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Market Functioning in the Japanese Corporate Bond Market

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Abstract

We construct a new composite index that comprehensively reflects the functioning of Japanese corporate bond markets, the Corporate Bond Market Functioning Index (CBMFI), by aggregating various price-, volume-, and trading environment-related measures of corporate bond market functioning in both primary and secondary markets, following Boyarchenko et al. [2022b]. The CBMFI shows the following. First, in the midst of the Global Financial Crisis from 2008 to 2009 and the period of global monetary tightening from 2022 to 2023, the index fell sharply as the functioning of bond markets deteriorated. The empirical results on the reasons for this decline suggest that, in addition to domestic factors, the tightening of foreign financial conditions had an impact by leading to a deterioration in investors' risk sentiment. Second, while the CBMFI has remained relatively stable in the period since 2013, sub-indexes for the primary and secondary markets show somewhat different developments. This partly reflects the fact that the large-scale monetary easing by the Bank of Japan, including outright purchases of corporate bonds, improved market functioning, especially in the primary market. Third, in terms of the link to the real economy, an improvement in the functioning of the corporate bond market has a positive effect on the real economy through an increase in business fixed investment. The empirical results suggest that the functioning of the primary market is especially important, as it directly affects firms' funding conditions. The CBMFI constructed in this paper proves to be a useful indicator for assessing the functioning of corporate bond markets in a comprehensive and timely manner as one of the transmission channels of monetary policy.

JEL Classification: G12, E44, E58

Keywords: Corporate bond markets, market functioning, corporate finance, business fixed investment, asset purchase

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1. Introduction

The corporate bond market is one of the most important funding channels for firms in Japan, especially large firms. If corporate bond markets function well, firms can raise sufficient amounts of funds with longer maturities as needed. As the funds raised are used for business fixed investment and mergers and acquisitions, well-functioning corporate bond markets have a positive impact on economic activity. From a monetary policy perspective, the smooth functioning of the corporate bond market is also extremely important, since it acts as a transmission channel of monetary policy to economic activity through changes in financial conditions. Against this background, central banks regularly monitor corporate bond markets as part of financial conditions.[1]

In this paper, we construct a composite index of the functioning of Japanese corporate bond markets, the Corporate Bond Market Functioning Index (CBMFI), following the methodology proposed by Boyarchenko et al. [2022b], who construct a composite index of the functioning of U.S. corporate bond markets. Specifically, the CBMFI is constructed by aggregating various measures of transaction prices, volumes, and the trading environment in both primary and secondary markets. Our empirical analysis using the CBMFI finds that the functioning of corporate bond markets has a significant impact on business fixed investment, and an improvement in financial conditions and an increase in the Bank of Japan's (BOJ's) outright purchases of corporate bonds tend to improve corporate bond market functioning, implying that they have a positive impact on the real economy through the functioning of corporate bond markets. These results suggest that the CBMFI is a useful indicator for assessing the functioning of corporate bond markets as a transmission channel of monetary policy in a comprehensive and timely manner.

The importance of the functioning of corporate bond markets has been highlighted in a number of studies. For example, Bernanke and Gertler [1995] point out that frictions such as incomplete information and incomplete contracts in credit markets create a premium for external funds by preventing markets from functioning smoothly, and argue that the impact of monetary policy on this premium and hence the real economy – that is, the credit channel – is an important transmission mechanism of monetary policy. An empirical study focusing on corporate bond market functioning is that by Gilchrist and Zakrajšek [2012], who estimate the "excess bond premium" using corporate bond market data for the U.S. and report that excess bond premiums have a significant impact on the economy.

Turning to Japan, a number of studies have argued that one of the reasons for Japan's sluggish growth since the collapse of the bubble economy in the 1990s is that the credit channel did not function properly. The deterioration of firms' and banks' balance sheets due to the collapse in asset prices led to sluggish business fixed investment and likely

[1] Many central banks report and discuss developments in corporate bond markets at their monetary policy meetings (see the minutes and transcripts of individual central banks), and the results of their regular monitoring efforts are sometimes presented in their financial stability reports.

exacerbated the economic downturn (e.g. Ueda [2005]; Fukunaga [2006]). While corporate bond markets only played a limited role in Japan's economy at the time, since only blue-chip firms were able to issue bonds due to strict regulations on bond issuance, so that the impact that the macro level was limited, Nagahata and Sekine [2002] and Fukuda et al.'s [2005] finding that large firms that had not issued bonds and small and medium-sized firms that did not have access to direct financing tended to reduce investment when the financial condition of their main bank deteriorated implies that widely-accessible and well-functioning corporate bond markets are crucial, especially in times of a banking crisis. In addition, there are a number of studies that analyze developments in Japanese corporate bond markets using indicators such as credit spreads and excess bond premiums (e.g. Shirasu and Yonezawa [2007]; Nakashima and Saito [2009]; Ohyama and Hongo [2010]; Ochi and Osada [2023]), while other studies show that such indicators have useful information for predicting future economic activity (e.g. Okimoto and Takaoka [2022]).

In recent years, a number of central banks started to implement corporate bond purchases as an additional monetary easing measure in response to the disinflationary environment since the Global Financial Crisis (GFC), and such corporate bond purchases became more prevalent in the wake of the outbreak of the COVID-19 pandemic in 2020. Reflecting this, there is a growing body of empirical literature examining the effects of corporate bond purchases on the functioning of corporate bond markets and their impact on the real economy from different perspectives, for example using granular data or focusing on the differential impacts on primary and secondary markets.[2] However, to the best of our knowledge, the only empirical studies examining the effects of the BOJ's corporate bond purchases are Suganuma and Ueno [2018] and Ochi and Osada [2023], which focus only on the effects on credit spreads.

This paper is organized as follows. Section 2 describes the data and methodology used to construct our composite index (CBMFI) and provides a brief discussion of concepts regarding corporate bond market functioning. Section 3 presents the CBMFI and developments in the CBMFI over time. Section 4 then presents empirical analyses to examine (1) the determinants of the functioning of corporate bond markets and (2) the link between corporate bond market functioning and the real economy and argues that the CBMFI can be a useful indicator for assessing the functioning of corporate bond markets in terms of the transmission channel of monetary policy. Section 5 concludes.

2. Data and Methodology

2.1. Various measures to capture corporate bond market functioning

In functioning financial markets, transactions and pricing take place in an efficient and

[2] See, for example, Bernanke [2020], Gilchrist et al. [2021], Boyarchenko et al. [2022a], Zaghini [2020], D'Amico and Kaminska [2019], and Catalan and Hoffmaister [2023].

smooth manner. Bank for International Settlements [2019] highlights that necessary conditions for functioning markets are a high degree of liquidity and resiliency (i.e., imbalances resulting from shocks are resolved immediately) and suggests monitoring the functioning of markets using a combination of indicators on prices and volumes.

Against this background, a growing number of studies have sought to examine the quantitative impact of large-scale monetary easing by the BOJ on the functioning of Japanese government bond (JGB) markets. Studies on JGB futures include quantitative analyses using indicators such as turnover, trading volume, bid-ask spreads, the price range to turnover ratio, "thickness" on the trading board, which indicates market depth, and the price impact of trades (e.g. Nishizaki et al. [2013], Kurosaki et al. [2015]). Studies on the JGB cash market have tried to create various indicators using granular data on transactions among dealers (Sakiyama and Kobayashi [2018]). Meanwhile, with regard to the functioning of the secondary market for JGBs, the Bond Market Survey conducted quarterly by the BOJ asks market participants about their overall assessment in terms of the following seven items: (1) bid-ask spreads, (2) order volumes, (3) trading frequencies, (4) the number of counterparties they traded with, (5) lot sizes, (6) whether trades were executed at the intended prices, and (7) whether trades were executed at the intended lot sizes. Aggregating the responses to these items makes it possible to quantify qualitative information for monitoring.

