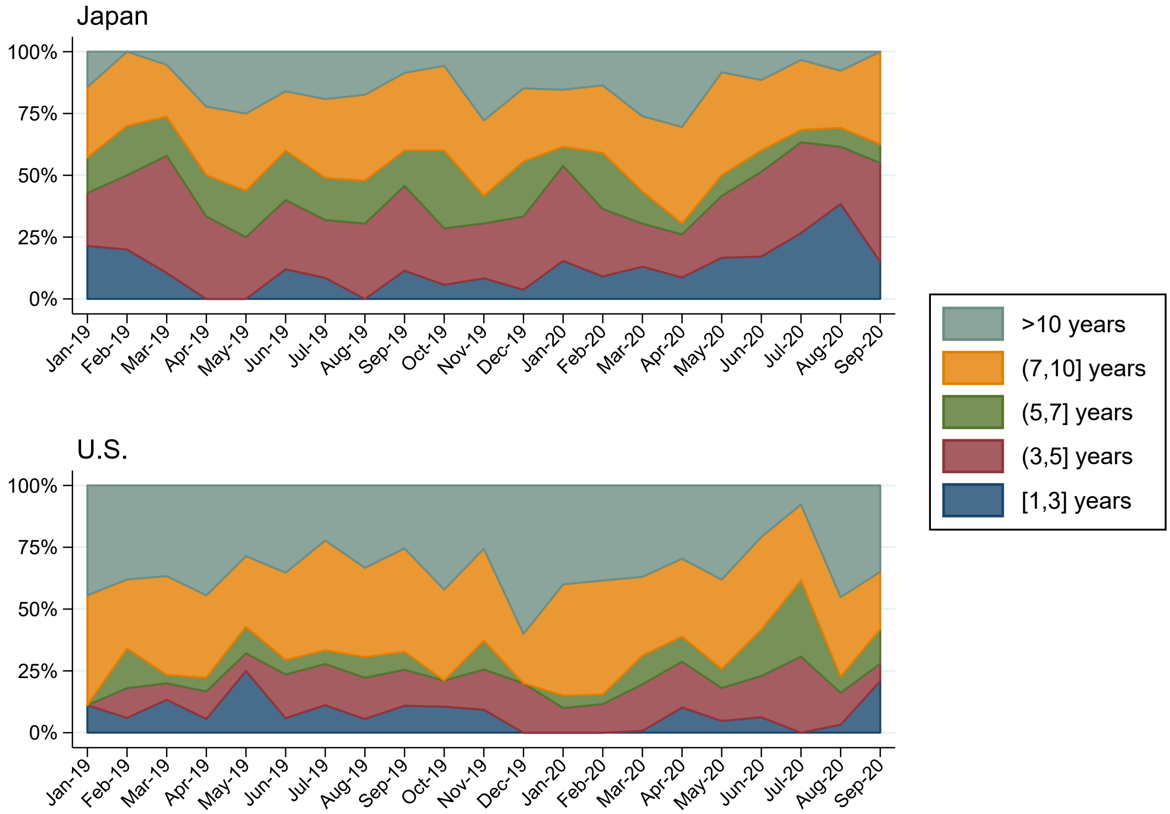
This figure shows the number of newly issued bonds and their aggregate face value. The sample firms are public, non-financial, and non-utility firms. The Japanese data were obtained from the JSDA and Datastream. The U.S. data were obtained from the SDC Platinum and Compustat.

Figure 4: Maturity distribution



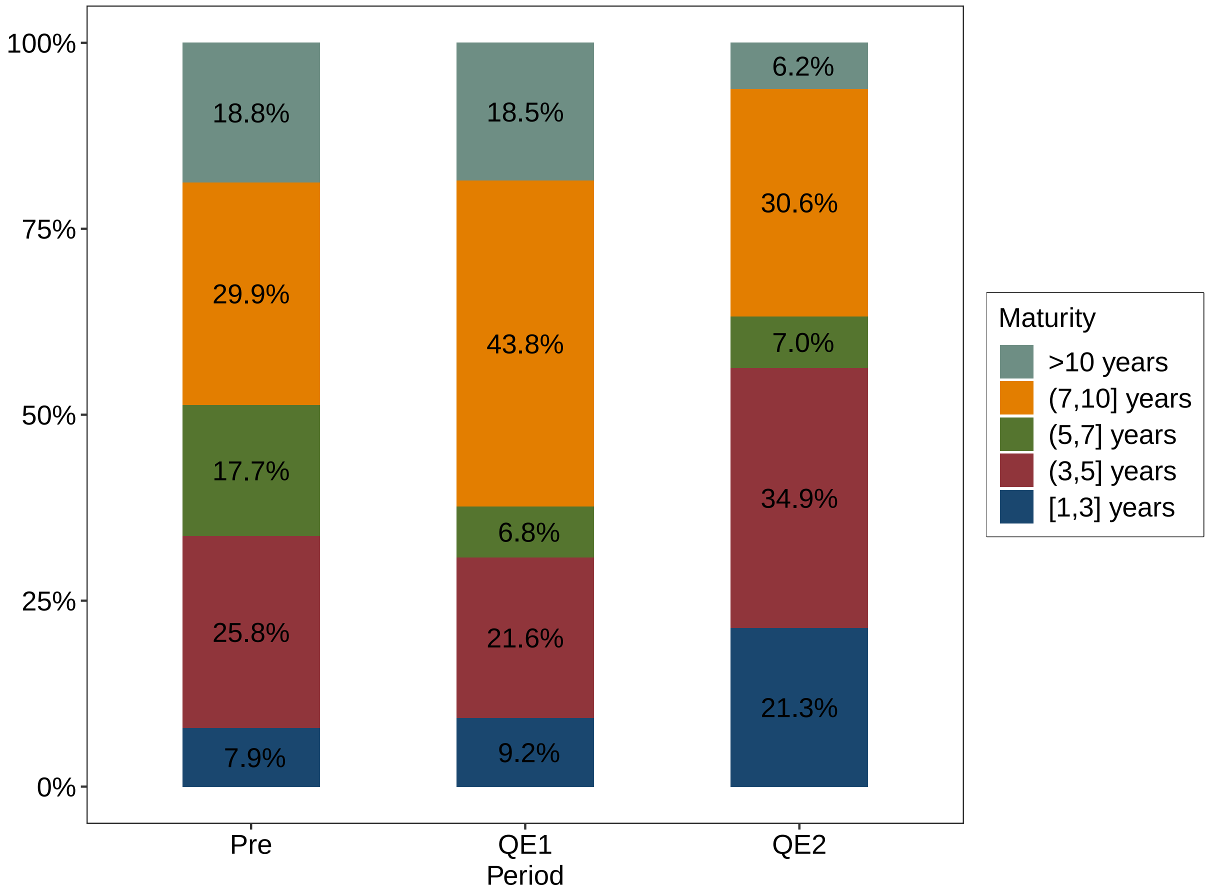
This figure shows the distributions of corporate straight bond issues by maturity. The issuers are public firms in non-financial and non-utility industries in Japan. The data were obtained from the JSDA.

Figure 5: Maturities of newly issued corporate bonds in Japan and the U.S.



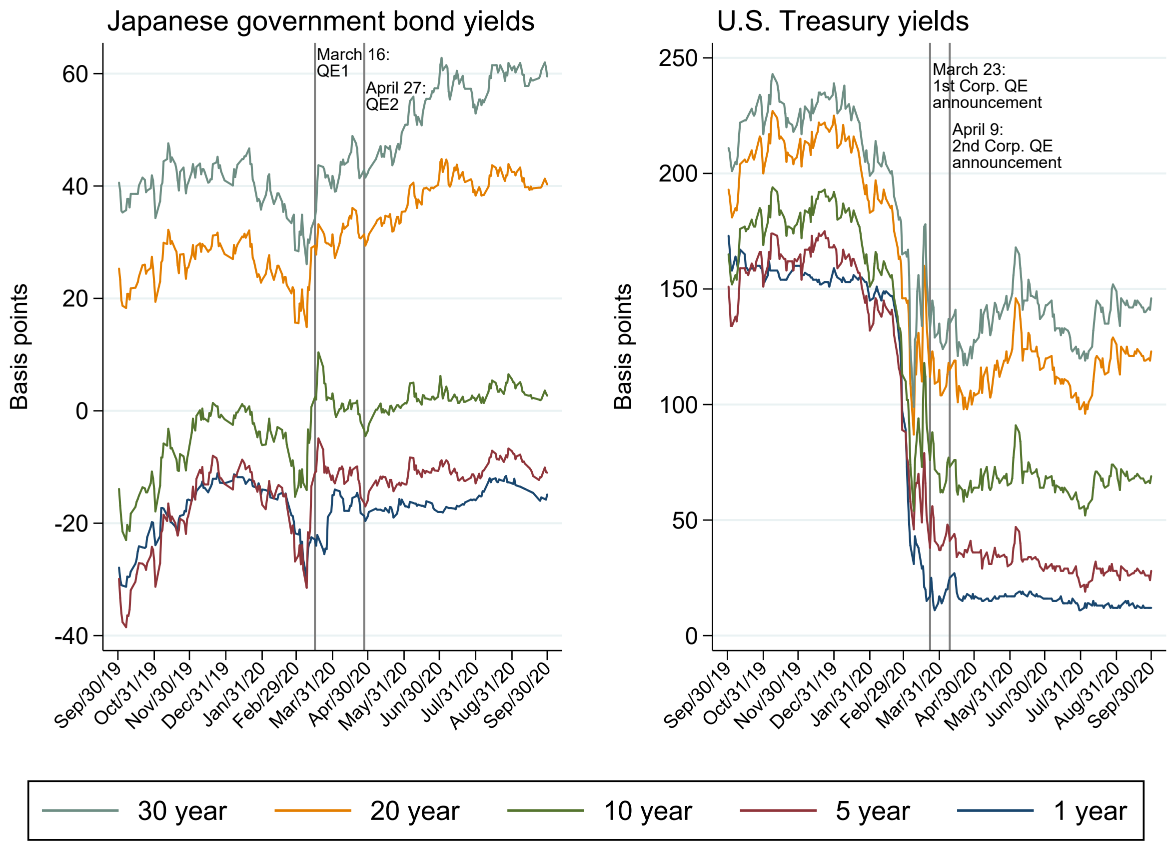
This figure shows the proportions of maturities of newly issued corporate bonds in Japan and the U.S. The sample firms are public, non-financial, and non-utility firms. The Japanese data were obtained from the JSDA and Datastream. The U.S. data were obtained from the SDC Platinum and Compustat.

Figure 6: Predicted probabilities based on the baseline multionomial logit model



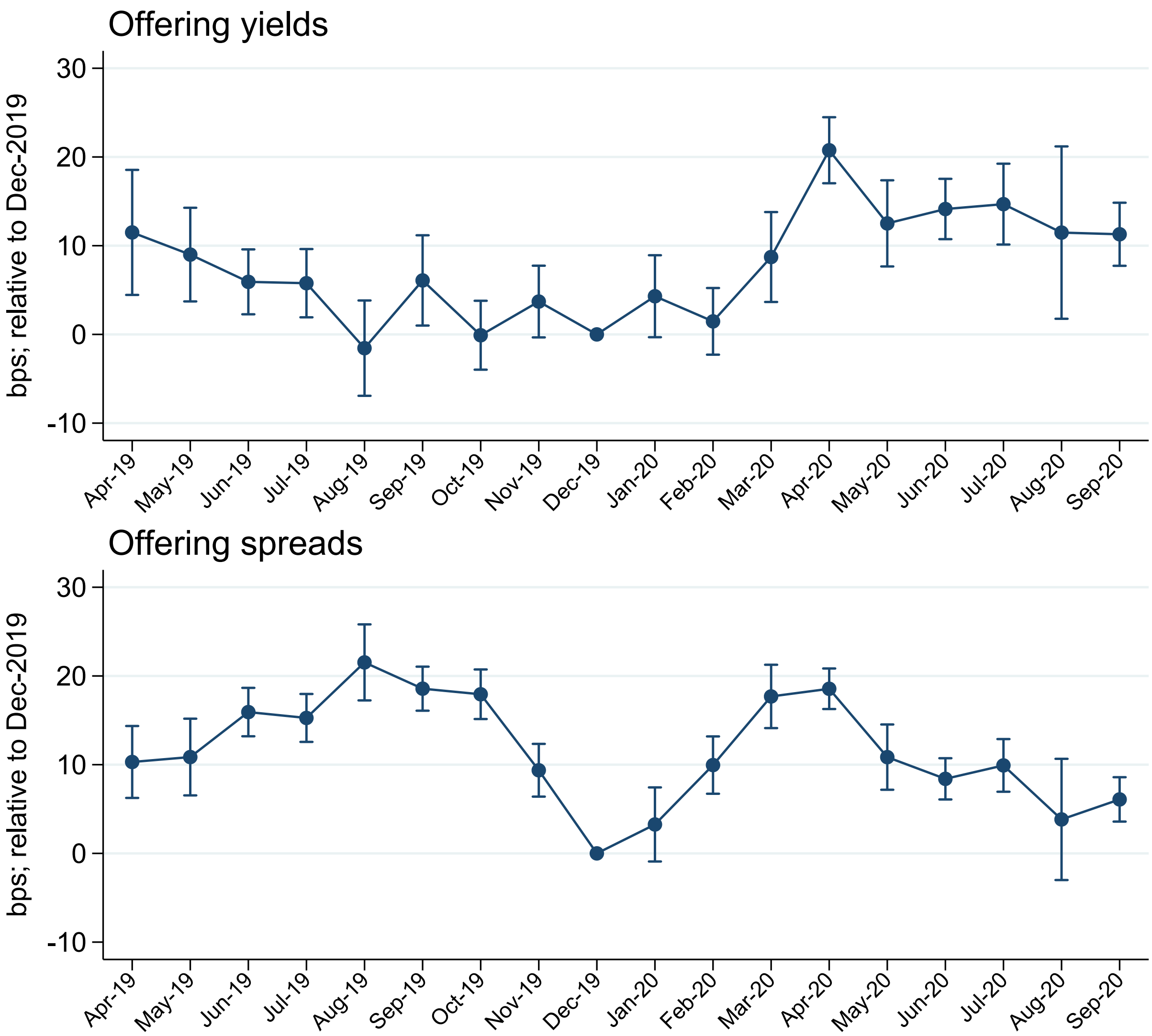
The estimated predicted probabilities of maturity bins for Pre-, QE1, and QE2 periods are displayed. They are derived from the multinomial logit model in Table 5.