In the United States, the Trade Reporting and Compliance Engine (TRACE) was put in place in early 2000. Designed to enhance market transparency, TRACE is a mechanism that ensures that information on all corporate bond transactions in over-the-counter (OTC) markets is reported and published. Boyarchenko et al. [2022b] use granular data extracted from TRACE to examine the functioning of the secondary market in corporate bonds in the United States by constructing four indicators of transaction volumes, four indicators of liquidity, three indicators of duration-matched spreads, and six indicators of default-adjusted spreads. Moreover, they examine the functioning of the primary market by constructing two transaction volume indicators and two spread indicators with issue-level granular data.

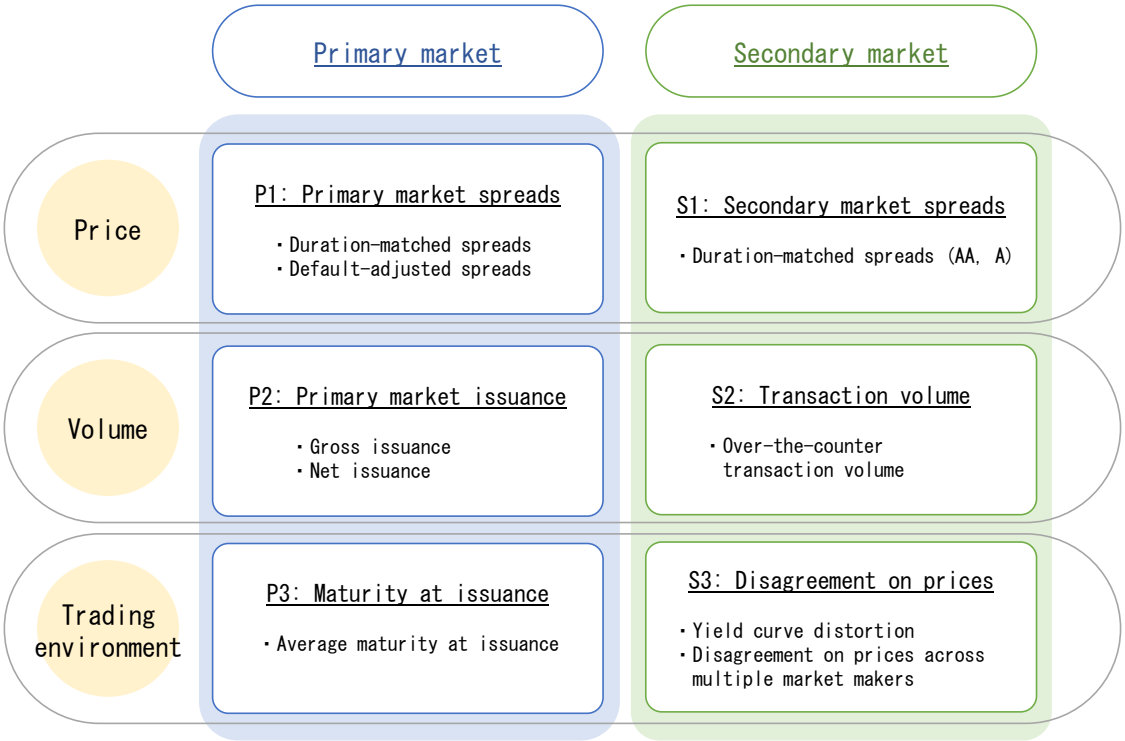
As frequently pointed out, Japan's corporate bond market is much smaller than that in the United States, and available data for analyses is also much more limited. That said, data published has increased in recent years due to the initiative of the Japanese Securities Dealers Association (JSDA) to expand the transaction information reporting system and improve the price information infrastructure with the aim of revitalizing the corporate bond market. Nevertheless, the data available on the corporate bond market is still very limited compared with JGB markets and U.S. corporate bond markets, as described before.[3] For this reason, we construct several alternative indicators as needed using the limited data available in order to properly gauge the functioning of corporate bond markets.

[3] For details on efforts to revitalize corporate bond markets in Japan, see Japan Securities Dealers Association [2023] and Financial Services Agency [2023].

2.2. Data for constructing category-level indexes

Before compiling our overall index (CBMFI), for the purpose of constructing category-level indexes, we group various measures of the functioning of corporate bond markets into six categories as shown in Chart 1, based on whether they relate to the primary or the secondary market and whether they cover prices, volumes, or the trading environment.

Chart 1. Category classification



The binding constraint in our selection of indicators, as mentioned, is data availability. In our analysis below, we use data that are continuously available from 2005 onward, allowing us to examine developments during the GFC as well as later periods using the aggregate index. The following describes the indicators we use for each category and how they relate to the functioning of corporate bond markets.

Measures of corporate bond pricing

As measures of corporate bond pricing in corporate bond markets, we use *primary and secondary market spreads* vis-à-vis the yields on government bonds, which are used as the risk-free benchmark. It should be noted that the simple average of corporate bond spreads reflects not only market conditions such as investors' risk sentiment but also changes in the credit risk of individual issuers, as well as changes in the composition of issuers. The latter means that, especially in the primary market, the simple average of spreads is affected by the fact that new bonds by different issuers are issued every month. This is particularly the

case when the number of issuers is limited. To remove such effects, it is therefore necessary to calculate default-adjusted spreads, where spreads are adjusted by issuers' probability of default.

More concretely, for the primary market (P1 Primary market spreads), we use two indicators, namely *duration-matched spreads* and *default-adjusted spreads*. The data for duration-matched spreads are calculated by (1) taking the simple averages of spreads within the same rating categories and then (2) taking the weighted average of the values obtained using issuance amounts as weights to deal with differences in credit risk within the rating categories.[4] The data for default-adjusted spreads are calculated by adjusting spreads for the credit risk of each issue estimated using granular issue-level time-series data, following the method in Gilchrist and Zakrajšek [2012].[5] Next, for the secondary market (S1 Secondary market spreads), we use *duration-matched spreads*, which are the aggregated spreads of corporate bonds falling into the AA or A rating categories. More specifically, we take the average of duration-matched spreads for all remaining maturities with less than 10 years for each rating category based on the published data in the OTC Bond Trading Reference Statistics[6] released by the JSDA.[7]

Measures of corporate bond market transaction volumes

As measures of corporate bond market transaction volumes, we use the *amount of corporate bonds issued* in the primary market and the *actual transaction volume* in the secondary market. In periods in which the functioning of corporate bond markets is impaired, such as when there is a rise in uncertainty in markets and investors' risk sentiment worsens, the spreads described above are likely to rise and issuances and transactions are less likely to occur.

Specifically, *gross issuance* and *net issuance* are used as indicators for the primary market (P2 Primary market issuance). The data for gross issuance are calculated as the sum of the issuance amounts of straight corporate bonds issued each month.[8] The data for net issuance

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[4] In addition, subordinated bonds, which are highly heterogeneous across issues, issues for individual investors, and issues with an initial maturity of 15 years or longer are excluded.

[5] See Appendix A for the detailed methodology. See Ochi and Osada [2023] for recent developments in default-adjusted spreads (in the article, default-adjusted spreads are called "across-issue common factors").

[6] The JSDA collects and publishes data on the indicative quoted prices of yields on all issues in the secondary market submitted for trading reference by its members.

[7] Although Suganuma and Ueno [2018] estimate default-adjusted spreads in the secondary market, we do not use them in the analysis since data for the period after their study are not available.

[8] We use the ratio of the amount of bonds issued in a particular month to the average of the amount of bonds issued in the same month in the preceding three years to remove seasonality and trend-like developments in monthly issuance volumes. (We do the same with regard to the transaction volume in the secondary market, as will be described later.) Unlike in the case of primary market spreads described above, subordinated bonds, issues for individual investors, and issues with initial maturity of 15 years or longer are included for aggregation

are calculated as month-on-month changes in the total amount of corporate bonds outstanding in each month, which indicates the net funding demand and credit supply without the effect of refinancing at reimbursement. As the measure of the transaction volume (S2 Transaction volume) in the secondary market, we use the *OTC transaction volume*, which is the aggregate amount of corporate bonds traded by securities companies that are members of the JSDA.[9]

Measures of the trading environment

As measures of the trading environment in U.S. corporate bond markets, Boyarchenko et al. [2022b] employ widely-used indicators of liquidity such as standard bid-ask spreads and the price impact of trades calculated using granular data on transactions among dealers for U.S. corporate bond markets. However, such granular data for corporate bond markets in Japan are not available. This means that we need to find other data to measure the trading environment. Specifically, we use the following.

First, for the primary market, we use the *average maturity at issuance* (P3 Maturity at issuance). Generally, maturity at issuance tends to be longer when interest rates are low and financial conditions are favorable. On the other hand, maturity at issuance tends to be shorter when uncertainty regarding the future outlook is high and it is difficult for investors to take duration risk. In facts, credit analysts have pointed out that, since mid-2022, there has been an increase in spreads at issuance, a decrease in the volume of issuance, and a shortening of the maturity at issuance in periods when investors' risk sentiment deteriorated. The data for the average maturity at issuance are processed as follows: (1) we calculate the simple average of the maturity at issuance for corporate bonds within the same rating categories and then (2) take the weighted average of the values obtained using issuance amounts as weights.

Second, for the secondary market, we construct an indicator that focuses on the degree of *disagreement on prices among investors* (S3 Disagreement on prices). During periods of high interest rate volatility, investors' expectations of future price movements vary widely, leading to difficulties in transacting and a deterioration in market liquidity. Many previous studies employ widely-used indicators such as bid-ask spreads to capture these conditions. However, such data are not available for Japanese corporate bond markets, partly due to the popularity of OTC transactions over market transactions. Therefore, we construct indicators for the *yield curve distortion* and *disagreement on prices across multiple market makers* to

since there is less necessity to consider the heterogeneity within issues in the process of aggregating issuance amounts.

[9] Another potential measure of transaction volume in the secondary market would be the number of transactions. However, data on the number of transactions are available only for the period after October 2015, so that we do not use them. Meanwhile, Boyarchenko et al. [2022b] use the average trade size as one of their indicators of transaction volume and point out that the amount per transaction tends to decrease in times of stress, since investors become more risk-averse and more likely to avoid large risks.

capture the transaction environment in the secondary market.[10] Specifically, for issuers that have issued bonds with various maturities, we calculate the issuer-level bond yield curve distortion as the deviation between the actual and the hypothetical yield curve of bonds issued by the issuer. The hypothetical yield curve is estimated as the smooth yield curve that would materialize in the case that arbitrage across bonds with different maturities functions well. We then aggregate the deviations for all issuers. The data for disagreement on prices across multiple market makers are calculated as the simple average of issue-level deviations between the maximum and the minimum of indicative quoted prices submitted by security firms.

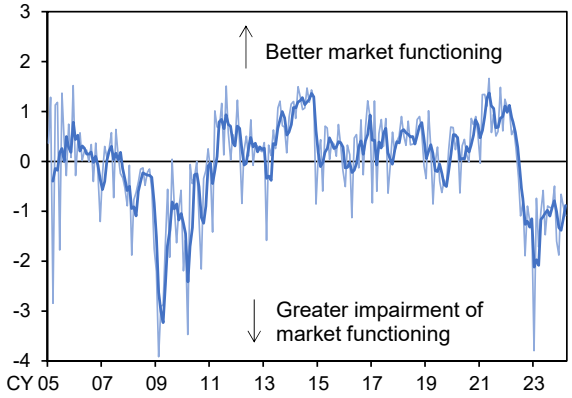
Category-level indexes

Chart 2 shows the market functioning index for each category obtained when aggregating the indicators for each category. Specifically, the category-level indexes are calculated as follows: (1) we standardize the indicators included in each category such that a higher positive value denotes a higher degree of functioning and (2) then take the average of these standardized indicators when a category contains multiple indicators. We use monthly data from January 2005 onward.

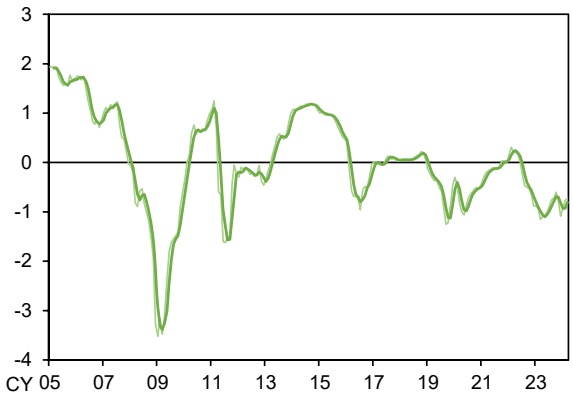
[10] See Appendix B for the specific methodology for calculating the indicators for disagreement on prices. Goldberg and Nozawa [2021] also calculate issuer-level yield curve distortions and suggest a methodology to decompose them into the portion due to liquidity demand and the portion due to liquidity supply, and Miyakawa and Watanabe [2010] calculate an indicator of disagreement on prices and report that this is related to the liquidity premium included in corporate bond spreads.

Chart 2. Category-level Indexes

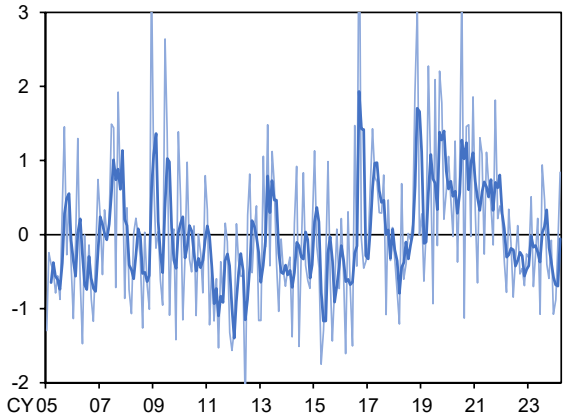
P1: Primary market spreads



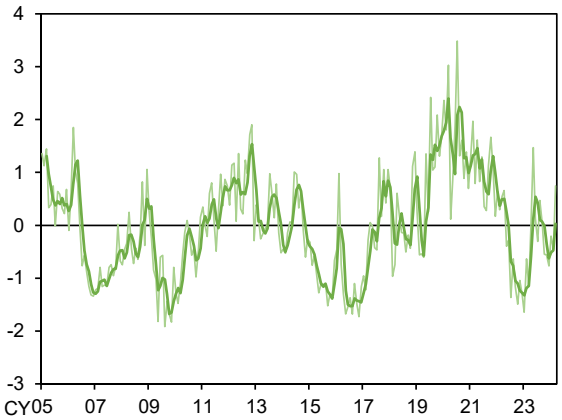
S1: Secondary market spreads



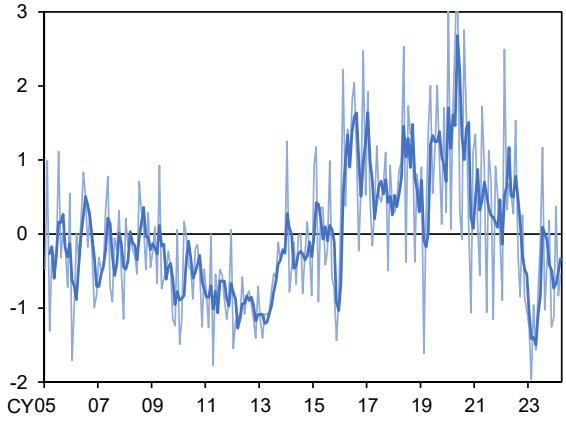
P2: Primary market issuance



S2: Transaction volume



P3: Maturity at issuance



S3: Disagreement on prices

Note: The bold lines denote 3-month moving averages. The latest data are as of March 2024.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association.