Figure 7: Dynamics of the term structures of Japanese government bonds and U.S. Treasuries



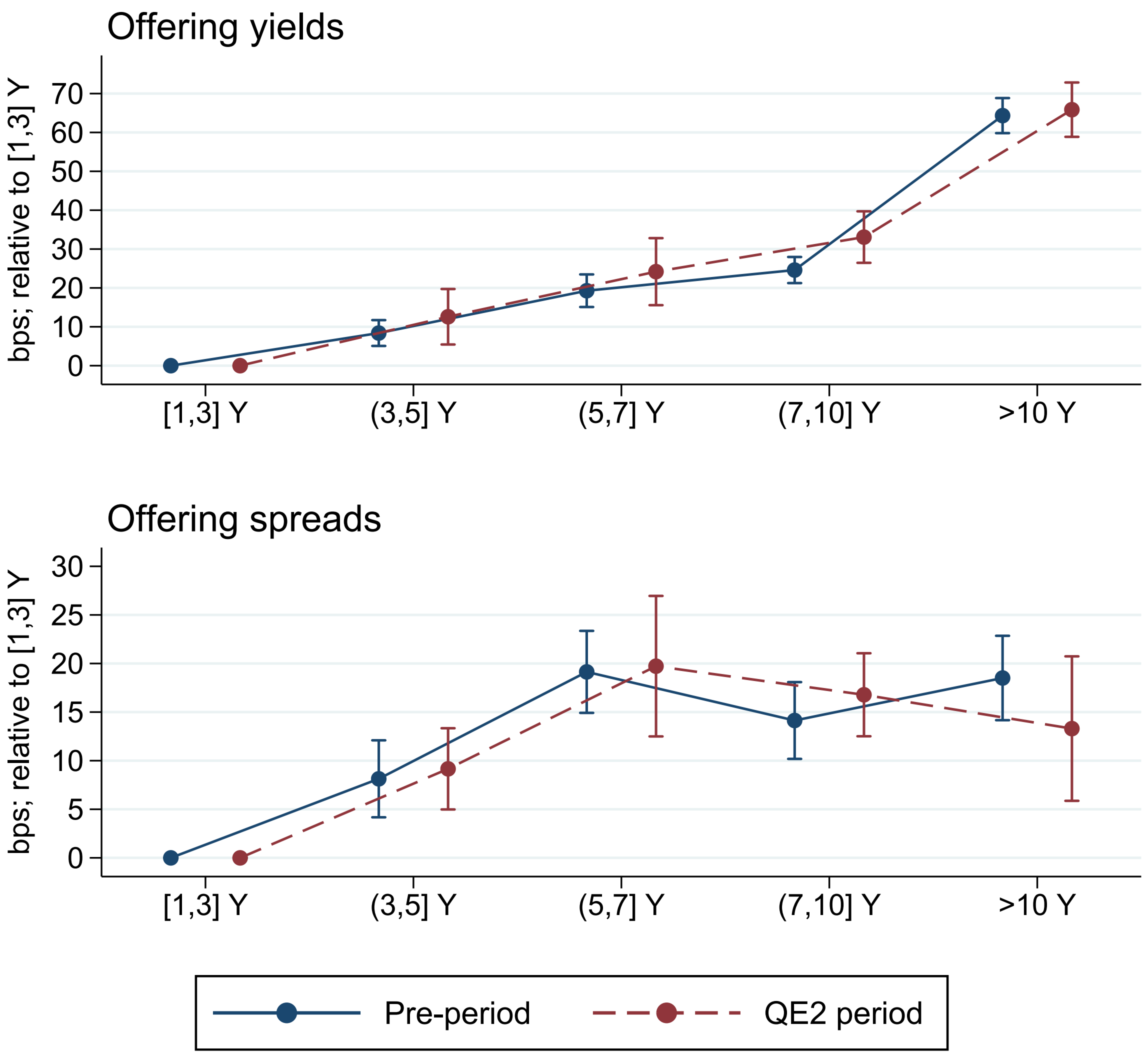
This figure plots the yields of Japanese government bonds (left graph) and U.S. Treasuries (right graph) with constant maturities of 1, 5, 10, 20, and 30 years. The sample period is from October 1, 2019 to September 30, 2020. The Japanese government bond yield data were obtained from the Ministry of Finance's website at `https://www.mof.go.jp/english/jgbs/reference/interest_rate/index.htm`. The U.S. Treasury yield data were obtained from FRED.

Figure 8: Dynamics of offering yields and spreads



This figure plots coefficients of monthly dummies obtained from the OLS regressions of at-issuance yields and spreads. The reference month is December 2019 and the sample spans from April 2019 to September 2020. Capped spikes represent 10% confidence intervals based on heteroskedasticity-robust standard errors. The models include fixed effects for maturity bin, credit rating, and industry and the following control variables: *Ln(proceeds)*, *Ln(total assets)*, *Net book leverage*, *Profitability*, and *Asset tangibility*. Variable definitions are provided in Table IA.2. All the continuous variables are winsorized at the 2.5% and 97.5% levels.

Figure 9: Term structures of offering yields and spreads



This figure plots coefficients of dummies for maturity bins obtained from the OLS regressions of at-issuance yields and spreads. The models are estimated separately for the pre- and QE2 periods. The pre-period covers one full year ending on March 15, 2020. The QE2 period starts on April 27, 2020 and ends on September 30, 2020. The reference category is bonds maturing in [1,3] years. Capped spikes represent 10% confidence intervals based on heteroskedasticity-robust standard errors. The models include credit rating and industry fixed effects and the following control variables: *Ln(proceeds)*, *Ln(total assets)*, *Net book leverage*, *Profitability*, and *Asset tangibility*. Variable definitions are provided in Table IA.2. All the continuous variables are winsorized at the 2.5% and 97.5% levels.

8 Tables

Table 1: Key contents of the BOJ's announcements on March 16 and April 27, 2020

	March 16 announcement: "Enhancement of Monetary Easing in Light of the Impact of the Outbreak of the Novel Coronavirus (COVID-19)"	**April 27 announcement: "Enhancement of Monetary Easing"**
CP and corporate bond purchases	• The caps for CP and corporate bond purchases were increased by one trillion yen each. Consequently, the cap for CP was increased from ¥2.2 trillion to ¥3.2 trillion and that for corporate bonds was increased from ¥3.2 trillion to ¥4.2 trillion. • The additional purchases of one trillion yen each would be conducted until September 2020. • The key eligibility criteria remained the same. Eligible bonds were still required to have credit ratings of BBB or above (i.e., investment grades) and one- to three-year remaining maturities.	• The amounts of additional purchases of CP and corporate bond purchases were increased from one trillion yen each to ¥7.5 trillion each. As a result, the total cap became around ¥20 trillion. • The termination date was moved from September 2020 to March 2021. • While the credit rating eligibility criterion did not change, the maximum remaining maturity was extended from three years to five years. • The maximum purchase amount per issuer was increased from ¥100 billion to ¥500 billion for CP and from ¥100 billion to ¥300 billion for corporate bonds. Similarly, the BOJ's maximum ownership share per issuer was increased from 25% to 50% for CP and from 25% to 30% for corporate bonds.
Equity ETF purchases	The cap was increased from ¥6 trillion to ¥12 trillion.	The cap remained at ¥12 trillion.
"Special funds-supplying operations to facilitate corporate financing regarding the novel coronavirus (COVID-19)"	The BOJ launched the special funds-supplying operations, through which the BOJ would provide financial institutions with up to one-year loans at zero rate. The loans could be made against a variety of corporate debt, which totaled ¥8 trillion as of February 29, 2020.	Most notably, the eligible collaterals were expanded to a wider variety of private debt, which totaled ¥23 trillion as of March 31, 2020.
JGB purchases	The BOJ's JGB purchases would be maintained. The amount of JGBs held by the BOJ was planned to be increased by around ¥80 trillion per year.	The cap for JGB purchases was removed.

This information was obtained from the BOJ's website: `https://www.boj.or.jp/en/mopo/mpmdeci/state_2020/index.htm/`.

Table 2: Bond issuances and maturity by credit rating

Panel A: Credit rating distribution

	Pre-period (9/15/19–3/15/20)	QE1 period (3/16/20–4/26/20)	QE2 period (4/27/20–9/30/20)	Total
AA	99	11	54	164
A	194	12	99	305
BBB	21	0	5	26
Total	314	23	158	495

Panel B: Maturity by credit rating

	AA	A	BBB	Total
[1,3] years	28	29	3	60
(3,5] years	40	92	12	144
(5,7] years	20	44	3	67
(7,10] years	50	98	7	155
>10 years	26	42	1	69
Total	164	305	26	495

This table summarizes corporate straight bond issuances by credit rating at issuance for the period from October 1, 2019 to September 30, 2020. The issuers are public firms in non-financial and non-utility industries in Japan. When a bond is rated by more than one credit rating agency, the highest rating is assigned.

Table 3: Descriptive statistics

	Mean	S.d.	Min.	Median	Max.	N
Ln(maturity)	1.996	0.553	1.099	1.946	2.996	495
Ln(proceeds)	23.368	0.624	22.333	23.026	24.972	495
offer yield (bps)	33.515	23.810	1.000	28.000	103.000	495
Offering spread (bps)	41.890	14.422	16.400	41.200	85.100	495
Credit rating: BBB	0.053	0.223	0.000	0.000	1.000	495
Ln(total assets)	27.947	1.159	25.638	27.987	30.449	486
Net book leverage	0.199	0.196	-0.196	0.206	0.554	486
Profitability	0.090	0.036	0.025	0.085	0.182	486
Asset tangibility	0.369	0.206	0.027	0.326	0.799	486
QE1	0.046	0.211	0.000	0.000	1.000	495
QE2	0.319	0.467	0.000	0.000	1.000	495

Variable definitions are provided in Table IA.2. All the continuous variables are winsorized at the 2.5% and 97.5% levels.

Table 4: Comparison by period

	Pre	QE1	QE2	QE1 minus...		QE2 minus...	
	(N=310)	(N=23)	(N=153)	Pre	Prev. yr. (N=17)	Pre	Prev. yr. (N=140)
Ln(maturity)	2.073	2.273	1.818	0.199*	0.165	-0.256***	-0.249***
	(0.538)	(0.614)	(0.525)	[1.70]	[0.90]	[-4.85]	[-4.02]
Ln(proceeds)	23.308	23.384	23.427	0.075	-0.360*	0.119**	0.101
	(0.637)	(0.581)	(0.542)	[0.55]	[-1.70]	[1.99]	[1.44]
offer yield (bps)	32.841	53.783	31.261	20.941***	12.165	-1.580	-1.497
	(23.757)	(18.248)	(23.019)	[4.14]	[1.55]	[-0.68]	[-0.54]
Offering spread (bps)	44.519	47.909	34.763	3.390	5.679*	-9.756***	-12.771***
	(13.421)	(5.962)	(14.073)	[1.20]	[1.80]	[-7.24]	[-8.09]
Credit rating: BBB	0.068	0.000	0.033	-0.068	0.000	-0.035	-0.039
	(0.252)	(0.000)	(0.178)	[-1.29]	[.]	[-1.54]	[-1.50]
Ln(total assets)	27.923	28.462	27.918	0.539**	-0.063	-0.005	-0.035
	(1.197)	(0.789)	(1.114)	[2.13]	[-0.22]	[-0.04]	[-0.27]
Net book leverage	0.198	0.268	0.191	0.069	0.099*	-0.008	-0.015
	(0.198)	(0.158)	(0.195)	[1.64]	[1.90]	[-0.40]	[-0.67]
Profitability	0.093	0.070	0.087	-0.023***	-0.062***	-0.006	0.000
	(0.037)	(0.021)	(0.035)	[-2.90]	[-5.25]	[-1.61]	[0.03]
Asset tangibility	0.365	0.466	0.364	0.101**	0.118*	-0.000	-0.012
	(0.206)	(0.213)	(0.204)	[2.26]	[1.85]	[-0.01]	[-0.51]

This table reports the means and the differences in means of bond and issuer characteristics by sub-period. The sample period consists of three sub-periods: the pre-period (from March 16, 2019 to March 15, 2020), QE1 period (from March 16 to April 26, 2020), and QE2 period (from April 27 to September 30, 2020). The first three columns report the means accompanied by the standard deviations in parentheses. The remaining four columns document the differences in means between different sub-periods and *t*-statistics of the differences in square brackets. Specifically, bonds issued in the QE1 and QE2 periods are compared with those issued in the pre-period and those issued in the same periods of the previous year. Variable definitions are provided in Table IA.2. All the continuous variables are winsorized at the 2.5% and 97.5% levels. ***, **, and * indicate that the difference is significant at 1%, 5%, and 10% levels, respectively.

Table 5: Multinomial logit regressions of corporate bond maturity choice

Panel A: Coefficients (reference category = (7,10] years)

	[1,3] years	(3,5] years	(5,7] years	(7,10] years	>10 years
QE1	-0.240	-0.566	-1.360		-0.404
	(0.834)	(0.646)	(0.945)		(0.596)
QE2	1.025***	0.317	-0.960**		-1.359***
	(0.340)	(0.262)	(0.388)		(0.432)
Credit rating: BBB	0.542	0.665	0.226		-1.303
	(0.769)	(0.537)	(0.737)		(1.058)
Ln(total assets)	0.225	-0.092	0.115		0.354**
	(0.162)	(0.119)	(0.149)		(0.169)
Net book leverage	2.031*	0.006	-1.162		0.024
	(1.221)	(0.880)	(1.127)		(1.251)
Profitability	-0.032	-1.115	-3.473		-13.031**
	(5.835)	(4.224)	(5.271)		(6.610)
Asset tangibility	-0.362	-0.881	1.160		3.990***
	(1.011)	(0.810)	(1.036)		(1.055)
Industry FE	✓	✓	✓		✓
N	486				
McFadden's pseudo R^2	0.105				

Panel B: Average marginal effects

	[1,3] years	(3,5] years	(5,7] years	(7,10] years	>10 years
QE1	0.013	-0.042	-0.109*	0.139	-0.002
	(0.061)	(0.097)	(0.060)	(0.112)	(0.068)
QE2	0.135***	0.091**	-0.107***	0.007	-0.126***
	(0.036)	(0.046)	(0.030)	(0.046)	(0.028)

Panel C: Alternative reference categories

	[1,3] Y vs. (3,5] Y	(5,7] Y vs. (3,5] Y	(5,7] Y vs. [1,5] Y	(5,7] Y vs. >7 Y
	(1)	(2)	(3)	(4)
QE1	0.326	-0.794	-0.824	-1.209
	(0.894)	(1.014)	(0.963)	(0.904)
QE2	0.708**	-1.277***	-1.481***	-0.639*
	(0.339)	(0.390)	(0.373)	(0.377)
Control variables	✓	✓	✓	✓
Industry FE	✓	✓	✓	✓
N	486		486	486
McFadden's pseudo R^2	0.105		0.105	0.078

This table reports the results of the multinomial logit regressions using the bias-correction methods of Kosmidis and Firth (2011). The dependent variable is a bond maturity category. In Panel A, the reference category is the maturity bin of (7,10] years. The derived average marginal effects of *QE*1 and *QE*2 are reported by Panel B, together with standard errors obtained using the delta method. Panel C reports the MNLM results with alternative reference groups. In the first two columns of Panel C, the reference category is the maturity bin of (3,5] years. In column 3 (4) of Panel C, the maturity bins of [1,3] years and (3,5] years ((7,10] years and >10 years) are grouped together and used as the reference group. The sample period starts on March 16, 2019, one year before the BOJ's first corporate bond purchase announcement during the COVID-19 pandemic. It ends on September 30, 2020. Variable definitions are provided in Table IA.2. All the continuous variables are winsorized at the 2.5% and 97.5% levels. Standard errors are reported in parentheses below the estimated coefficients. ***, **, and * indicate that the difference is significant at 1%, 5%, and 10% levels, respectively.

Table 6: Effect heterogeneity: Comparing the average marginal effects of QE2

	Panel A: Credit rating			Panel B: Market capitalization			Panel C: Net book leverage		
	AA rated (1)	A/BBB rated (2)	Diff. (1) - (2)	≥ median (3)	< median (4)	Diff. (3) - (4)	≥ median (5)	< median (6)	Diff. (5) - (6)
[1,3] years	0.131*	0.140***	-0.008	0.132**	0.141***	-0.010	0.173***	0.103**	0.070
	(0.068)	(0.041)	(0.080)	(0.052)	(0.050)	(0.071)	(0.051)	(0.050)	(0.071)
(3,5] years	0.070	0.084	-0.014	0.128**	0.029	0.099	0.083	0.073	0.010
	(0.075)	(0.057)	(0.093)	(0.061)	(0.067)	(0.090)	(0.061)	(0.067)	(0.090)
(5,7] years	-0.055	-0.130***	0.075	-0.128***	-0.084**	-0.044	-0.124***	-0.086*	-0.038
	(0.053)	(0.035)	(0.063)	(0.042)	(0.041)	(0.059)	(0.036)	(0.046)	(0.059)
(7,10] years	-0.006	0.019	-0.025	0.030	-0.004	0.035	0.036	-0.015	0.052
	(0.077)	(0.055)	(0.094)	(0.061)	(0.067)	(0.090)	(0.063)	(0.064)	(0.089)
>10 years	-0.141***	-0.113***	-0.028	-0.162***	-0.082**	-0.080	-0.169***	-0.074***	-0.094
	(0.050)	(0.032)	(0.058)	(0.039)	(0.038)	(0.054)	(0.048)	(0.020)	(0.052)

The average marginal effects (AMEs) of *QE2* are reported together with standard errors in parentheses. The AMEs are based on the MNLMs where the dependent variable is the categorical variable for the maturity bins and the independent variables are QE1 dummy, QE2 dummy, an indicator variable dividing the sample, and the interaction between QE2 dummy and the indicator variable. In Panel A, the indicator variable takes a value of one if the bond is rated AA. In Panel B (C), the indicator variable takes a value of one if the market capitalization (net book leverage) is equal to or greater than the median at the beginning of the sample period. The AMEs are calculated separately based on the indicator variable values, and the differences in AMEs are also tested. ***, **, and * indicate that the difference is significant at 1%, 5%, and 10% levels, respectively.

Table 7: Maturity compositions

Panel A: No. of different maturities

	Pre-period (3/16/19–3/15/20)	QE1 period (3/16/20–4/26/20)	QE2 period (4/27/20–9/30/20)	Total
Single maturity	90	4	23	117
Two maturities	61	5	29	95
Three maturities	28	3	24	55
Four maturities	3	0	0	3
Five maturities	1	0	1	2
Total	183	12	77	272
Multiple maturities prop.	0.508	0.667	0.701	
Diff. vs. Pre: *p*-value (Fisher's exact test)		0.376	0.004	

Panel B: Characteristics of multiple-maturity issuances

	Pre-period (N=93)	QE1 period (N=8)		QE2 period (N=54)	
	Mean	Mean	Diff. vs. Pre (*p*-value)	Mean	Diff. vs. Pre (*p*-value)
N. of different maturities	2.398	2.375	-0.023 (0.92)	2.500	0.102 (0.33)
Ln(sum of proceeds)	24.217	24.326	0.109 (0.66)	24.352	0.135 (0.23)
Ln(average proceeds)	23.375	23.481	0.106 (0.62)	23.467	0.091 (0.33)
Including [1,3] Y	0.183	0.250	0.067 [0.64]	0.463	0.280 [0.00]
Including (3,5] Y	0.591	0.500	-0.091 [0.72]	0.926	0.335 [0.00]
Including (5,7] Y	0.441	0.125	-0.316 [0.13]	0.167	-0.274 [0.00]
Including (7,10] Y	0.753	1.000	0.247 [0.19]	0.796	0.044 [0.69]
Including >10 Y	0.344	0.500	0.156 [0.45]	0.111	-0.233 [0.00]
Ln(weighted average maturity)	2.158	2.134	-0.024 (0.88)	1.872	-0.286 (0.00)
Weighted SD of maturities	3.181	3.605	0.424 (0.55)	2.543	-0.638 (0.03)
Incl. [1,5] Y and >10 Y	0.505	0.625	0.120 [0.72]	0.741	0.235 [0.01]

Panel C: Maturity compositions of issuances including maturities of [1,5] years and ≥10 years

Maturities (years)	Pre-period	QE1 period	QE2 period	Total
5, 10	18	2	15	35
5, 7, 10	14	0	5	19
3, 5, 10	0	1	15	16
5, 10, >10	3	1	2	6
5, >10	3	0	0	3
3, 10	2	0	0	2
3, 10, >10	0	1	1	2
3, 5, 7, 10	2	0	0	2
1.5, 3, 5, 7, 10	0	0	1	1
3, >10	1	0	0	1
3, 5, 7, 10, >10	1	0	0	1
3, 7, 10	1	0	0	1
3, 7, 10, >10	1	0	0	1
4, 10	0	0	1	1
5, 7, >10	1	0	0	1
Total	47	5	40	92

Bonds that have different maturities but were issued by the same company on the same date are treated as part of one unique bond issuance event. Panel A addresses all the sample bond issuances, whereas Panel B considers only multiple-maturity issuances. In Panel B, characteristics of multiple-maturity bond issuances in the QE1 and QE2 periods are compared and tested against those of the pre-period. For non-binary variables, *p*-values obtained from *t*-tests are reported in round brackets. For binary variables, *p*-values obtained from two-sided Fisher's exact tests are reported in square brackets. All the continuous variables are winsorized at the 2.5% and 97.5% levels. Panel C further limits the sample to multiple-maturity issuances including bonds maturing in five years or less and in 10 years or more.

Table 8: Skipping a maturity of seven years: Analyzing multiple-maturity issuances including bonds maturing in [1,5] years and ≥10 years

Dependent variable: Indicator variable of the issuance including a seven-year bond						
Sample:	All			Issues with three maturities		
	(1)	(2)	(3)	(4)	(5)	(6)
QE1	-1.666***	-1.975***	-2.065***	-3.473***	-3.487***	-3.468***
	(0.307)	(0.567)	(0.736)	(0.411)	(0.342)	(1.049)
QE2	-1.078***	-1.361***	-1.411***	-2.628***	-2.665***	-3.099***
	(0.384)	(0.297)	(0.316)	(0.547)	(0.556)	(0.534)
Ln(weighted average maturity)		0.161	0.209		-0.207	-1.460
		(0.785)	(0.678)		(1.188)	(1.192)
N. of maturities: three or more		2.251***	2.408***			
		(0.299)	(0.338)			
Credit rating: BBB			-0.010			
			(0.586)			
Ln(total assets)			-0.171			-0.621*
			(0.142)			(0.347)
Net book leverage			-2.774**			-4.894**
			(1.150)			(1.961)
Profitability			-7.296			-16.177*
			(5.042)			(8.937)
Asset tangibility			-0.652			0.809
			(0.887)			(1.255)
Industry FE			✓			✓
N	92	92	90	45	45	45
McFadden's pseudo R^2	0.026	0.114	0.134	0.127	0.127	0.210
Mean of dep. var.	0.283	0.283	0.267	0.467	0.467	0.467
Average marginal effects						
QE2	-0.221***	-0.240***	-0.235***	-0.574***	-0.580***	-0.560***
	(0.083)	(0.049)	(0.052)	(0.091)	(0.093)	(0.088)

In Panel A, the sample includes only multiple-maturity issuances including bonds maturing in [1,5] years and ≥10 years. In Panel B, the sample issuances are further restricted to those whose number of different maturities is three. The dependent variable is an indicator variable that takes a value of one if the issuance includes a bond maturing in (5,7] years. The bias-corrected logit models of Kosmidis and Firth (2009) are estimated, using Stata's `brglm` command. Heteroskedasticity-robust standard errors are reported in parentheses. The AMEs of $QE1$ are not reported because Stata's `margins` command returns implausibly low standard errors for them in some columns, presumably due to the rarity of the observations falling into this category. All the continuous variables are winsorized at the 2.5% and 97.5% levels. ***, **, and * indicate significance at 1%, 5%, and 10% levels.

Table 9: Changes in the determinants of offering yields

	Pre-period	QE2 period	QE2 period vs. Pre-period	
			Diff. in coeff.	χ^2 stat. [p-value]
Maturity: (3,5] Y	8.40***	12.58***	4.19	0.88 [0.35]
	(2.01)	(4.31)		
Maturity: (5,7] Y	19.28***	24.19***	4.91	0.81 [0.37]
	(2.54)	(5.21)		
Maturity: (7,10] Y	24.61***	33.08***	8.47**	4.03 [0.04]
	(2.03)	(4.00)		
Maturity: >10 Y	64.33***	65.86***	1.53	0.10 [0.75]
	(2.73)	(4.22)		
Credit rating: A	10.15***	11.40***	1.25	0.09 [0.76]
	(1.74)	(4.04)		
Credit rating: BBB	24.54***	31.00**	6.46	0.23 [0.63]
	(3.22)	(14.03)		
Ln(proceeds)	1.86	-1.55	-3.41	1.16 [0.28]
	(1.62)	(2.96)		
Ln(total assets)	0.26	0.66	0.40	0.03 [0.87]
	(0.63)	(2.46)		
Net book leverage	4.42	24.08**	19.66*	3.30 [0.07]
	(3.20)	(11.12)		
Profitability	-45.87***	-56.45	-10.58	0.03 [0.87]
	(17.69)	(66.84)		
Asset tangibility	-1.85	-19.63***	-17.79**	5.57 [0.02]
	(3.65)	(7.13)		
Industry FE	✓	✓		
N	310	153		
Adjusted R^2	0.822	0.590		
Mean of dep. var.	32.84	31.26		
S.D. of dep. var.	23.76	23.02		

The dependent variable is the offering yield. Variable definitions are provided in Table IA.2. All the continuous variables are winsorized at the 1% and 99% levels. In the first two columns, heteroskedasciticy-robust standard errors are reported in parentheses. The differences in coefficients are tested using Wald tests obtained by the "stacking" method of Stata's `suest` command (Weesie et al., 2000). ***, **, and * indicate that the difference is significant at 1%, 5%, and 10% levels, respectively.

Internet Appendix for “Are corporate bond maturities shortened to match corporate QE criteria during the COVID-19 pandemic? Evidence from Japan”

Internet Appendix

Internet Appendix A A brief history of the BOJ's corporate bond purchases

While the BOJ pioneered quantitative easing in March 2001 as an alternative monetary policy tool under close-to-zero interest rates,[1] the bank did not take a further step of purchasing corporate bonds until the global financial crisis occurred. The possibility of purchasing short-term corporate debt was first mentioned in an announcement in December 2008.[2] The bank then began purchasing CP in the next month,[3] and corporate bonds in March 2009 under the following two key eligibility conditions: remaining maturities of one year or less and credit ratings of A or above.[4] The BOJ ended the program at the end of the year, stating that "issuing conditions in the CP and corporate bond markets have been improving markedly."[5]

The Comprehensive Monetary Easing (CME) program announced in October 2010 marked the resumption of the bank's corporate bond purchases. One of the pillars of the CME was the creation of the Asset Purchase Program, through which the BOJ could purchase a wide range of assets such as government bonds, CP, corporate bonds, and equity ETFs.[6] Corporate bonds that were rated as investment grade and maturing within one or two years were eligible for purchase.[7]

The CME was then supplanted by a new program, the Quantitative and Qualitative Monetary Easing (QQME), which was unveiled on April 4, 2013. The newly appointed BOJ Governor Haruhiko Kuroda explained that the QQME was based on his belief that the BOJ "should do whatever is necessary to overcome deflation" and " should make all-out efforts to utilize every possible resource bestowed upon the Bank."[8]

[1] Its effects are analyzed by Bernanke et al. (2004) and Honda et al. (2013).

[2] Bank of Japan (2008, December 19) On Monetary Policy Decisions. Retrieved from `https://www.boj.or.jp/en/announcements/release_2008/k081219.pdf`.

[3] Bank of Japan (2009, January 22) Outright Purchases of Corporate Financing Instruments. Retrieved from `https://www.boj.or.jp/en/announcements/release_2009/un0901b.pdf`.

[4] Bank of Japan (2009, February 19) Statement on Monetary Policy. Retrieved from `https://www.boj.or.jp/en/announcements/release_2009/k090219.pdf`.

[5] Bank of Japan (2009, October 30) Statement on Monetary Policy. Retrieved from `https://www.boj.or.jp/en/announcements/release_2009/k091030.pdf`.

[6] One of the most controversial features is the purchase of equity via ETFs. It has been shown that although the BOJ's equity ETF purchases increased stock prices (Barbon and Gianinazzi, 2019), its effect on firms' investment was limited (Charoenwong et al., 2021).

[7] Bank of Japan (2010, October 28) Statement on Monetary Policy. Retrieved from `https://www.boj.or.jp/en/announcements/release_2010/k101028.pdf`.

[8] Haruhiko Kuroda (2013, April 12) Quantitative and Qualitative Monetary Easing. *Speech at a Meeting Held by the Yomiuri International Economic Society in Tokyo.* Retrieved from `https://www.boj.or.jp/en/announcements/press/koen_2013/data/ko130412a1.pdf`.

As part of the change, the BOJ was enabled to buy investment-grade bonds with remaining maturities of from one to three years.

Internet Appendix B Institutional details of the BOJ's corporate bond purchases

B.1 Purchase methods of QE and corporate QE

There are two major forms through which central banks conduct large-scale purchases of already issued government/corporate bonds: reverse auctions and bilateral purchases in the secondary market. A typical reverse auction goes as follows: First, the central bank announces the expected purchase amount and target securities in advance. Then, on the auction day, auction participants submit offers of price-quantity pairs of auction-eligible securities that they intend to sell. Lastly, the central bank decides which offers to accept based on its algorithm that may or may not be publicly disclosed. Reverse auctions are commonly used as a means of repurchasing government bonds. They have been used in QE operations of the BOJ (Pelizzon et al., 2018) and other major central banks, such as the Fed (Song and Zhu, 2018; D'Amico and King, 2013) and the BoE (Breedon, 2018; D'Amico and Kaminska, 2019; Joyce and Tong, 2012). Alternatively, a central bank may choose to purchase securities directly from the secondary market. The Eurosystem has mainly employed this approach to purchase bonds issued by Eurozone countries (Hammermann et al., 2019; Schlepper et al., 2020).

The BOJ has also used reverse auctions to purchase (already issued) corporate bonds, as did the BoE in its Corporate Bond Purchase Scheme (CBPS), which was initiated in 2016 (Boneva et al., 2019). On the other hand, when the Fed started its first-ever corporate QE in response to the pandemic, it hired BlackRock to purchase corporate bonds on its behalf in both the primary and secondary markets.

B.2 Auction design of the BOJ's corporate bond purchases

The BOJ's corporate bond reverse auctions are structured in the following manner. First, normally, on the last or the second last business day of a month, the bank discloses information regarding planned auctions for the subsequent two months. During the sample period, the auctions were held once a month, except for April 2020, in which two auctions were held. As already mentioned, the bank announced on April 27, 2020 that the maximum eligible remaining maturity was extended from three years to five years. Following the announcement, the BOJ started to hold separate auctions of bonds with remaining maturities of [1,3] years and for those with remaining maturities of (3,5] years. Each has been held once a month since May 2020. The pre-auction announcements include the auction dates and each auction's expected purchase amount.

Then, on the day of the auction, participants submit multiple offers, each of which is a pair of yield (price) and quantity for a specific eligible corporate bond. The auction participants are financial firms pre-screened by the BOJ. As of October 2020, there were 36 participating financial firms.[9] Each auction accepts all eligible corporate bonds, as long as they satisfy the auction's target remaining maturity range (i.e., [1,3] or (3,5] years). Note that the auctions are price-discriminatory ones, meaning that winning offers are executed at their own offer yields (prices).

Finally, the BOJ determines winning offers. The multi-good nature of these auctions means that the BOJ needs an algorithm to compare offers of different bonds. One natural method would be to rank them based on their yield "concessions" (Breedon, 2018), which are differences between the offer yields and the market yields of the associated corporate bonds. The government bond reverse auctions organized by the BOJ and the BoE employ this approach to compare offers of different (eligible) bonds.[10] The BoE's CBPS takes a somewhat similar approach, in the sense that it sets a "reserve spread" for each eligible corporate bond and the BoE considers the differences between offer and reserve spreads in determining which offers to accept (Boneva et al., 2019).

Nevertheless, the BOJ states that it compares only unadjusted offer yields. Specifically, the BOJ states that it "accepts bids by starting with the highest desired yield and continuing down so that the amount purchased per single issuer's CP and corporate bonds remains within the unused purchase value," while "the Bank reserves the right to reject all or some of bids which a counterparty submits when deemed appropriate."[11] Therefore, taken at face value, the BOJ's protocol implies that bonds issued by relatively riskier firms, to the extent that they inherently bear higher yields, are preferred among those issued by eligible firms. This is a unique (and often overlooked) feature of the BOJ's corporate bond auctions.

[9] `https://www.boj.or.jp/mopo/measures/select/opelist01.pdf`

[10] In the case of the Fed's QE reverse auctions, the offer yields are compared with the yields implied by its (confidential) yield curve model (Song and Zhu, 2018).