2.3. Aggregation method for the overall market-functioning index

Next, we explain the methodology for constructing the CBMFI, our index that represents the functioning of corporate bond markets overall, by aggregating the category-level indexes constructed above. While there are a variety of methodologies we could use for the aggregation, such as taking the arithmetic average or extracting principal components, the one we use here is to use time-varying correlation weights.[11] The specific steps to calculate the weights are as follows.

To begin with, we calculate the time-varying covariance ($\sigma_{ij,t}$: the exponential moving average of the covariance) of the market functioning indexes (y_i, y_j) using the following equation:

$$\sigma_{ij,t} = \begin{cases} \frac{1}{T}\sum_{s=1}^{T}(y_{i,s} - \bar{y}_i)(y_{j,s} - \bar{y}_j) \ , & if \ \ t = 0, \\ \lambda\sigma_{ij,t-1} + (1-\lambda)(y_{i,t} - \bar{y}_i)(y_{j,t} - \bar{y}_j) \ , & otherwise, \end{cases} \quad (1)$$

where T denotes the number of observations and $\bar{y}_i$ is the average of $y_{i,t}$ over all periods (which equals 0, since it is standardized in Section 2.2). λ, the smoothing factor of the exponential moving average, is set to 0.90 following the previous literature.[12] In the case where $i = j$, $\sigma_{ij,t}$ is equivalent to the time-varying variance $\sigma_{ii,t}$.

We define time-varying correlation coefficient $\rho_{ij,t}$ as follows using the time-varying covariance and variance:

$$\rho_{ij,t} = \frac{\sigma_{ij,t}}{\sqrt{\sigma_{ii,t}\sigma_{jj,t}}} \quad (2)$$

Lastly, weights $\omega_{i,t}$ of the market functioning index y_i for category i at time t are calculated as follows using time-varying correlation coefficients:

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[11] Boyarchenko et al. [2022b] draw on the aggregation methodology in Holló et al. [2012] and Schüler et al. [2015], which are previous studies on indicators of systemic risk or the financial cycle in Europe. A similar technique is used in the aggregation to obtain the "financial gap" in the BOJ's Financial System Report (Bank of Japan [2019]). Meanwhile, Chavleishvili and Kremer [2023] calculate systemic risk indicators using various aggregation methodologies and, using quantile regression, compare the predictive power of the indicators with regard to economic growth. They report that the indicators with time-varying correlation weights have higher predictive power than the other indicators, especially with regard to tail events.

[12] For instance, Boyarchenko et al. [2022b] use $\lambda = 0.90$, Holló et al. [2012] use $\lambda = 0.93$, and Schüler et al. [2015] use $\lambda = 0.90$. When $\lambda = 0.90$ and monthly data are used, information for the past 2 years accounts for about 90 percent in the weights for the current period.

$$\omega_{i,t} = \frac{\sum_{j=1}^{k} \rho_{ij,t}}{\sum_{i=1}^{k} \sum_{j=1}^{k} \rho_{ij,t}} \quad (3)$$

Using these time-varying weights means that the more the index for one category is correlated with the indexes for the other categories, the larger the weight it is assigned. The importance of different indexes can change over time, since the correlations between indexes are continuously updated as the latest data become available.[13] Furthermore, following Schüler et al. [2020] and Metiu [2022], when the correlation coefficients take negative values, we replace them with 0 to avoid negative weights, since the category-level indexes are standardized such that they take a positive value when the degree of market functioning is high.

Chart 3 presents the correlation matrix of the category-level indexes. It shows the following: (1) "P1 Primary market spreads" are correlated with all the other category-level indexes except "P2 Primary market issuance," (2) "S2 Transaction volume" is correlated with "P2 Primary market issuance," and (3) "P1 Primary market spreads," "S1 Secondary market spreads," and "S3 Disagreement on prices" are strongly correlated with each other. Next, Chart 4 shows that while the calculated category-level weights fluctuate over time, on the whole, the primary market indexes tend to have a relatively large weight and the secondary market indexes a relatively small weight.

Chart 3. Correlation between category-level indexes

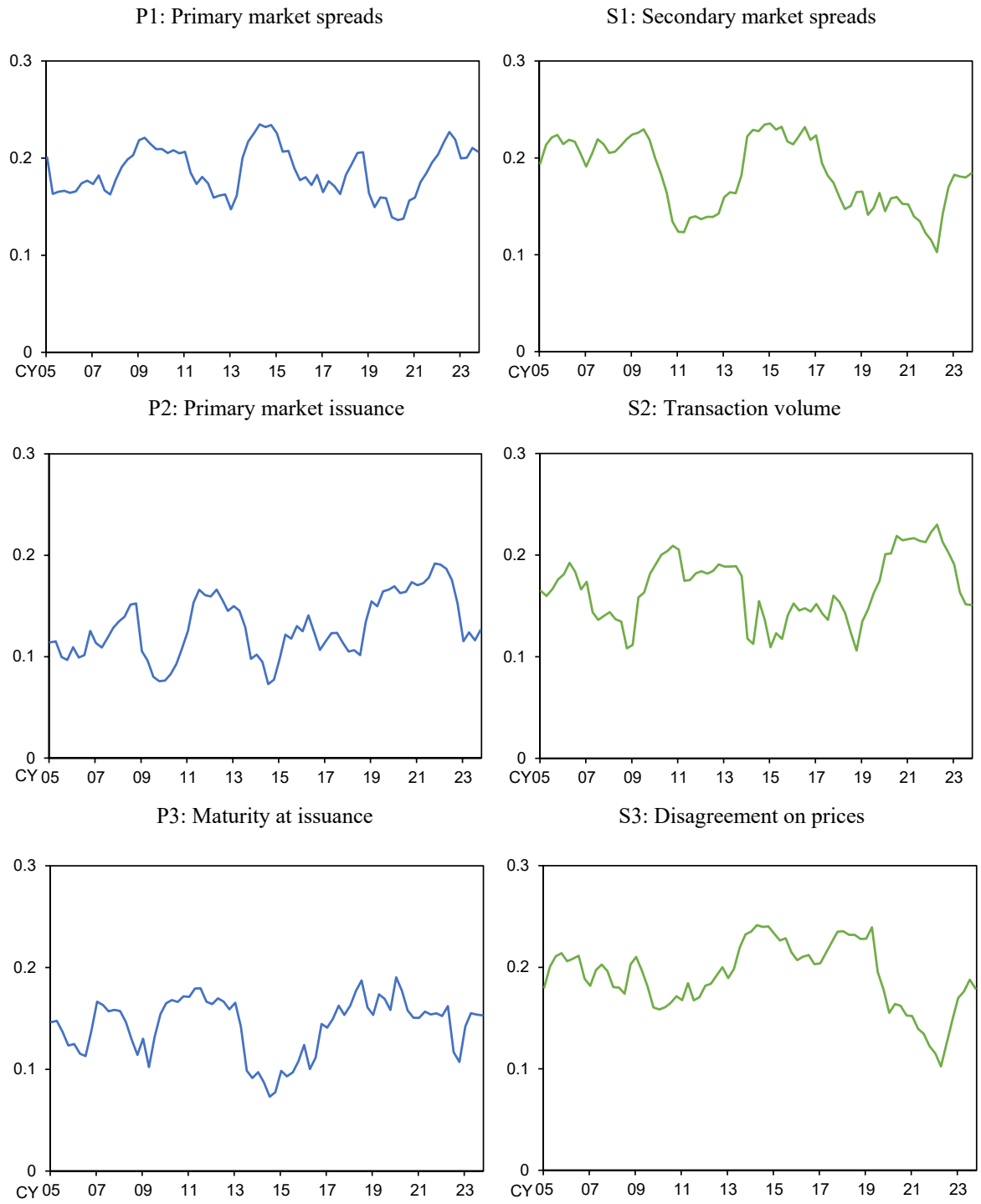
	P1 Primary market spreads	P2 Primary market issuance	P3 Maturity at issuance	S1 Secondary market spreads	S2 Transaction volume	S3 Disagreement on prices
P1 Primary market spreads	-	-0.03	0.21***	0.42***	0.29***	0.37***
P2 Primary market issuance	-0.03	-	0.12*	-0.13**	0.25***	-0.12*
P3 Maturity at issuance	0.21***	0.12*	-	-0.07	0.12*	-0.03
S1 Secondary market spreads	0.42***	-0.13**	-0.07	-	0.02	0.58***
S2 Transaction volume	0.29***	0.25***	0.12*	0.02	-	-0.06
S3 Disagreement on prices	0.37***	-0.12*	-0.03	0.58***	-0.06	-