[11] `https://www.boj.or.jp/en/mopo/measures/mkt_ope/ope_s/opetori19.htm/`

B.3 Auction concessions and the "BOJ trade"

It has been argued that the BOJ's massive purchases of JGBs and corporate bonds have unintentionally distorted the Japanese financial market. At the core of this criticism is the existence of the so-called "BOJ trade." According to the financial press, this trading strategy aims to profit from yield concessions in the BOJ's reverse auctions, by purchasing assets targeted by BOJ's purchase operations in the primary or secondary market to sell them to the BOJ at the earliest possible time. It has been claimed that the BOJ trade has played an important role in the JGB market[12] and the corporate bond market.[13] Notably, Breedon (2018) documents significant yield concessions in the context of the BoE's reverse auctions of U.K. government bonds.[14]

To grasp the nature of the BOJ's corporate bond auctions, Table IA.1 summarizes the key information released by the BOJ regarding its reverse auctions of corporate bonds from January to September 2020. Notably, there were two auctions of bonds with remaining maturities of [1,3] years in April 2020 following the first corporate QE expansion announcement on March 16, 2020. Then, as a result of the second expansion announcement on April 27, the auctions of bonds with remaining maturities of (3,5] years started in the next month.

Although only pre-screened financial firms can join the reverse auctions, other investors can sell bonds to the central bank indirectly through the auction participants. Using transaction-level data, Boneva et al. (2019) show that when the BoE's CBPS purchased corporate bonds, there were large increases in the net purchases by dealers, most of whom could participate in the reverse auctions, and in the net selling by other active bond investors such as insurance companies. Boneva et al. (2019, p. 10) conclude, "The aggregate quantity of bonds sold by insurance companies and asset managers during the purchase period suggests that these investors were the ultimate sellers of around half of the bonds bought by the BoE, with the remainder coming from dealers balance sheets."

The available data strongly suggest the existence of yield concessions for both of the two maturity

[12]Eleanor Warnock (2014, April 14) Massive BOJ-Buying Silences JGB Market. *The Wall Street Journal.* Retrieved from `https://www.wsj.com/articles/BL-MBB-19545`.

[13]Ayai Tomisawa and Issei Hazama (2019, October 16) Record-Low 0.0000000091% Yield on Japan Bond Shows BOJ Effect. *Bloomberg.* Retrieved from `https://www.bnnbloomberg.ca/record-low-0-0000000091-yield-on-japan-bond-shows-boj-effect-1.1332580`.

[14]I am not aware of any study that systematically analyzes yield concessions in the BOJ's reverse auctions of JGBs.

categories. Nonetheless, it is impossible to precisely measure yield concessions, and therefore the profit opportunity of the BOJ trade, because the BOJ has not disclosed the identities of the purchased corporate bonds.[15] Therefore, I first compare the average winning offer yields (column (b)) and the average market yields of corporate bonds with eligible credit ratings and remaining maturities (column (g)). The third last column shows that the average winning offer yields were always lower than the average market yields of eligible corporate bonds. The average winning offer yields are further compared with the average market yields of AAA-AA rated bonds with eligible remaining maturities (column (h)). Note that this set of bonds *un*likely provides appropriate benchmark market yields for bonds purchased by the BOJ because the auction mechanism implies that higher-yield (i.e., riskier) bonds are purchased first, as mentioned earlier. The reason why AAA-AA rated bonds are examined is to provide reasonable lower bounds of corresponding market yields. The last column of Panel A shows that the average winning offer yields were even lower than the average market yields for the least risky bonds.

In particular, Table IA.1 implies that striking yield concessions were present for reverse auctions of bonds with remaining maturities of [1,3] years in a period following the BOJ's corporate QE expansions. The average (lowest) winning offer yields had been negative since June (May) 2020. In June 2020, presumably as a result of the extremely low yields, the BOJ started to publish the lower limits that it set on offer yields for this shorter maturity category. The financial press explained that as the lower limit in June 2020 (−0.14%) was on par with the market yield of JGBs with comparable remaining maturities, the BOJ intended to signal not to buy corporate bonds at yields lower than the comparable JGB yields.[16]

[15] To be fair, the BoE also does not disclose information regarding individual corporate bonds that it has purchased in its reverse auctions (Boneva et al., 2019). It, however, discloses its sector-level corporate bond holding data, while the BOJ does not do so.

[16] *Nichigin, shasai ope de hatsu no kagen rimawari settei* (The BOJ set the lower limit yield in its corporate bond operations for the first time) (in Japanese) (2020, June 9) *Nikkei.* Retrieved from `https://www.nikkei.com/article/DGXMZO60155990Z00C20A6EN2000/`.

Table IA.1: Corporate bond operations of the BOJ, January–September 2020

Panel A: Remaining maturities: [1,3] years

									Eligible bond yields in the secondary market			
									AAA-BBB bonds		AAA-AA bonds	
Auction date	Settlement date	(a) Planned purchase amount (billion ¥)	(b) Offer amount (billion ¥)	(c) Purchase amount (billion ¥)	Offer-to-cover ratio: (b) / (c)	(d) Average winning offer yield (%)	(e) Lowest winning offer yield (%)	(f) Lower limit on offer yields (%)	(g) Average yield (%)	Diff: (d) - (g)	(h) Average yield (%)	Diff: (d) - (h)
1/23/2020	1/29/2020	100.0	315.1	100.0	3.15	0.064	0.055		0.142	-0.078	0.087	-0.023
2/20/2020	2/27/2020	100.0	254.1	100.0	2.54	0.053	0.033		0.122	-0.069	0.073	-0.020
3/23/2020	3/27/2020	200.0	370.8	200.1	1.85	0.113	0.082		0.149	-0.036	0.096	0.017
4/7/2020	4/13/2020	150.0	283.3	150.0	1.89	0.117	0.082		0.216	-0.099	0.139	-0.022
4/20/2020	4/24/2020	150.0	265.1	150.0	1.77	0.091	0.040		0.215	-0.124	0.135	-0.044
5/8/2020	5/14/2020	300.0	313.7	300.0	1.05	0.012	-0.120		0.215	-0.203	0.133	-0.121
6/9/2020	6/15/2020	300.0	375.7	300.3	1.25	-0.114	-0.140	-0.140	0.208	-0.322	0.125	-0.239
7/3/2020	7/9/2020	300.0	616.2	300.0	2.05	-0.073	-0.092	-0.140	0.189	-0.262	0.110	-0.183
8/5/2020	8/7/2020	300.0	788.6	300.0	2.63	-0.034	-0.044	-0.130	0.187	-0.221	0.107	-0.141
9/9/2020	9/11/2020	300.0	542.7	300.1	1.81	-0.037	-0.053	-0.120	0.194	-0.231	0.112	-0.149

Panel B: Remaining maturities: (3,5] years

									Eligible bond yields in the secondary market			
									AAA-BBB bonds		AAA-AA bonds	
Auction date	Settlement date	(a) Planned purchase amount (billion ¥)	(b) Offer amount (billion ¥)	(c) Purchase amount (billion ¥)	Offer-to-cover ratio: (b) / (c)	(d) Average winning offer yield (%)	(e) Lowest winning offer yield (%)	(f) Lower limit on offer yields (%)	(g) Average yield (%)	Diff: (d) - (g)	(h) Average yield (%)	Diff: (d) - (h)
5/20/2020	5/26/2020	200.0	592.0	200.1	2.96	0.212	0.170		0.289	-0.077	0.183	0.029
6/23/2020	6/29/2020	200.0	617.7	200.0	3.09	0.192	0.170		0.287	-0.095	0.176	0.016
7/22/2020	7/28/2020	200.0	487.4	200.0	2.44	0.173	0.154		0.261	-0.088	0.153	0.020
8/21/2020	8/25/2020	200.0	471.6	200.0	2.36	0.181	0.165		0.283	-0.102	0.169	0.012
9/23/2020	9/25/2020	200.0	345.1	200.0	1.73	0.154	0.133		0.251	-0.097	0.140	0.014

This table summarizes corporate bond purchases by the BOJ for the period from January to September 2020. The monetary unit is billion yen for columns (a)–(c). The auction information is disclosed by the BOJ at `https://www.boj.or.jp/en/statistics/boj/fm/ope/index.htm/`. To compare the winning offer yields with the yields of comparable bonds in the secondary market, I use the "rating matrix data" released by the JSDA. The data provide the average yield for each credit rating-remaining maturity pair on a given date. I retain only the credit rating-remaining maturity pairs whose remaining maturities correspond with the BOJ's target remaining maturities (i.e., [1,3] and (3,5] years). In column (e) ((f)), the bonds are restricted to those rated at AAA–BBB (AAA–AA). I rely on credit ratings provided by R&I. The weighted average yields on the auction dates are calculated, with the weight being the number of bonds of each credit rating-remaining maturity pair. Note that the JSDA's rating matrix data present the average yield for each $[t, t+1)$ year, where t is 2, …, 19. Bonds with remaining maturities of less than two years are put into one group. Thus, the average yields for bonds with remaining maturities of [1,2) years were linearly interpolated, under the assumption that the numbers of bonds whose remaining maturities are (0,1) and [1,2) years are the same.

Internet Appendix C The Treasury-backed Federal Reserve corporate bond purchase programs

The Fed announced on March 23, 2020 that it would significantly expand its debt purchases in both size and variety beyond that announced on March 15, 2020. What surprised the market, in particular, was the Fed's intention to purchase corporate bonds for the first time in its history. Specifically, with backing from the U.S. Treasury, the Fed launched two special purpose vehicles (SPVs): the PMCCF for purchasing newly issued corporate bonds and syndicated loans and the SMCCF for purchasing corporate bonds in the secondary market. Although the March 23 announcement specified the cap for the PMCCF and the SMCCF to be $200 billion in total, the purchasing capacities were greatly enhanced on April 9. Under the revised plan, their combined purchase size became $750 billion.

The main eligibility criteria are as follows. The SMCCF could purchase only investment-grade bonds with remaining maturities of five years or less or bond ETFs that "provide broad exposure to the market for U.S. investment grade corporate bonds."[17] However, the eligibility criteria were relaxed by the April 9 announcement. For one thing, eligible bonds were expanded to accommodate bonds issued by "fallen angels" that had been investment-graded as of March 22 and were not downgraded to below BB-/Ba3 yet. For another, regarding the SMCCF's bond ETF purchases, it was said that although the "preponderance" of purchased bond ETFs would still be those of investment-grade corporate bonds, the rest would consist of bond ETFs providing exposure to high-yield corporate bonds. Then, another major change was an announcement on June 15 that the Fed would also start purchasing "Eligible Broad Market Index Bonds," which was a diversified portfolio of eligible corporate bonds.[18]

[17] https://www.federalreserve.gov/newsevents/pressreleases/files/monetary20200323b2.pdf.

[18] https://www.federalreserve.gov/newsevents/pressreleases/files/monetary20200615a1.pdf.

Internet Appendix D Definition of variables

Table IA.2: Definition of variables

Variable	Description
Individual bond-level variables (Data source: JSDA)	
Maturity	Time to maturity (half-years)
Proceeds	Bond issue proceeds (billions of yen)
Offering yield	Offering yield (basis points)
Offering spread	Offering spread (basis points) measured as the difference between the offering yield and the yield of the same-maturity JGBs
Credit rating: AA	Dummy variable that takes a value of one if the bond is rated AA by at least one credit rating agency
Issuance event-level variables (Data source: JSDA)	
N. of different maturities	Number of different maturities included
Ln(sum of proceeds)	Natural logarithm of the sum of proceeds of the simultaneous bond issuance
Ln(average proceeds)	Natural logarithm of the average of proceeds of the simultaneous bond issuance
Including [1,3] Y	A dummy variable that takes a value of one if the simultaneous bond issuance includes a maturity in [1,3] years
Including (3,5] Y	A dummy variable that takes a value of one if the simultaneous bond issuance includes a maturity in (3,5] years
Including (5,7] Y	A dummy variable that takes a value of one if the simultaneous bond issuance includes a maturity in (5,7] years
Including (7,10] Y	A dummy variable that takes a value of one if the simultaneous bond issuance includes a maturity in (7,10] years
Including ¿10 Y	A dummy variable that takes a value of one if the simultaneous bond issuance includes a maturity greater than 10 years
Ln(weighted average maturity)	Natural logarithm of the proceeds-weighted average maturity
Weighted SD of maturities	Proceeds-weighted (population) standard deviation of maturities
Incl. [1,5] Y and $\geq$10 Y	A dummy variable that takes a value of one if the simultaneous bond issuance includes a maturity of [1,5] years and a maturity of 10 years or above
Firm-level variables (Data source: Datastream/Worldscope)	
Ln(total assets)	Natural logarithm of total assets (WC02999)
Net book leverage	Total debt (WC03255) minus cash and short-term investments (WC02001) divided by total assets
Profitability	EBITDA (WC18198) divided by total assets
Asset tangibility	Net PPE (WC02501) divided by total assets
Other variables	
QE1	Dummy variable that takes a value of one if the bond was offered between March 23 and April 26, 2020
QE2	Dummy variable that takes a value of one if the bond was offered on April 27, 2020 or later

Internet Appendix E Data sources for Figure 2

The Japanese bond market data were obtained from statistics released by the JSDA.[19] I use the total outstanding amount of "corporate straight bonds" (*futsu shasai*) as a proxy for the domestic bond market size. The amount was ¥69.2 trillion (equivalent to $637 billion) as of December 2019.[20] Bonds issued by foreign companies are not included in this number, and indeed, they indeed should be excluded because they are not targeted by the BOJ's corporate bond purchase program.

To calculate the relative size of the Fed's purchase capacities, I rely on SEC (2020), which estimates the size of the outstanding corporate bonds in the U.S., issued by U.S. and foreign firms, to be $9.1 trillion as of December 31, 2019.[21] Notably, this estimate is fairly close to the figure stated by O'Hara and Zhou (forthcoming) ($8.8 trillion).

Internet Appendix F Corporate bond issuances in Japan

Figure IA.1 documents bond issuances of all public firms, including financial firms and utilities. Other sample restrictions are the same as those explained in Section 4.

In the Japanese corporate bond market, electric power companies have long been major issuers and their bonds had a special status, being called general mortgage bonds (*ippan tanpo sai*). Some companies are founded based on special acts stating that the bonds issued by these companies would be secured by not specific but all company properties and that the bondholders are senior to other creditors. The most notable examples are, as mentioned earlier, electric power companies. Based on the Electricity Business Act of 1964, *all* of their bonds were long regarded as general mortgage bonds.[22] Although secured bonds and general mortgage bonds are not included in the main sample of the paper, this restriction is not applied to the sample of Figure IA.1.

[19] `https://www.jsda.or.jp/en/statistics/bonds/index.html`

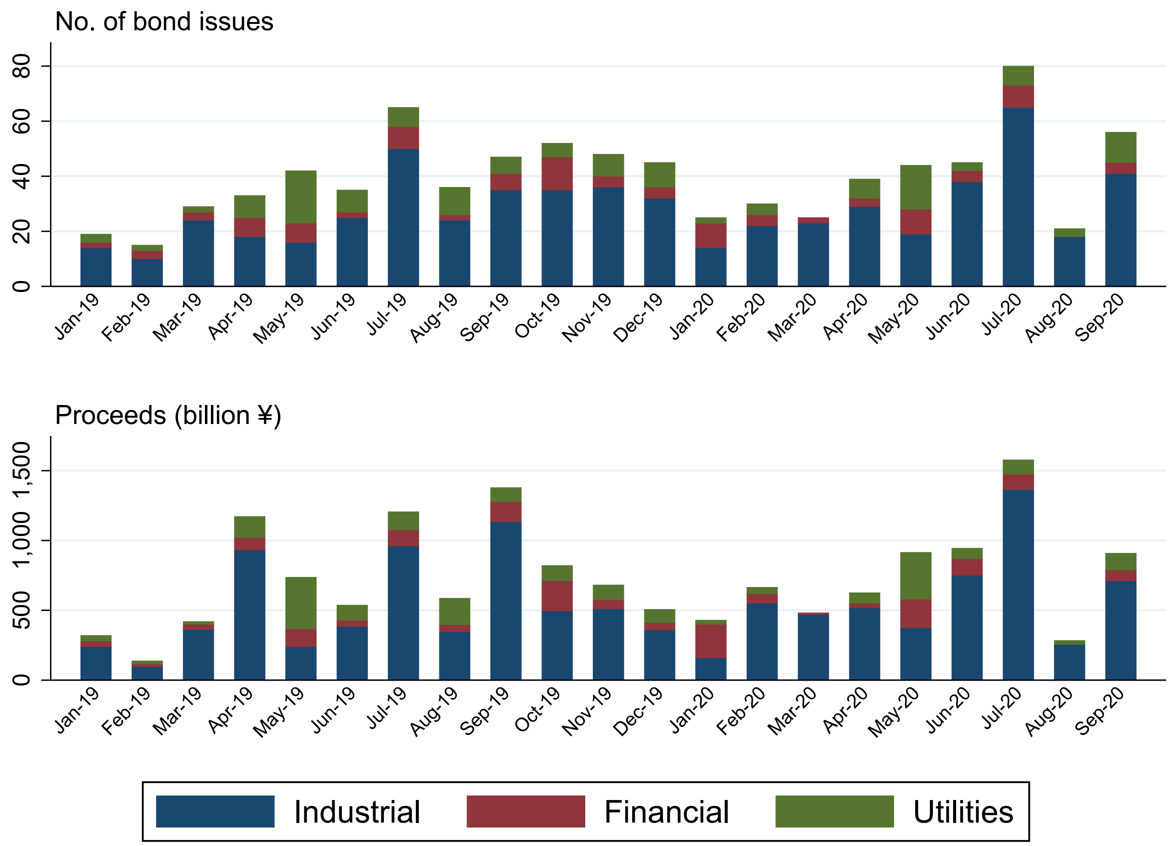
[20] The other types of bonds included in the category of "publicly offered private bonds," namely, asset backed bonds and convertible bonds, were much smaller in size. Their outstanding amounts were less than 0.4% of that of corporate straight bonds each.

[21] Note that U.S. subsidiaries of foreign companies could become eligible issuers.

[22] The consensus view of practitioners is that these special acts apply to *all* bonds issued by the special act companies. Therefore, all bonds issued by Japanese electric power companies were general mortgage bonds, until the first subordinated bond was issued by Kyushu Electric Power Company in October 2020 following modifications to the Electricity Business Act (Hirose and Oka, 2020).

Figure IA.1 shows that industrial firms occupy a significant share of bond issuances, and the graphs excluding and including financial firms and utilities exhibit similar dynamics.

Figure IA.1: Corporate bond issues in Japan



This figure shows the number of corporate straight (i.e., non-callable and non-convertible) bonds newly issued by public companies in Japan and their total face value. The sample excludes permanent bonds, equity-like bonds, and investment corporation bonds, but not general mortgage bonds. The bond information was obtained from the JSDA and the issuer information from the Datastream.

Internet Appendix G Impact of COVID-19 on Japanese financial markets

Figure IA.2 shows that the movements in the Japanese stock market resembled the movements in the U.S. stock markets, both before and after the emergence of the pandemic.[23] This similarity between the two countries is consistent with the finding of Capelle-Blancard and Desroziers (2020) that neither cross-sectional nor time-series variations in stock returns during the COVID-19 crisis are well explained by country-specific variables.

The yields and spreads of Japanese corporate bonds with various remaining maturities are plotted in Figure IA.3. The underlying data are the JSDA's "rating matrix data," which report daily average bond yields (and other statistics) for each pair of credit ratings and remaining maturities.[24] I use the average yields of bonds rated A by Rating and Investment Information (R&I) because the data show that this rating agency rated more bonds than any of its competitors and because the mode of R&I's ratings was A during the sample period.[25] To compute spreads, JGB yields were obtained from the website of the Ministry of Finance.[26]

Three observations emerge from Figure IA.3. First, the figure shows that spreads were *lower* than yields, meaning that short-term JGB yields were *negative*. Credit spreads were also very low. Second, spreads at most only modestly fluctuated around the onset of the pandemic. In stark contrast, in the U.S., credit spreads of both investment-grade and high-yield bonds soared in the weeks preceding the Fed's announcement of corporate QE facilities on March 23, 2020 (Gilchrist et al., 2020; Nozawa and Qiu, forthcoming).[27] Third, Figure IA.3 also addresses the term structure of credit spreads, and credit spread is shown to almost always increase with remaining maturity (at least up to seven years).

[23] Cross-sectional differences in stock market movements in the wake of the pandemic are studied by Ramelli and Wagner (2020) in the U.S. and by Takahashi and Yamada (2021) in Japan.

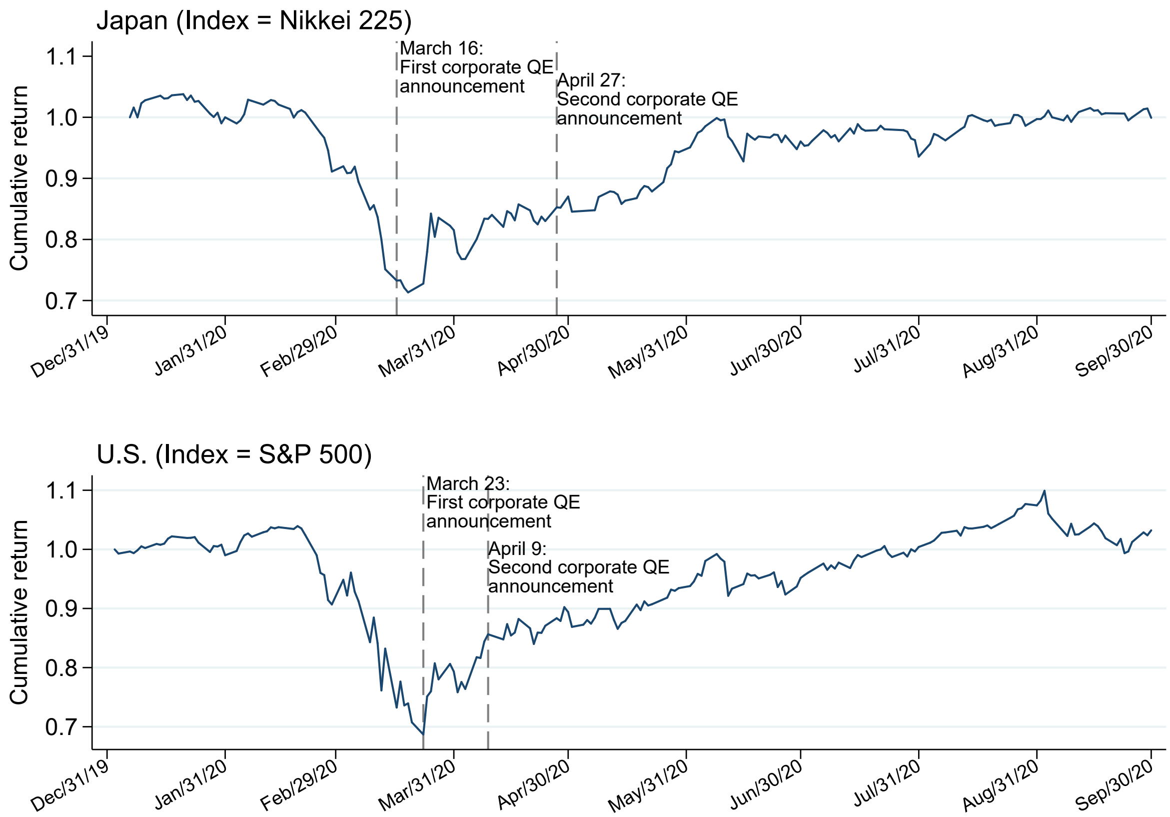
[24] The data were obtained from `https://market.jsda.or.jp/en/statistics/bonds/prices/otc/index.html?_ga=2.18029305.1753901559.1606199224-1082313156.1598336970`.

[25] Okimoto and Takaoka (2020) also employ R&I's ratings when using this data. Yields of non-investment grade bonds are not analyzed because there were very few bonds rated below BBB whose yield data were available (less than two per day on average based on the ratings of R&I).

[26] `https://www.mof.go.jp/english/jgbs/reference/interest_rate/index.htm`

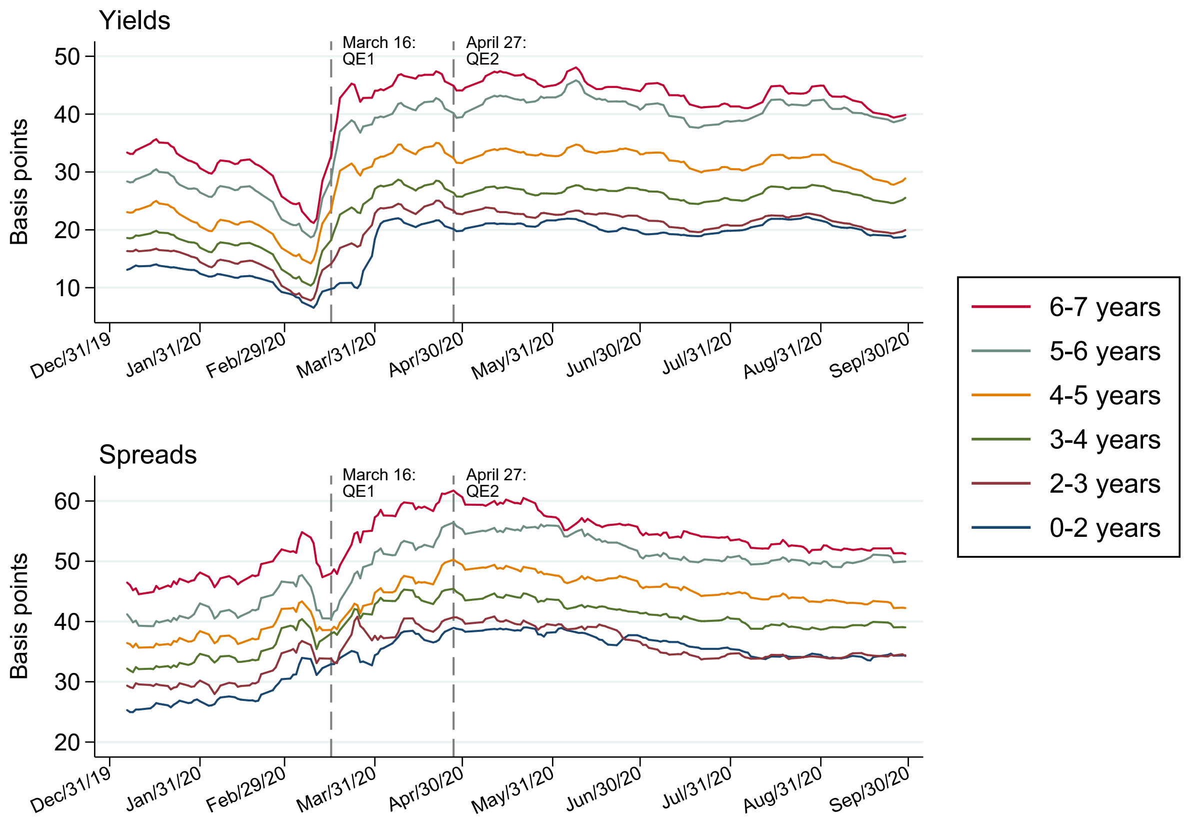
[27] Likewise, liquidity conditions of the U.S. bond market materially worsened during the same period (O'Hara and Zhou, forthcoming).

Figure IA.2: Stock index movements in Japan and the U.S.



This figure shows the cumulative returns of the Nikkei 225 index and that of the S&P 500. Their values at the beginning of 2020 are normalized to one. The data were obtained from Yahoo! Finance. This figure also indicates the dates of key announcements related to corporate bond purchase during the COVID-19 pandemic in Japan and the U.S.

Figure IA.3: Yields and spreads of A-rated Japanese corporate bonds by remaining maturity



This figure shows the yields and spreads of Japanese corporate bonds that are rated A by R&I. For better readability, their three-day moving averages are plotted. Bonds are divided by the remaining maturity. The data come from the "rating matrix" files reported by the JSDA, which are available at `https://market.jsda.or.jp/en/statistics/bonds/prices/otc/index.html?_ga=2.18029305.1753901559.1606199224-1082313156.1598336970`. To compute spreads, JGB yields were obtained from the Ministry of Finance's website: `https://www.mof.go.jp/english/jgbs/reference/interest_rate/index.htm`.

Internet Appendix H Changes in proceeds

The MNLM is employed to analyze changes in firms' bond maturity choice after controlling for bond- and issuer-characteristics. Also, it is a standard approach in the literature concerning the determinants of the maturity of newly issued debt (Badoer and James, 2016; Guedes and Opler, 1996). Nevertheless, one limitation of the MNLM is that it cannot analyze changes in issuance amounts. Therefore, in this section, I analyze changes in proceeds by collapsing the bond issuance data into a weekly time series for each of the five maturity bins.

The collapsed data are analyzed in the following manner. First, the following regression model is estimated separately for each maturity category i:

$$Proceeds_{it} = \beta_0 + \beta_1 QE1_t + \beta_2 QE2_t + \epsilon_{it}, \quad (1)$$

where $Proceeds_{it}$ is the total proceeds (in billions of yen) of maturity bin i in week t and $QE1_t$ and $QE2_t$ are dummy variables taking a value of one from the week of Mar-15 to the week of Apr-19, 2020 and from the week of Apr-26 to the week of Sep-20, 2020, respectively. The Newey-West standard errors are employed to account for serial correlation in the error term. Note that this model is a saturated regression model. As such, the constant β_0 corresponds to the average weekly issuance amount in the pre-period and the coefficient of $QE1_t$ ($QE2_t$) estimates the difference in the average weekly issuance amounts between the pre-period and the QE1 (QE2) period.

Then, I test the differences in the coefficients of $QE1$ and $QE2$ estimated by Model 1 between adjacent maturity bins. Specifically, this is done by estimating the following model separately for each *pair* of neighboring maturity bins i and $i+1$:

$$Proceeds_{jt} = \alpha_1 QE1_t + \alpha_2 QE2_t + \gamma_1 QE1_t \times Maturity_j + \gamma_2 QE2_t \times Maturity_j + \delta_j + \epsilon_{jt}, \quad (2)$$

where j is either i or $i+1$, $Maturity_j$ is an indicator variable taking a value of one if the maturity bin is i, and α_i is the maturity bin fixed effects. The independent variables of interest are the interaction terms. The coefficient γ_1 (γ_2) corresponds to the difference in the coefficients of $QE1_t$ ($QE2_t$) in Model 1 between two neighboring maturity bins i and $i+1$. Standard errors are calculated based on the method proposed by Driscoll and Kraay (1998), which allows the errors to have both cross-sectional dependence and autocorrelation.[28]

The results of these exercises are presented in Table IA.3, and they are largely consistent with the findings of the MNLM results. Panel A reports the result of estimating Model 1. It documents a drop in issuance amounts of bonds maturing in (5,7] years during the QE2 period. Furthermore, Panel B shows that

[28]They are computed using Stata's `xtscc` command (Hoechle, 2007). The maximum lag lengths are set to three.

the decrease is statistically significant relative to either the shorter maturity bin (Column 2) or the longer bin (Column 3). The economic significance is also sizable. In Panel A, the constant terms of the maturity segments of (3,5] years and (5,7] years show that these segments had similar average proceeds per week during the pre-period (¥26.9 billion and ¥27.0 billion, respectively). Their weekly average proceeds during the QE2 period, however, are very different. While the former increased by ¥15.8 billion, the latter decreased by ¥19.5 billion.