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The calculation period is from January 2005 to December 2023.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association.

[13] However, past values are not updated as new data become available. This feature is useful when using the index for real-time monitoring.

Chart 4. Time-varying weight of each category based on time-varying correlation



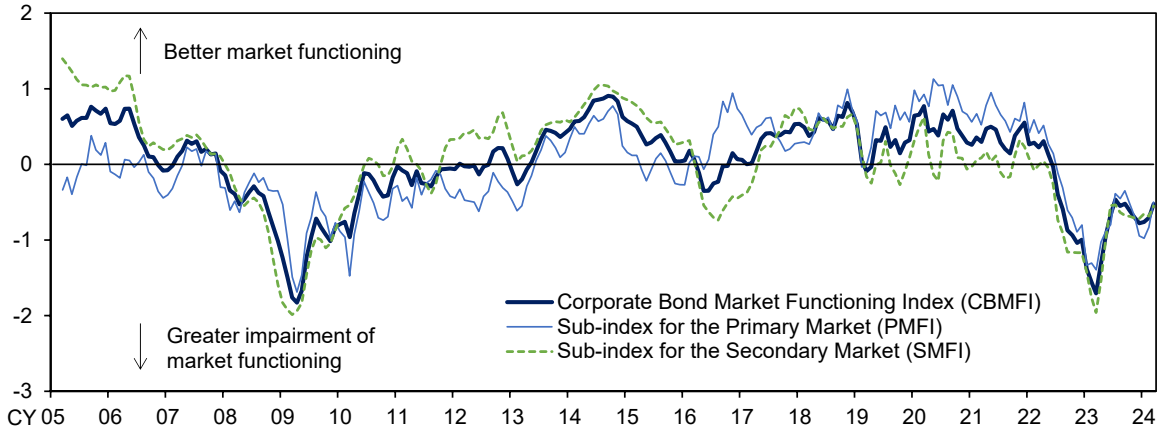
Note: The figures show quarterly values obtained by calculating the simple average of monthly data.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association.

3. Developments in the CBMFI

Chart 5 shows the CBMFI (Corporate Bond Market Functioning Index) calculated using the methodology explained in Section 2. The index is standardized so that its average over the observation period is 0, and a higher index value indicates a higher degree of market functioning. The chart also shows the Primary Market Functioning Index (PMFI) and the Secondary Market Functioning Index (SMFI), which are obtained by calculating the weighted averages of the three category-level indexes for each market. In the following, we examine developments in these market functioning indexes by dividing our observation period from January 2005 to March 2024 into four phases.

Chart 5. Corporate Bond Market Functioning Index (CBMFI)



Note: The Corporate Bond Market Functioning Index (CBMFI) is calculated as the time-varying correlation-weighted average of the six category-level indexes consisting of various price-, volume-, and trading environment-related measures of corporate bond market functioning in both the primary and secondary markets. 3-month moving average. The latest data are as of March 2024.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association.

The first phase is the period before and after the GFC in the late 2000s. In the beginning of this phase, credit spreads widened and issuance amounts decreased, particularly in the case of lower-rated issues, as long-term interest rates rose and financial conditions tightened against the backdrop of improvements in the domestic and overseas economies (see, e.g., Bank of Japan Financial Markets Department [2006]). Reflecting this, the CBMFI declined moderately from high levels. The CBMFI then fell sharply in late 2008 during the GFC, when domestic and foreign financial markets suffered severe stress, followed by improvement that was partly due to the effect of market stabilization measures by central banks. The BOJ launched outright purchases of corporate bonds in March 2009, coinciding with the period when the CBMFI hit bottom.

The second phase is the recovery period from the GFC. The CBMFI improved notably from mid-2009 to 2010 and then remained more or less unchanged from 2011 to 2012. However, the PMFI remained lower after 2010 than the SMFI. The likely reason for this is the impact of the Great East Japan Earthquake in March 2011. While in the secondary market

the turmoil immediately after the earthquake was only temporary, in the primary market the issuance of bonds became difficult and the average maturity at issuance shortened sharply, since the creditworthiness of energy-related companies, which had accounted for about 20 percent of total issuance, was severely damaged and there was concern over the outlook for their financial positions. Meanwhile, in order to prevent that the deterioration in business sentiment due to the earthquake and a tightening of financial conditions through increased risk aversion had an adverse impact on the real economy, the BOJ decided to increase the purchase of risk assets, including corporate bonds. (Specifically, the BOJ increased corporate bond purchases by 1.5 trillion yen in March 2011, 0.9 trillion yen in August 2011, and 0.3 trillion yen in October 2012 under the Asset Purchase Program).

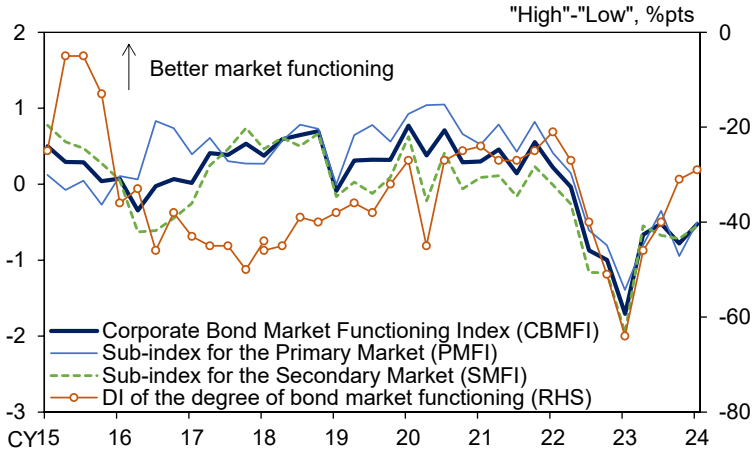
The third phase consists of the period from 2013 onward, when the BOJ conducted large-scale monetary easing. The CBMFI stayed in positive territory from 2013 to 2021. During this period, the BOJ conducted Quantitative and Qualitative Monetary Easing (QQE) with the intention of stimulating the economy and prices by improving financial conditions through lower real interest rates by putting downward pressure on the entire yield curve. For corporate bond markets, this meant that the BOJ's JGB purchases increased investors' risk-taking capacity and strengthened their preference for riskier assets promising higher return than JGBs. In other words, QQE stimulated the demand for corporate bonds through the portfolio rebalancing effect. In addition, the sharp increase in the BOJ's corporate bond purchases in early 2020 likely also contributed to putting upward pressure on the CBMFI. In fact, the issuance of super-long bonds rose substantially and the average maturity at issuance increased to more than 10 years around 2020 compared with 7.5 years before QQE.