In addition, this analysis produces a result that can be viewed as consistent with firms' catering behavior during the QE1 period. Specifically, the first column of Panel B of Table IA.3 shows that the shortest maturity bin, which was the only eligible maturity category for the BOJ's enhanced purchases during the period, significantly increased relative to the longer maturity bin. On the other hand, the first row of Panel B shows no other statistically significantly differences. For instance, although the proceeds of the maturity bin of (5,7] years decreased during the QE1 period (Column 3 of Panel A), this decrease is not significant when compared with the changes in the neighboring maturity bins (Columns 2 and 3 of Panel B), which also decreased during the QE1 period. Thus, a statistically significant discontinuous change occurred only around the maturity eligibility threshold of the period (three years). However, it is important to re-emphasize that $QE1$ results should be taken with great caution.

One concern, again, about this exercise is possible seasonality in the maturity of new bond issues. Table IA.11 in Internet Appendix K shows that the results remain qualitatively the same even when the sample period is extended backward and month-of-the-year fixed effects are included to control for possible effects of seasonality.

Table IA.3: Changes in total proceeds from bond issues

Panel A: Separate regressions

	All	[1,3] Y	(3,5] Y	(5,7] Y	(7,10] Y	>10 Y
	(1)	(2)	(3)	(4)	(5)	(6)
QE1	-47.33	-0.62	-13.55	-25.29***	-7.77	-0.09
	(47.67)	(10.45)	(10.50)	(8.04)	(16.15)	(8.75)
QE2	7.97	19.94*	15.80	-19.46**	1.68	-9.99***
	(36.96)	(10.34)	(12.21)	(8.16)	(10.50)	(3.76)
Constant	112.83***	12.29***	26.88***	26.96***	31.93***	14.76***
	(20.75)	(4.57)	(4.82)	(7.93)	(6.06)	(2.87)
N	80	80	80	80	80	80
Adjusted R^2	-0.016	0.040	0.024	0.016	-0.022	0.040
Mean of dep. var.	111.47	17.73	30.21	19.71	31.81	12.01
S.D. of dep. var.	137.69	35.44	38.55	49.37	39.06	17.71

Panel B: Comparing neighboring maturity bins

	[1,3] Y vs. (3,5] Y	(3,5] Y vs. (5,7] Y	(5,7] Y vs. (7,10] Y	(7,10] Y vs. >10 Y
	(1)	(2)	(3)	(4)
QE1	12.93**	11.74	-17.53	-7.67
	[5.23]	[10.36]	[15.41]	[9.07]
QE2	4.14	35.26***	-21.14**	11.67
	[7.06]	[11.60]	[9.66]	[10.63]

The dependent variable is proceeds (in billions of yen). The unit of observation is the total bond issuance amount in maturity category i in week t. The sample contains 80 weeks from Mar-17, 2019 to Sep-26, 2020. Proceeds are right-winsorized at the 97.5% level for each maturity bin. Panel A reports the result of estimating Specification 1, where $QE1$ is a dummy variable taking a value of one from the week of Mar-15, 2020 to the week of Apr-19, 2020, and $QE2$ takes a value of one from the week of Apr-26, 2020 to the week of Sep-20, 2020. The Newey-west standard errors with a lag length of three are reported in the round brackets. The differences in the coefficients of $QE1$ and $QE2$ between neighboring maturity bins are tested in Panel B. Specifically, it reports $\gamma 1$ and $\gamma 2$ of Specification 2. Driscoll-Kraay standard errors (with a lag length of three) are reported in the square brackets. ***, **, and * indicate significance at 1%, 5%, and 10% levels.

Internet Appendix I Bond issuances by financial firms

The BOJ is not allowed to purchase bonds issued by financial institutions that hold current accounts at the BOJ (i.e., the BOJ's counterpart financial institutions) and their parent holding companies. This exclusion is due to the following reason. The BOJ's corporate debt purchases target only CP and corporate bonds that counterpart financial institutions can use as collateral when they obtain short-term funding from the BOJ. Nevertheless, according to the Guidelines on Eligible Collateral,[29] debt securities issued by counterpart financial institutions and their parent holding companies are explicitly excluded from eligible collateral for this purpose.

One might think that bonds issued by these ineligible issuers can be used as a control group for a difference-in-difference analysis. This approach is not taken due to the following reasons: First, the sample size of these ineligible bonds is very small. Panel A of Figure IA.4 shows that the BOJ's counterpart financial institutions collectively issued only 13, 0, and 8 bonds in the pre-, QE1, QE2 periods, respectively. Second, the within-issuer variation in maturities of new bond issues seems to be very limited for this group. Sample bonds issued by BOJ's counterpart financial institutions are listed in Table IA.5. This table shows that the number of unique issuers is only seven. Furthermore, it documents that no individual counterpart financial institution issued *both* of bonds maturing in $\leq$5 years and bonds maturing in $>$5 years during the sample period. Bonds with maturities of greater than five years were issued only by Mitsubishi UFJ Financial Group and Mizuho Financial Group. (Both of them are holding companies controlling "mega banks" in Japan.) Therefore, it is implied that changes in the maturity distribution of bonds issued by counterpart financial institutions are driven not by individual issuers' maturity decisions but by changes in the composition of bond issuers.[30] Lastly, Table IA.5 also shows that the long-term bonds issued by these two holding companies were subordinated bonds. This is not the case for the remaining bonds listed in Table IA.5.[31]

[29] `https://www.boj.or.jp/en/mopo/measures/term_cond/yoryo18.htm/`

[30] Section 5.3 of the main text focuses on simultaneous issuances of multiple-maturity bonds, and in particular, those covering a wide range of maturities, to analyze whether individual issuers indeed catered to the positive demand shock.

[31] Subordinated bonds were also issued by other financial firms and non-financial firms. Nevertheless, they are not included in the sample because all of the subordinated bonds issued by these firms were bonds with special features (e.g., callable bonds and convertible bonds) or permanent bonds.

Table IA.4: Maturities of bonds issued by financial firms

Panel A: BOJ's counterpart financial institutions

	Pre-period (9/15/19–3/15/20)	QE1 period (3/16/20–4/26/20)	QE2 period (4/27/20–9/30/20)	Total
[1,3] years	6	0	3	9
(3,5] years	4	0	2	6
(5,7] years	0	0	0	0
(7,10] years	2	0	2	4
>10 years	1	0	1	2
Total	13	0	8	21

Panel B: Other financial firms

	Pre-period	QE1 period	QE2 period	Total
[1,3] years	15	3	7	25
(3,5] years	23	0	10	33
(5,7] years	11	0	0	11
(7,10] years	9	1	2	12
>10 years	1	0	0	1
Total	59	4	19	82

This table summarizes the maturities of corporate straight bonds issued by public financial firms for the period from October 1, 2019 to September 30, 2020. Panel A is restricted to bonds issued by BOJ's counterpart financial institutions and their parent holding companies, which are ineligible for BOJ purchases. Panel B includes bonds issued by other financial firms.

Table IA.5: List of bonds issued by BOJ's counterpart financial institutions

Offering date	Issuer name	Subordinated	Maturity (years)	Proceeds (billion ¥)
6/4/2019	Aozora Bank Ltd	No	3	10
7/11/2019	Resona Holdings Inc	No	5	30
8/28/2019	Nomura Holdings Inc	No	5	40
9/6/2019	Mitsubishi UFJ Financial Group Incorporated	Yes	10.5	44
10/4/2019	Shinsei Bank Ltd	No	3	10
10/4/2019	Shinsei Bank Ltd	No	5	20
10/11/2019	Mizuho Financial Group Inc	Yes	10	41
12/3/2019	Aozora Bank Ltd	No	3	10
12/6/2019	Mitsubishi UFJ Financial Group Incorporated	Yes	10	22
12/6/2019	Resona Holdings Inc	No	3	10
1/17/2020	Shinsei Bank Ltd	No	3	20
1/17/2020	Shinsei Bank Ltd	No	5	30
3/6/2020	Aozora Bank Ltd	No	3	10
5/19/2020	Daiwa Securities Group Incorporated	No	3	37
5/19/2020	Daiwa Securities Group Incorporated	No	5	38
5/22/2020	Mitsubishi UFJ Financial Group Incorporated	Yes	10	34
6/16/2020	Mizuho Financial Group Inc	Yes	10	40
7/3/2020	Shinsei Bank Ltd	No	3	30
7/3/2020	Shinsei Bank Ltd	No	5	30
9/1/2020	Aozora Bank Ltd	No	3	10
9/11/2020	Mitsubishi UFJ Financial Group Incorporated	Yes	10.5	54

Bonds issued by BOJ's counterpart financial institutions are listed in this table.

Internet Appendix J Anticipation of the BOJ's April 27 announcement

During the initial months of the COVID-19 pandemic, the BOJ made two key announcements—on March 16 and April 27. The period between the two dates is referred to as the "QE1 period" in this paper. This section, however, explains that the second announcement was likely to have been, to a certain extent, anticipated.

The April 27 announcement was made following the pre-scheduled Policy Board meeting on that day. Although the meeting was originally scheduled for the day and the next, the board decided to limit it to its first day.

To my knowledge, the first news article that reported that the BOJ would discuss options to expand its CP and corporate bond purchases at the meeting was an article by Reuters on April 14.[32] According to the article, the reporters' sources had informed that the Policy Board would discuss measures to support corporate funding conditions, including a possibility of expanding its CP and corporate bond purchases "[w]hile discussions are still in the initial stages." Therefore, the public was likely to have become aware of the possibility of the BOJ announcing an expansion of its corporate bond purchases well before the meeting took place. Notably, the fact that the BOJ had not announced any material changes after the Fed announced the launch of the PMCCF and the SMCCF on March 23 could have bolstered the public's belief that some expansion would be announced following the meeting.

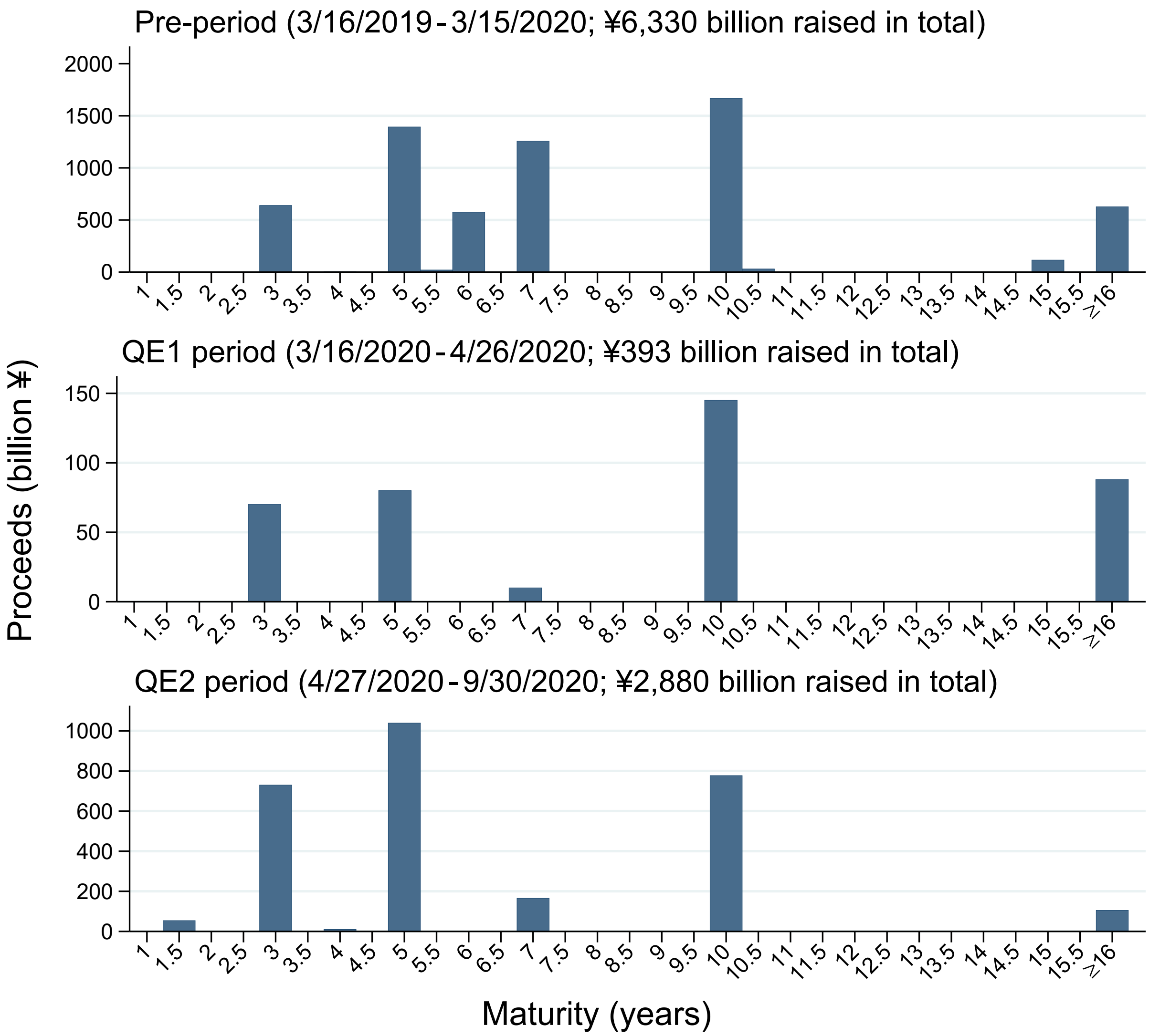
Then, Nikkei, Japan's leading business newspaper, reported on April 23 that the BOJ was planning to double the size of its CP and corporate bond purchases and revise the terms to allow for more flexible purchases.[33] Although this April 23 article did not explicitly mention the maturity eligibility criterion, it seems possible for sophisticated players such as underwriters to guess that a further increase in the bank's corporate bond purchases would necessitate an expansion toward longer maturity bonds.

[32] Leika Kihara and Takahiko Wada (2020, April 14) Exclusive: BOJ considering steps to ease corporate funding strains in April - sources. *Reuters.* Retrieved from `https://www.reuters.com/article/uk-health-coronavirus-japan-boj-exclusiv/exclusive-boj-considering-steps-to-ease-corporate-funding-strains-in-april-sources-idUKKCN21W0IY?`.

[33] *Kokusai kounyuu seigen naku, nichigin giron he CP shasai kounyuu baizou* (The BOJ to discuss removing its JGB purchase limit and doubling its CP and corporate bond purchases) (in Japanese) (2020, April 23) *Nikkei.* Retrieved from `https://www.nikkei.com/article/DGXMZO58430050T20C20A4MM8000`.