On the other hand, it has been argued that the BOJ's large-scale monetary easing may have reduced the functioning of bond markets. For instance, the results of the BOJ's Special Survey of bond market participants conducted in November 2023 show that the diffusion index (DI) for the degree of functioning of the secondary JGB market declined following the introduction of QQE, particularly after the introduction of the negative interest rate policy and Yield Curve Control (YCC).[14] Chart 6 shows the correlations between the DI for the degree of bond market functioning taken from the Bond Market Survey and the CBMFI from 2015 onward, when the survey was launched. The corporate bond market functioning indexes, and especially the SMFI, are positively correlated with the DI for the degree of JGB market functioning. In fact, the SMFI, unlike the PMFI, shows similar movements as the DI for the degree of JGB bond market functioning. For example, both declined when the negative interest rate policy was introduced in 2016 and when the COVID-19 outbreak occurred in 2020. This suggests that the secondary corporate bond market may have been

[14] The BOJ compiles liquidity indicators for the JGB market using various data and releases these on a quarterly basis. Looking at these indicators shows that while some deteriorated sharply after the introduction of QQE, the introduction of negative interest rates, and the introduction of YCC, in some cases this deterioration was only temporary, so that the assessment of liquidity differs depending on which indicator is used. See Nishizaki et al. [2013], Kurosaki et al. [2015], and Sakiyama and Kobayashi [2018] for views on and assessments of these liquidity indicators.

more likely to be affected by a deterioration in other financial markets and less likely to be affected by the positive impact of QQE than the primary market.

Chart 6. JGB Market Functioning and Corporate Bond Market Functioning



	Correlation coefficient
Corporate Bond Market Functioning Index (CBMFI)	0.39 **
Sub-index for the Primary Market (PMFI)	0.20
P1 Primary market spreads	0.48 ***
P2 Primary market issuance	-0.14
P3 Maturity at issuance	0.00
Sub-index for the Secondary Market (SMFI)	0.45 ***
S1 Secondary market spreads	0.56 ***
S2 Transaction volume	0.08
S3 Disagreement on prices	0.22

Note: The DI for the degree of bond market functioning is based on respondents' view on the current situation in the secondary JGB market in the "Bond Market Survey" conducted by the Bank of Japan. In the table, ***, **, and * denote statistical significance at the 1 %, 5%, and 10% levels, respectively. The calculation period for the correlation coefficients is from 2015/Q1 to 2023/Q4.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; Bank of Japan.

The fourth phase is the period when the CBMFI deteriorated from mid-2022 to 2023. As examined in detail by Ochi and Osada [2023], developments in corporate bond markets in Japan during this period may have been affected by the tightening of financial conditions abroad in addition to domestic financial conditions.[15] Due to high inflation following the COVID-19 pandemic, most central banks around the world were forced to tighten monetary policy. Different expectations with regard to central banks' policy stance going forward meant that investors' interest rate outlook often did not match, so that indicators of the transaction environment in corporate bond markets deteriorated, and issuance in the primary market and the transaction volume in the secondary market decreased sharply. The CBMFI we propose in this paper should make it possible to properly capture such changes in market functioning that are difficult to detect looking at prices alone.

Overall, developments in the CBMFI can be summarized as follows. (1) Both the PMFI and the SMFI declined together during phases in which market functioning deteriorated, such as the GFC in 2008–2009 and when interest rates rose globally from 2022 to 2023. On the other hand, (2) the PMFI and the SMFI showed somewhat different developments in the phase since 2013, when the CBMFI remained relatively stable, but different factors caused the PMFI and the SMFI to fluctuate.

[15] Ochi and Osada [2023] suggest that the widening of corporate bond spreads from mid-2022 to early 2023 was mainly driven by (1) increased demand for working capital due to rising commodity prices and (2) spillover effects from the tightening of financial conditions abroad as a result of monetary tightening by overseas central banks, as well as (3) a decline in the degree of functioning of the JGB market from mid-2022 to early 2023.

4. Empirical Analysis using the CBMFI

In this section, we conduct empirical analyses using the CBMFI. Specifically, we assess whether the CBMFI is useful in evaluating the functioning of corporate bond markets as a transmission channel of monetary policy by quantitatively examining (1) the determinants of the functioning of corporate bond markets and (2) the effect of the functioning of corporate bond markets on economic activity.

4.1. Determinants of changes in the CBMFI

As shown in Section 3, the functioning of corporate bond markets can be affected both directly and indirectly by domestic and foreign financial conditions.[16] The following part of this section presents quantitative analyses on the determinants of changes in the CBMFI using standard regression and vector autoregression (VAR) models.

Decomposition of changes in the CBMFI: Standard regression analysis

We start by estimating the following regression model using the CBMFI ($CBMFI_t$) or one of the sub-indexes, i.e., the PMFI or SMFI, as the dependent variable and various indicators representing foreign financial conditions ($ForeignFC_t$), domestic financial conditions ($DomesticFC_t$), and corporate bond market-specific factors ($CBspecific_t$) as explanatory variables:

$$CBMFI_t = \alpha + \boldsymbol{\beta} \cdot ForeignFC_t + \boldsymbol{\gamma} \cdot DomesticFC_t + \boldsymbol{\delta} \cdot CBspecific_t + \epsilon_t \qquad (4)$$

Specifically, we use the following two variables as measures of foreign financial conditions ($ForeignFC_t$): (1) U.S. interest rate volatility (MOVE index: ICE BofAML U.S. Bond Market Option Volatility Estimate Index, which indicates the volatility of U.S. Treasury bond yields), and (2) the "Corporate-bond Market Distress Index" created by Boyarchenko et al. [2022b].[17] We use the following three variables as measures of financial conditions in Japan ($DomesticFC_t$): (3) Japanese interest rate volatility (S&P/JPX JGB VIX, measured by 10-year JGB futures prices); (4) swap-JGB spreads (the difference between 5-

[16] Channels through which a tightening of financial conditions overseas could affect corporate bond markets in Japan include not only spillovers on economic activity such as through international trade but also through financial channels. For example, when long-term interest rates rise abroad, this could lead to (1) portfolio rebalancing by globally active investors that affects domestic financial assets prices and to (2) changes in the risk-taking capacity of or deleveraging by globally active financial institutions, which could then affect domestic financial conditions. For details, see, e.g., Caldara et al. [2022], Akinci et al. [2022], Kearns et al. [2023], Bruno and Shin [2015], He and Krishnamurthy [2013], and Adrian and Shin [2011].

[17] The results of the analyses below remain more or less unchanged when instead we use the excess bond premiums estimated by Favara et al. [2016] using the method proposed by Gilchrist and Zakrajšek [2012].

year TONA swap rates and 5-year JGB yields), which indicate the smoothness of arbitrage transactions in medium- and longer-term term markets; and (5) the JGB yield curve distortion index (an aggregated index of the gap between the actual and estimated values of JGB yields, calculated by Bloomberg), which denotes the smoothness of arbitrage transactions among remaining maturities of JGBs (see Appendix D for details of these data).[18,19]

As corporate bond market-specific factors ($CBspecific_t$), we take the monthly amount of the BOJ's outright purchases of corporate bonds and the BOJ's holdings of corporate bonds as a result of such purchases into account (both variables are expressed as the ratio to the total outstanding amount of bonds issued). Regarding the outright purchases of corporate bonds by central banks, previous studies have highlighted that (1) in phases when market liquidity is severely impaired, not only actual central bank purchases but also central banks' signaling of their intention to purchase assets has the effect of reducing risk premiums and restoring market liquidity by reassuring investors (flow effects), and (2) in normal periods, the decrease in the supply of corporate bonds in the market due to central bank purchases may have the effect of pushing down yields on bonds that are close substitutes to purchased corporate bonds, pushing down overall corporate bond yields by increasing investors' capacity to invest in bonds and take more risk (stock effects). Moreover, more recently, studies have highlighted (3) the positive spillover effects of central bank corporate bond purchases through the improvement in firms' funding conditions. For example, it becomes easier for corporate bond issuers to launch new bonds or refinance existing ones, which in turn revitalizes issuance in the primary market.[20] For Japan, Suganuma and Ueno [2018] and Ochi and Osada [2023] report that outright purchases of corporate bonds by the BOJ have helped to put significant downward pressure on credit spreads. This positive impact on

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[18] For 5-year TONA swap rates, 5-year LIBOR swap rate are used for the period before January 2022.

[19] In the estimation, for the JGB yield curve distortion and swap-JGB spreads, we use residuals of separate regressions of them on the indicators for financial conditions in Japan and the United States. This allows us to capture the size of the indirect effects of financial conditions in Japan and the United States on the degree of functioning of the corporate bond market through the degree of functioning of the JGB market, in addition to the size of their direct effects.

[20] Given the growing number of foreign central banks that used outright corporate bond purchases as a policy tool, the empirical literatures on the effects of such purchases is gradually increasing. For example, examining the Secondary Market Corporate Credit Facility (SMCCF) and the Primary Market Corporate Credit Facility (PMCCF) introduced by the U.S. Federal Reserve immediately after the outbreak of COVID-19, Gilchrist et al. [2021] empirically show that these had a positive impact on the secondary market spreads of program-eligible bonds, while Boyarchenko et al. [2022a] find that these facilities had a positive impact on funding conditions for issuers that intended to refinance and argue that the underwriting capacity of dealers, who act as intermediaries between the primary and secondary markets, plays an important role. Focusing on Europe, Zaghini [2020] examines the role of the Corporate Sector Purchase Programme (CSPP) implemented by the European Central Bank (ECB) as part of its monetary easing measures and finds that it significantly pushed down the secondary market spreads of eligible corporate bonds. Finally, for the United Kingdom, D'Amico and Kaminska [2019] report that the Corporate Bond Purchase Scheme (CBPS) conducted by the Bank of England (BOE) from 2016 onward was more effective than the purchase of government bonds alone in reducing credit spreads and increased corporate bond issuance quite rapidly, since the scheme directly influenced the corporate bond market.

corporate bond markets may extend not only to corporate bond pricing but also to the transaction volume and the transaction environment.

The estimation results for Equation (4) are presented in Chart 7. The results of Model (1), which uses the CBMFI as the dependent variable, show the following. As for the domestic government bond market, the coefficients on "Japanese interest rate volatility," "JGB yield curve distortion," and "swap-JGB spreads" are all negative and statistically significant, indicating that a rise in these variables is associated with a decline in market functioning. The results thus indicate that greater interest volatility in the JGB market and a decline in the functioning of the JGB market have an adverse effect on the corporate bond market. Turning to foreign factors, represented by "U.S. interest rate volatility" and the "U.S. Corporate-bond Market Distress Index," we find that the coefficient on the former is negative and significant, while the latter is negative but insignificant. This result indicates that tighter financial conditions in the United States are associated with a reduction in the functioning of corporate bond markets in Japan. Turning to the results for the sub-indexes (Models (4) and (7)), these generally follow a similar pattern as those for Model (1), although there are some differences in the statistical significance of some of the coefficient estimates.

Chart 7. Estimation results: Determinants of the CBMFI

	Corporate Bond Market Functioning Index (CBMFI)			Sub-index for the Primary Market (PMFI)			Sub-index for the Secondary Market (SMFI)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Japanese interest rate volatility	-0.09*	-0.11**	-0.11**	-0.14**	-0.08	-0.08	-0.04	-0.12**	-0.12*
	(0.05)	(0.05)	(0.05)	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)
JGB yield curve distortion	-0.32***	-0.32***	-0.32***	-0.38***	-0.37***	-0.37***	-0.26***	-0.28***	-0.27***
	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)
Swap-JGB spreads	-0.07*	-0.08**	-0.06	-0.11**	-0.09	-0.09	-0.03	-0.07	-0.04
	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)
U.S. interest rate volatility	-0.34***	-0.33***	-0.30***	-0.29***	-0.33***	-0.32***	-0.40***	-0.34***	-0.28***
	(0.05)	(0.05)	(0.06)	(0.07)	(0.07)	(0.08)	(0.06)	(0.06)	(0.07)
U.S. Corporate-bond Market Distress Index	-0.04	-0.05	-0.08	0.01	0.06	0.06	-0.08	-0.16***	-0.21***
	(0.04)	(0.04)	(0.05)	(0.06)	(0.06)	(0.07)	(0.05)	(0.05)	(0.06)
BOJ corporate bond holdings		-0.01	-0.02		0.04**	0.04*		-0.06***	-0.07***
		(0.01)	(0.02)		(0.02)	(0.02)		(0.02)	(0.02)
BOJ outright corporate bond purchases			0.31			0.06			0.62*
			(0.31)			(0.44)			(0.37)
Adjusted R-squared	0.618	0.618	0.618	0.427	0.436	0.433	0.531	0.563	0.567
Number of observations	192	192	192	192	192	192	192	192	192

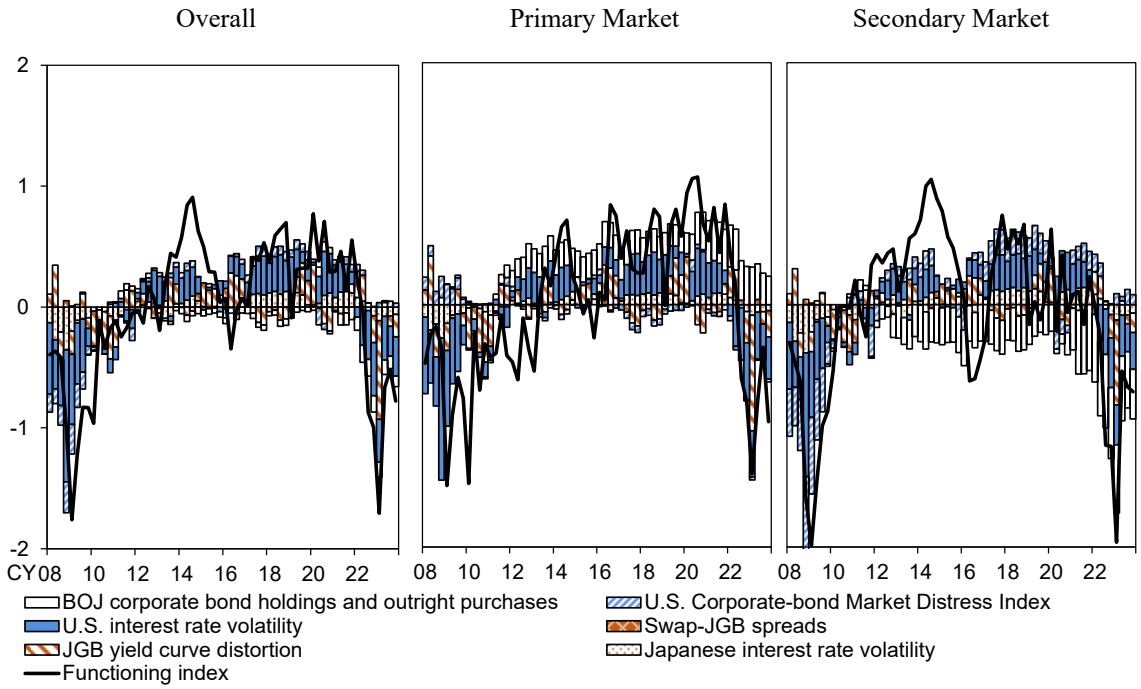
Note: Explanatory variables except "BOJ corporate bond holdings" and "BOJ outright corporate bond purchases" are standardized. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. The estimation period is from January 2008 to December 2023.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; LSEG; ICE Data Indices; Bank of Japan.