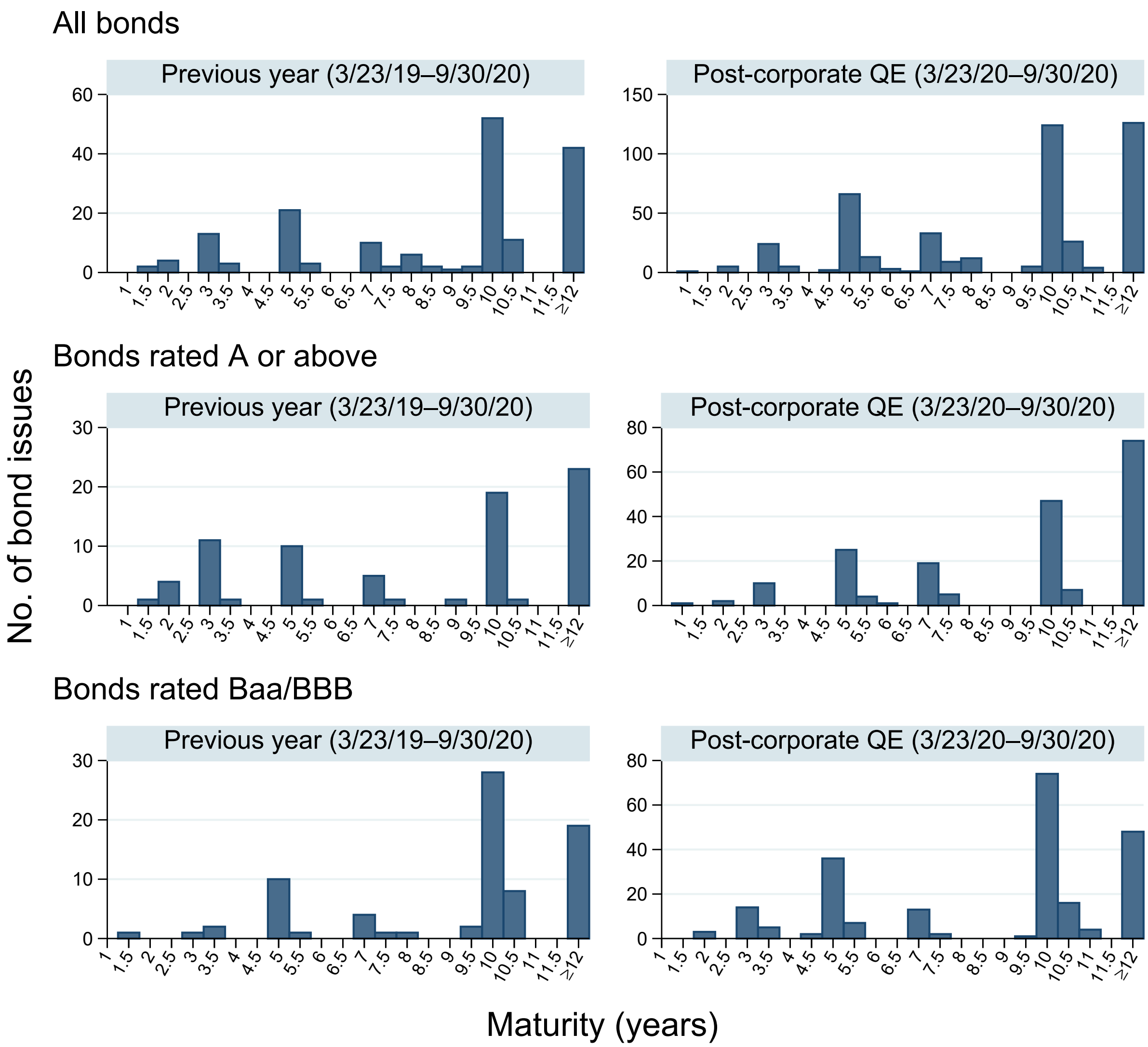
Internet Appendix K Supplementary results

Figure IA.4: Total proceeds by maturity



This figure shows the total proceeds of corporate straight bond issues by maturity. The issuers are public firms in non-financial and non-utility industries in Japan. The data were obtained from the JSDA.

Figure IA.5: Maturity distribution in the U.S.



This figure shows the maturity distributions of corporate straight bond issues in the U.S. The issuers are public firms in non-financial and non-utility industries. Moody's bond ratings are used. The data were obtained from the SDC Platinum.

Table IA.6: Multinomial logit: Without control variables and industry fixed effects

Panel A: Coefficients

	Model 1: Ref. cat. = (7,10] Y				Model 2: Ref. cat. = (3,5] Y	
	(1,3] Y	(3,5] Y	(5,7] Y	≥10 Y	(1,3] Y	(5,7] Y
QE1	0.036	-0.626	-1.293	0.335	0.662	-0.666
	(0.782)	(0.621)	(0.940)	(0.542)	(0.862)	(1.008)
QE2	0.990***	0.215	-0.926**	-1.211***	0.774**	-1.142***
	(0.318)	(0.246)	(0.370)	(0.411)	(0.317)	(0.370)
N	495				495	
Pseudo R^2	0.032				0.032	

Panel B: Average marginal effects

	(1,3] Y	(3,5] Y	(5,7] Y	(7,10] Y	≥10 Y
QE1	0.021	-0.094	-0.117**	0.068	0.122
	(0.064)	(0.083)	(0.054)	(0.104)	(0.097)
QE2	0.138***	0.076*	-0.104***	0.010	-0.119***
	(0.036)	(0.045)	(0.030)	(0.045)	(0.028)

This table reports the results of multinomial logit regressions using the bias-correction methods of Kosmidis and Firth (2011). The sample period starts on September 15, 2019, six months before the BOJ's first corporate bond purchase announcement during the COVID-19 pandemic, and ends on September 30, 2020. Variable definitions are provided in Table IA.2. Standard errors are reported in parentheses below the estimated coefficients. ***, **, and * indicate that the difference is significant at 1%, 5%, and 10% levels, respectively.

Table IA.8: Descriptive statistics: Alternative samples

Panel A: Longer sample period

	Mean	S.d.	Min.	Median	Max.	N
Ln(maturity)	2.015	0.540	1.099	1.946	2.996	1100
Ln(proceeds)	23.267	0.581	22.333	23.026	24.818	1100
offer yield (bps)	36.607	26.048	1.000	29.500	110.000	1100
Offering spread (bps)	37.893	15.364	15.400	34.950	88.500	1100
Credit rating: BBB	0.084	0.277	0.000	0.000	1.000	1100
Ln(total assets)	27.828	1.104	25.536	27.737	30.095	1082
Net book leverage	0.216	0.215	-0.196	0.218	0.723	1082
Profitability	0.088	0.036	0.026	0.082	0.177	1082
Asset tangibility	0.382	0.219	0.025	0.351	0.830	1082
QE1	0.021	0.143	0.000	0.000	1.000	1100
QE2	0.144	0.351	0.000	0.000	1.000	1100

Panel B: Including financial firms and utilities

	Mean	S.d.	Min.	Median	Max.	N
Ln(maturity)	2.025	0.630	1.099	1.946	3.401	731
Ln(proceeds)	23.377	0.600	22.333	23.026	24.818	731
offer yield (bps)	35.760	24.931	2.000	29.000	100.000	731
Offering spread (bps)	42.938	18.204	17.300	40.300	115.000	731
Credit rating: BBB	0.047	0.211	0.000	0.000	1.000	731
Ln(total assets)	28.228	1.181	25.638	28.324	30.665	722
Profitability	0.078	0.038	0.008	0.076	0.171	722
Asset tangibility	0.396	0.259	0.005	0.350	0.831	722
QE1	0.047	0.211	0.000	0.000	1.000	731
QE2	0.308	0.462	0.000	0.000	1.000	731
Industry: Financials	0.141	0.348	0.000	0.000	1.000	731
Industry: Utilities	0.182	0.386	0.000	0.000	1.000	731

Variable definitions are provided in Table IA.2. All variables are winsorized at the 2.5% and 97.5% levels.

Table IA.7: Multinomial logit: Without industry fixed effects

Panel A: Coefficients

	Model 1: Ref. cat. = (7,10] Y				Model 2: Ref. cat. = (3,5] Y	
	(1,3] Y	(3,5] Y	(5,7] Y	≥10 Y	(1,3] Y	(5,7] Y
QE1	0.048	-0.473	-1.332	-0.372	0.521	-0.859
	(0.796)	(0.634)	(0.948)	(0.589)	(0.876)	(1.017)
QE2	1.014***	0.269	-0.981**	-1.399***	0.745**	-1.250***
	(0.330)	(0.254)	(0.384)	(0.429)	(0.330)	(0.385)
Credit rating: BBB	0.586	0.623	0.190	-1.238	-0.038	-0.434
	(0.746)	(0.531)	(0.731)	(1.038)	(0.708)	(0.697)
Ln(total assets)	0.180	-0.050	0.179	0.347**	0.229	0.228
	(0.148)	(0.111)	(0.139)	(0.157)	(0.149)	(0.142)
Net book leverage	1.343	-0.217	-0.903	0.543	1.560	-0.686
	(1.048)	(0.771)	(0.970)	(1.143)	(1.049)	(0.984)
Profitability	0.761	-0.803	1.195	-7.854	1.564	1.998
	(4.721)	(3.643)	(4.438)	(5.450)	(4.741)	(4.529)
Asset tangibility	-0.968	-0.874	0.576	3.643***	-0.094	1.450
	(0.907)	(0.698)	(0.890)	(0.916)	(0.921)	(0.916)
N	486				486	
Pseudo R^2	0.084				0.084	

Panel B: Average marginal effects

	(1,3] Y	(3,5] Y	(5,7] Y	(7,10] Y	≥10 Y
QE1	0.035	-0.035	-0.110*	0.118	-0.007
	(0.071)	(0.099)	(0.058)	(0.112)	(0.065)
QE2	0.138***	0.083*	-0.107***	0.010	-0.124***
	(0.036)	(0.046)	(0.030)	(0.046)	(0.027)

This table reports the results of multinomial logit regressions using the bias-correction methods of Kosmidis and Firth (2011). The sample period starts on September 15, 2019, six months before the BOJ's first corporate bond purchase announcement during the COVID-19 pandemic, and ends on September 30, 2020. Variable definitions are provided in Table IA.2. All the continuous variables are winsorized at the 2.5% and 97.5% levels. Standard errors are reported in parentheses below the estimated coefficients. ***, **, and * indicate that the difference is significant at 1%, 5%, and 10% levels, respectively.

Table IA.9: Multinomial logit regressions of corporate bond maturity choice: Longer sample period with month-by-year fixed effects

Panel A: Coefficients

	Model 1: Ref. cat. = (7,10] Y				Model 2: Ref. cat. = (3,5] Y	
	[1,3] Y	(3,5] Y	(5,7] Y	≥10 Y	(1,3] Y	(5,7] Y
QE1	-0.446	-0.391	-1.351	-0.095	-0.055	-0.960
	(0.965)	(0.727)	(1.012)	(0.751)	(1.029)	(1.083)
QE2	1.009***	0.398	-0.858**	-1.412***	0.610*	-1.256***
	(0.327)	(0.256)	(0.383)	(0.422)	(0.326)	(0.384)
Credit rating: BBB	0.402	0.598*	0.789**	-1.847***	-0.196	0.192
	(0.449)	(0.314)	(0.364)	(0.637)	(0.433)	(0.343)
Ln(total assets)	0.211*	-0.139	0.058	0.349***	0.350***	0.197*
	(0.119)	(0.085)	(0.099)	(0.115)	(0.118)	(0.101)
Net book leverage	2.373***	0.201	-1.039	0.620	2.173***	-1.240*
	(0.743)	(0.558)	(0.699)	(0.838)	(0.711)	(0.688)
Profitability	5.706	1.179	-0.688	-5.000	4.528	-1.867
	(4.423)	(3.044)	(3.547)	(4.665)	(4.364)	(3.542)
Asset tangibility	-1.040	-1.599***	0.277	3.154***	0.559	1.875***
	(0.663)	(0.543)	(0.661)	(0.677)	(0.666)	(0.674)
Industry FE	✓	✓	✓	✓	✓	✓
Month-by-year FE	✓	✓	✓	✓	✓	✓
N	1082				1082	
Pseudo R^2	0.108				0.108	

Panel B: Average marginal effects

	[1,3] Y	(3,5] Y	(5,7] Y	(7,10] Y	≥10 Y
QE1	-0.009	-0.013	-0.116*	0.109	0.030
	(0.063)	(0.118)	(0.061)	(0.129)	(0.088)
QE2	0.130***	0.101**	-0.107***	-0.003	-0.121***
	(0.041)	(0.048)	(0.027)	(0.044)	(0.021)

This table reports the results of multinomial logit regressions using the bias-correction methods of Kosmidis and Firth (2011). The sample consists of corporate straight bonds issued for the period from October 1, 2016 to September 30, 2020. The dependent variable is a bond maturity category and the reference category is the maturity bin of (7, 10] years. Variable definitions are provided in Table IA.2. All the continuous variables are winsorized at the 1% and 99% levels. Standard errors are reported in parentheses below the estimated coefficients. ***, **, and * indicate that the difference is significant at 1%, 5%, and 10% levels, respectively.

Table IA.10: Multinomial logit: Including financial firms and utilities

Panel A: Coefficients						
	Model 1: Ref. cat. = (7,10] Y				Model 2: Ref. cat. = (3,5] Y	
	(1,3] Y	(3,5] Y	(5,7] Y	≥10 Y	(1,3] Y	(5,7] Y
QE1	0.053	-0.974	-1.623*	-0.473	1.027	-0.649
	(0.554)	(0.596)	(0.899)	(0.484)	(0.673)	(0.987)
QE2	0.690***	0.329	-1.027***	-0.585**	0.361	-1.356***
	(0.265)	(0.225)	(0.355)	(0.279)	(0.260)	(0.356)
Credit rating: BBB	0.687	0.868*	0.423	-0.876	-0.181	-0.445
	(0.606)	(0.498)	(0.665)	(0.965)	(0.525)	(0.605)
Ln(total assets)	-0.002	-0.080	0.020	0.143	0.078	0.099
	(0.122)	(0.100)	(0.127)	(0.131)	(0.117)	(0.127)
Profitability	-5.473	-0.637	0.055	-2.740	-4.836	0.693
	(4.575)	(3.580)	(4.550)	(4.662)	(4.528)	(4.578)
Asset tangibility	0.318	-1.037	0.392	2.037***	1.355*	1.428*
	(0.759)	(0.650)	(0.808)	(0.731)	(0.781)	(0.837)
Industry: Technology	1.691***	0.923*	1.023	-0.412	0.767	0.100
	(0.607)	(0.558)	(0.688)	(0.984)	(0.536)	(0.630)
Industry: Consumer Staples	0.998	0.206	1.212	0.559	0.792	1.005
	(0.853)	(0.722)	(0.764)	(0.858)	(0.849)	(0.772)
Industry: Health Care	0.492	0.144	0.204	-0.841	0.349	0.060
	(1.168)	(0.903)	(1.175)	(1.767)	(1.167)	(1.182)
Industry: Financials	1.619***	0.951**	0.750	-0.642	0.668	-0.201
	(0.514)	(0.446)	(0.585)	(0.733)	(0.476)	(0.557)
Industry: Real Estate	-0.442	0.495	0.215	0.474	-0.937	-0.279
	(0.803)	(0.584)	(0.695)	(0.513)	(0.837)	(0.732)
Industry: Consumer Discretionary	0.003	0.311	0.575	-0.395	-0.308	0.263
	(0.489)	(0.359)	(0.447)	(0.489)	(0.490)	(0.453)
Industry: Telecommunications	0.230	-0.055	0.430	0.187	0.285	0.484
	(0.737)	(0.608)	(0.744)	(0.736)	(0.752)	(0.774)
Industry: Basic Materials	-0.502	0.163	0.019	-0.544	-0.665	-0.143
	(0.507)	(0.332)	(0.446)	(0.466)	(0.513)	(0.455)
Industry: Energy	-1.350	0.305	0.418	-1.366	-1.655	0.112
	(1.806)	(0.921)	(1.199)	(1.785)	(1.804)	(1.210)
Industry: Utilities	-0.167	-0.550	-0.910	0.160	0.383	-0.359
	(0.472)	(0.455)	(0.582)	(0.391)	(0.540)	(0.643)
N	722				722	
Pseudo R^2	0.110				0.110	

Panel B: Average marginal effects					
	(1,3] Y	(3,5] Y	(5,7] Y	(7,10] Y	≥10 Y
QE1	0.073	-0.100	-0.105**	0.147*	-0.016
	(0.068)	(0.067)	(0.042)	(0.088)	(0.060)
QE2	0.098***	0.075**	-0.099***	0.004	-0.079***
	(0.031)	(0.037)	(0.023)	(0.037)	(0.027)

This table reports the results of multinomial logit regressions using the bias-correction methods of Kosmidis and Firth (2011). The sample includes financial firms and utilities. Industry dummies based on the Industrial Classification Benchmark (ICB) are included with the reference category being Industrials. All variables are winsorized at the 2.5% and 97.5% levels.

Table IA.11 shows the result of performing the same analysis as Table IA.3 except for two modifications. First, the sample covers a longer period (208 weeks spanning from October 1, 2016 to September 26, 2020). Second, the regression models include month-by-year fixed effects to control for possible seasonality in firms' debt maturity choice. Note that due to the inclusion of the month-by-year fixed effects, coefficients reported in Panel B do not exactly match the differences in coefficients reported in Panel A, unlike in Table IA.3.

Table IA.11: Changes in total proceeds from bond issues: Longer sample period with month-by-year fixed effects

Panel A: Separate regressions

	All	[1,3] Y	(3,5] Y	(5,7] Y	(7,10] Y	>10 Y
	(1)	(2)	(3)	(4)	(5)	(6)
QE1	-13.71	5.06	-5.07	-15.91***	-1.50	3.71
	(44.88)	(11.36)	(10.43)	(3.78)	(13.74)	(9.56)
QE2	14.20	16.17***	14.08	-9.11***	1.41	-8.35***
	(24.65)	(6.04)	(9.33)	(2.85)	(7.61)	(3.02)
Month-of-the-year FE	✓	✓	✓	✓	✓	✓
N	208	208	208	208	208	208
Adjusted R^2	0.060	0.083	0.049	0.039	0.065	0.041
Mean of dep. var.	79.57	11.25	23.05	12.74	22.84	9.70
S.D. of dep. var.	97.64	22.76	31.83	20.38	30.29	14.81

Panel B: Comparing neighboring maturity bins

	[1,3] Y vs. (3,5] Y	(3,5] Y vs. (5,7] Y	(5,7] Y vs. (7,10] Y	(7,10] Y vs. >10 Y
	(1)	(2)	(3)	(4)
QE1	10.24***	4.19	-14.51	-2.11
	[2.33]	[7.96]	[13.22]	[7.51]
QE2	-1.73	25.66***	-15.91***	15.03*
	[4.77]	[8.89]	[6.04]	[7.88]

The dependent variable is proceeds (in billions of yen). The unit of observation is bond issues in maturity category i in week t. The sample period contains 208 weeks from Oct-1, 2016 to Sep-26, 2020. Proceeds are right-winsorized at the 97.5% level for each maturity bin. Panel A reports the result of estimating a modified version of Specification 1 that includes month-by-year fixed effects. The Newey-west standard errors with a lag length of four are reported in the round brackets. The differences in the coefficients of $QE1$ and $QE2$ between neighboring maturity bins are tested in Panel B. Specifically, it reports $\gamma 1$ and $\gamma 2$ of Specification 2 with month-by-year fixed effects. Driscoll-Kraay standard errors (with a lag length of four) are reported in the square brackets. ***, **, and * indicate significance at 1%, 5%, and 10% levels.

Table IA.12 performs an analysis similar to Table 6. The difference is that Table IA.12 divides the sample firms by their reliance on bank debt. Specifically, I use *bank debt ratio*, the ratio of bank debt to total debt (measured at the beginning of the sample period), to split the sample.

The data source of *bank debt ratio* is the Capital IQ Capital Structure Summary database (accessed via WRDS). This database contains two items that can be used to construct *bank debt ratio*. Specifically, *TotBankDbt* measures the amount of total bank debt and *TotBankDbtPct* measures the percentage of total bank debt over total debt. Note that Capital IQ sometimes reports a non-missing value for only one of them. Therefore, I first looked at *TotBankDbtPct* and if it was missing, checked whether *bank debt ratio* could be computed by dividing *TotBankDbt* by total debt, which is the sum of *PrincipalAmtDbtOutstanding*, *TotAdjustments*, and *UnamortizedPremiumTot* (Kirti, 2020).

Capital IQ provides historical snapshots of detailed capital structure information and normally, there exist multiple snapshots available for each fiscal year. I constructed *bank debt ratio* in the following manner. First, I downloaded all snapshots for the one-year period leading up to the sample start date (March 16, 2019). Second, I dropped snapshots if their *TotBankDbtPct* and *TotBankDbtPct* were both missing. Third, because it is not rare that the ratio of bank debt computed from this database slightly exceeds 100%, the following modifications were made: If the ratio was greater than 100% but not more than 110%, I retained the data point and treated it as 100%. In contrast, I dropped snapshots with a ratio of bank debt greater than 110%. Lastly, *bank debt ratio* was measured as the ratio of the bank debt in the snapshot whose *PeriodEndDate* (fiscal period end date) was the closest to the beginning of the sample period (March 16, 2019) among the remaining snapshots.

Bank debt ratio is missing for two sample firms that issued eight bonds in total during the sample period. This is because Capital IQ records neither *TotBankDbt* nor *TotBankDbtPct* for these firms during the one-year period preceding the sample start date. Panel A of Table IA.12 reports descriptive statistics of *bank debt ratio*. The mean (median) is 63.3% (67.4%). The median value is used to divide the sample.

Panel B of Table IA.12 fails to find any statistically significant differences in the AMEs of *QE2* between the two sub-samples. The AME of *QE2* is negative and significant for (5,7] year bonds for both of the high-*bank debt ratio* firms and the low-*bank debt ratio* firms. The AME for the maturity bin of (3,5] years is statistically significant only for the latter group, although the difference in this AME between the two sub-samples is not statistically significant. In summary, the result of Panel B of Table IA.12 is in line with that of Table 6 in that no clear cross-sectional differences in the effect of *QE2* are observed.

Table IA.12: Ratio of bank debt and the average marginal effects of QE2

Panel A: Summary statistics of the ratio of bank debt to total debt

	Mean	S.d.	Min.	Median	Max.	N
Bank debt ratio (%)	63.250	21.713	2.405	67.431	100.000	487

Panel B: Comparing the average marginal effects of QE2

	(1) *Bank debt ratio* $\geq$ median	(2) *Bank debt ratio* $<$ median	Diff.: (1) - (2)
[1,3]	0.105**	0.169***	-0.065
	(0.049)	(0.053)	(0.072)
(3,5] years	0.023	0.124*	-0.101
	(0.064)	(0.065)	(0.091)
(5,7] years	-0.080*	-0.132***	0.051
	(0.042)	(0.042)	(0.060)
(7,10] years	0.051	-0.021	0.073
	(0.065)	(0.063)	(0.090)
$>$10 years	-0.098**	-0.140***	0.042
	(0.043)	(0.034)	(0.054)

Panel A provides a descriptive statistic of *bank debt ratio*, which is the fraction of bank debt over total debt (expressed in percentage terms) at the beginning of the sample period. The data source is the Capital IQ Capital Structure Summary database (accessed via WRDS). In Panel B, the average marginal effects (AMEs) of *QE2* are reported together with standard errors in parentheses. The estimation method is the same as that of Table 6. The AMEs are based on the MNLMs where the dependent variable is the categorical variable for the maturity bins and the independent variables are QE1 dummy, QE2 dummy, an indicator variable that takes a value of one if the firm's *bank debt ratio* is greater than or equal to the sample median, and the interaction between QE2 dummy and the indicator variable. The AMEs are calculated separately based on the indicator variable values, and the differences in AMEs are also tested. ***, **, and * indicate that the difference is significant at 1%, 5%, and 10% levels, respectively.

In Table IA.13, the bias-corrected logit model of Kosmidis and Firth (2009) is used for Columns 1, 2, 5, and 6 to handle the separation problem. Columns 3 and 4 use the zero-truncated Poisson because their dependent variable (*N. of different mat.*) is a count variable whose minimum value is one. Note that bonds that have different maturities but were issued by the same company on the same date are treated as part of one unique bond issuance event. While the first four columns include all bond issuance events, only multiple-maturity bond issuance events are included in the last two columns.

Table IA.13: Multiple-maturity bond issuances: Regression results

Dependent var. Model	*Multiple-mat. dummy* Bias-corrected logit		*N. of different mat.* Zero-truncated Poisson		*Incl. [1,5] Y and ≥10 Y* Bias-corrected logit	
	(1)	(2)	(3)	(4)	(5)	(6)
QE1	0.623	0.482	0.252	0.144	0.430	0.852
	(0.631)	(0.527)	(0.215)	(0.170)	(0.793)	(0.873)
QE2	0.830***	0.837***	0.348***	0.368***	1.021***	1.124***
	(0.285)	(0.286)	(0.102)	(0.095)	(0.354)	(0.361)
Credit rating: BBB		0.141		-0.100		0.162
		(0.490)		(0.276)		(0.885)
Ln(total assets)		0.548***		0.289***		0.021
		(0.120)		(0.045)		(0.181)
Net book leverage		-1.505		-0.632*		-0.217
		(0.970)		(0.356)		(1.259)
Profitability		-2.257		0.020		7.851
		(4.649)		(1.681)		(6.339)
Asset tangibility		-0.940		-0.053		-0.696
		(0.804)		(0.324)		(1.125)
Industry FE		✓		✓		✓
Observations	272	270	272	270	155	153
McFadden's pseudo R^2	0.010	0.052	0.011	0.070	0.016	0.040
Mean of dep. var.	0.570	0.567	1.790	1.781	0.594	0.588
Average marginal effects						
QE1	0.151	0.105	0.062	0.035	0.106	0.192
	(0.144)	(0.113)	(0.052)	(0.041)	(0.190)	(0.183)
QE2	0.196***	0.177***	0.085***	0.088***	0.235***	0.247***
	(0.064)	(0.059)	(0.025)	(0.022)	(0.077)	(0.076)

Bonds issued by the same company on the same date are treated as part of one bond issuance event. The first four columns use all of these bond issuances, whereas the last two column use only multiple-maturity bond issuances. The dependent variable of the first two columns is the indicator variable of being a multiple-maturity issue. In columns 2 and 3 the outcome variable is the number of different maturities included in the bond issue. This variable is right-winsorized at the 2.5% level (and thus the maximum number is three). The dependent variable of the last two columns is an indicator variable that takes a value of one if the (multiple-maturity) bond issanace includes a maturity of five years or less and a maturity of 10 years or more. The models of columns 1, 2, 5, and 6 are estimated by the bias-corrected logit model of Kosmidis and Firth (2009), using Stata's `brglm` command. Models of columns 3 and 4 are estimated by the zero-truncated Poisson as the dependent variable is a count data with the minimum of one. Heteroskedasticity-robust standard errors are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels.

Table IA.14: Changes in the determinants of offering spreads

	Pre-period	QE2 period	QE2 period vs. Pre-period	
			Diff. in coeff.	χ^2 stat. [p-value]
Maturity: (3,5] Y	8.13***	9.16***	1.03	0.09 [0.77]
	(2.12)	(3.03)		
Maturity: (5,7] Y	19.14***	19.72***	0.59	0.02 [0.89]
	(2.35)	(3.98)		
Maturity: (7,10] Y	14.13***	16.78***	2.65	0.62 [0.43]
	(2.13)	(2.85)		
Maturity: >10 Y	18.51***	13.30***	-5.21	1.79 [0.18]
	(2.60)	(3.18)		
Credit rating: A	8.92***	8.35***	-0.57	0.04 [0.85]
	(1.33)	(2.86)		
Credit rating: BBB	23.63***	20.55**	-3.08	0.11 [0.74]
	(2.70)	(9.55)		
Ln(proceeds)	2.90***	-0.29	-3.18	2.09 [0.15]
	(1.08)	(2.08)		
Ln(total assets)	-1.30*	-0.78	0.52	0.09 [0.77]
	(0.76)	(1.72)		
Net book leverage	11.16***	19.77**	8.61	1.06 [0.30]
	(3.93)	(8.00)		
Profitability	-30.04*	-47.04	-17.01	0.14 [0.71]
	(17.77)	(45.88)		
Asset tangibility	-13.41***	-15.41***	-2.00	0.11 [0.74]
	(3.72)	(5.34)		
Industry FE	✓	✓		
N	310	153		
Adjusted R^2	0.468	0.412		
Mean of dep. var.	44.52	34.76		
S.D. of dep. var.	13.42	14.07		

The dependent variable is the offering spread. Variable definitions are provided in Table IA.2. All the continuous variables are winsorized at the 1% and 99% levels. In the first two columns heteroskedasciticy-robust standard errors are reported in parentheses. The differences in coefficients are tested using Wald tests obtained by the "stacking" method (Weesie et al., 2000). ***, **, and * indicate that the difference is significant at 1%, 5%, and 10% levels, respectively.

References for Internet Appendix

Barbon, A., Gianinazzi, V., 2019. Quantitative easing and equity prices: Evidence from the etf program of the bank of japan. The Review of Asset Pricing Studies 9, 210–255.

Bernanke, B., Reinhart, V., Sack, B., 2004. Monetary policy alternatives at the zero bound: An empirical assessment. Brookings Papers on Economic Activity 2004, 1–100.

Boneva, L., Elliott, D., Kaminska, I., Linton, O., McLaren, N., Morley, B., 2019. The impact of QE on liquidity: evidence from the UK corporate bond purchase scheme. Bank of England, Staff Working Paper No. 782.

Breedon, F., 2018. On the transactions costs of UK quantitative easing. Journal of Banking & Finance 88, 347–356.

Capelle-Blancard, G., Desroziers, A., 2020. The stock market is not the economy? Insights from the COVID-19 crisis. Covid Economics: Vetted and Real-Time Papers, June 12.

Charoenwong, B., Morck, R., Wiwattanakantang, Y., 2021. Bank of japan equity purchases: The (non-)effects of extreme quantitative easing. Review of Finance 25, 713–743.

D'Amico, S., Kaminska, I., 2019. Credit easing versus quantitative easing: evidence from corporate and government bond purchase programs. Bank of England, Staff Working Paper No. 825.

D'Amico, S., King, T. B., 2013. Flow and stock effects of large-scale treasury purchases: Evidence on the importance of local supply. Journal of Financial Economics 108, 425–448.

Hammermann, F., Leonard, K., Nardelli, S., von Landesberger, J., et al., 2019. Taking stock of the Eurosystem's asset purchase programme after the end of net asset purchases. Economic Bulletin Articles 2.

Hirose, T., Oka, T., 2020. *Denryoku gaisha ni yoru retsugosai no hakkou* (Issuance of subordinate bonds by electric power companies) (in Japanese). *Capital Markets Legal Update*, Anderson Mori & Tomotsune, October 2020.

Honda, Y., Kuroki, Y., Tachibana, M., 2013. An injection of base money at zero interest rates: Empirical evidence from the japanese experience 2001–2006. Japanese Journal of Monetary and Financial Economics 1, 1–24.

Joyce, M. A., Tong, M., 2012. QE and the gilt market: a disaggregated analysis. The Economic Journal 122, F348–F384.

Kirti, D., 2020. Why do bank-dependent firms bear interest-rate risk? Journal of Financial Intermediation 41, 100823.

Kosmidis, I., Firth, D., 2009. Bias reduction in exponential family nonlinear models. Biometrika 96, 793–804.

Kosmidis, I., Firth, D., 2011. Multinomial logit bias reduction via the Poisson log-linear model. Biometrika 98, 755–759.

O'Hara, M., Zhou, X. A., forthcoming. Anatomy of a liquidity crisis: Corporate bonds in the COVID-19 crisis. Journal of Financial Economics, forthcoming .

Okimoto, T., Takaoka, S., 2020. No-arbitrage determinants of credit spread curves under the unconventional monetary policy regime in japan. Journal of International Financial Markets, Institutions and Money 64, 101143.

Pelizzon, L., Subrahmanyam, M. G., Tobe, R., Uno, J., 2018. Scarcity and Spotlight Effects on Liquidity and Yield: Quantitative Easing in Japan. IMES Discussion Paper Series, No. 18-E-14, Institute for Monetary and Economic Studies, Bank of Japan.

Ramelli, S., Wagner, A. F., 2020. Feverish stock price reactions to covid-19. The Review of Corporate Finance Studies 9, 622–655.

Schlepper, K., Hofer, H., Riordan, R., Schrimpf, A., 2020. The market microstructure of central bank bond purchases. Journal of Financial and Quantitative Analysis 55, 193–221.

SEC, 2020. U.S. credit markets: Interconnectedness and the effects of the COVID-19 economic shock. A staff report of the Division of Economic and Risk Analysis of the U.S. Securities and Exchange Commission, October 2020.

Song, Z., Zhu, H., 2018. Quantitative easing auctions of Treasury bonds. Journal of Financial Economics 128, 103–124.

Takahashi, H., Yamada, K., 2021. When the Japanese stock market meets COVID-19: Impact of ownership, China and US exposure, and ESG channels. International Review of Financial Analysis 74, 101670.