Next, Chart 8 decomposes changes in the CBMFI into the contribution of various factors. The figure indicates that tightening financial conditions at home and abroad had a major influence on the CBMFI before and after the GFC from 2008 to 2009 and the period of global rate hikes from 2022 to 2023. Among foreign factors, "U.S. interest rate volatility" made a large downward contribution during these periods. Among domestic factors,

"Japanese interest rate volatility" and "JGB yield curve distortion" made downward contributions. Similar patterns can be observed for the primary and secondary markets.

Chart 8. Decomposition of developments in the CBMFI and sub-indexes



Note: The figures present the results of decomposing changes in the indexes based on Models (3), (6), and (9) in Chart 7. "BOJ corporate bond holdings and outright purchases" is the sum of contributions of BOJ corporate bond holdings and outright purchases.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; LSEG; ICE Data Indices; Bank of Japan.

Next, outright purchases of corporate bonds by the BOJ did not have a statistically significant effect on the corporate bond market overall: the coefficients on "BOJ corporate bond holdings" and "BOJ outright corporate bond purchases" in Model (3) in Chart 7 are both insignificant. However, the results change dramatically when we divide the CBMFI into the PMFI and the SMFI (Models (6) and (9)).The coefficient on "BOJ outright corporate bond purchases" is positive and significant in the estimation for the SMFI, meaning that such purchases had a positive effect in the secondary market during periods of stress such as during the GFC, in the aftermath of the Great East Japan Earthquake, and during the COVID-19 pandemic. Meanwhile, the coefficient on "BOJ corporate bond holdings" is positive and significant in the estimation for the PMFI and negative and significant in the estimation for the SMFI, indicating that such holdings pushed up the PMFI and pushed down the SMFI. Looking at the decomposition in Chart 8, this suggests that, over the past 10 years or so, outright corporate bond purchases and corporate bond holdings by the BOJ have had a positive impact on the functioning of the primary market on the whole but a generally negative impact on the secondary market. The results thus suggest that the BOJ's outright purchases and holdings of corporate bonds have had a positive effect on the primary market,

for example by leading to the increased issuance of corporate bonds through an improvement in firms' funding conditions, but it did not have a positive effect on transactions in the secondary market. It is well known that investors in Japanese corporate bond markets tend to hold newly issued bonds to maturity, so that the volume of transactions in the secondary markets is limited. Under these circumstances, large scale holdings by the BOJ as a result of corporate bond purchases may lower the degree of functioning of the secondary market by reducing the amount of bonds available for trade.[21]

Analysis of connectedness using a VAR model

The previous subsection presented the results of a relatively simple regression model. On the other hand, to take the lag structure and the directions of transmission effects among variables into account, and to distinguish direct and indirect effects, analysis using a VAR model is helpful. This section therefore investigates how changes in domestic and foreign financial conditions spread to corporate bond markets in Japan, using the connectedness analysis proposed by Diebold and Yilmaz [2012, 2014].

Specifically, estimating a VAR model consisting of *n* endogenous variables, Diebold and Yilmaz [2012, 2014] define the influence of variable j on variable i (the directional connectedness from j to i: $C_{i\leftarrow j}^{H}$) as the contribution of a unique shock to variable j to the H-quarter ahead estimation errors of variable i using variance decomposition (d_{ij}^{H}) as follows:

$$C_{i\leftarrow j}^{H} = d_{ij}^{H} \tag{5}$$

Using this, we calculate indicators such as "net pairwise directional connectedness," ($NC_{j\leftarrow i}^{H}$) which shows whether variable i has a stronger influence on j or vice versa, and the "total directional connectedness" ($TC_{i\leftarrow\bullet}^{H}$) of variable i as follows: [22]

$$NC_{j\leftarrow i}^{H} = C_{j\leftarrow i}^{H} - C_{i\leftarrow j}^{H} \tag{6}$$

$$TC_{i\leftarrow\bullet}^{H} = \sum_{j\neq i} C_{i\leftarrow j}^{H} \tag{7}$$

Chart 9 shows the net pairwise directional connectedness ($NC_{j\leftarrow i}^{H}$) of variables based on

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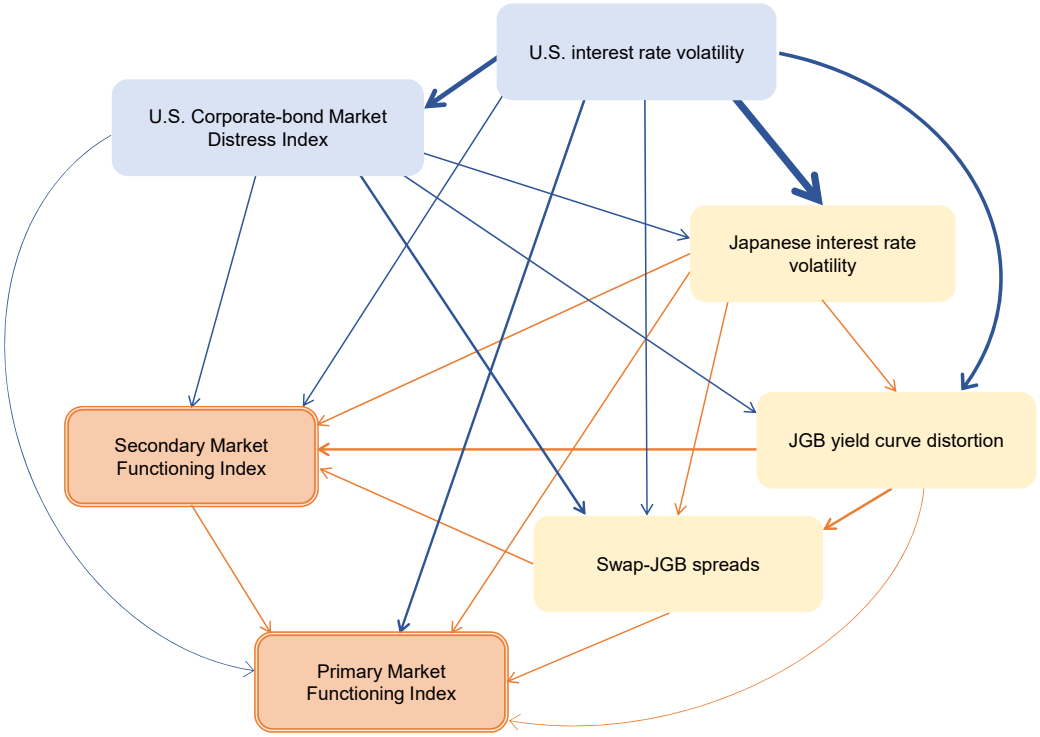
[21] The difference in the impact on the primary and the secondary markets may be linked to the fact that while the downward pressure on interest rates due to the stock effect reduces credit spreads at issuance in the primary market, it also reduces investment returns for investors trading in the secondary market.

[22] Diebold and Yilmaz [2014] analyze how shocks spill over among financial institutions in the United States. To this end, they create a total connectedness index ($TC^{H} = \frac{1}{n}\sum TC_{i\leftarrow\bullet}^{H}$) and examine the connectedness of financial institutions. They show that an increase in the degree of interdependence is positively correlated with a higher degree of systemic risk.

the result of the VAR model following the approach of Diebold and Yilmaz [2014]. We capture the influence of relatively large shocks (75th percentile of shocks) by using quantile VAR following Ando et al. [2022] who analyze the international spillover of credit spreads.[23] The direction and thickness of the arrows represent the net pairwise directional connectedness. If the net directional connectedness from variable i to variable j is positive, the arrow points from variable i to variable j. In addition, the larger the absolute value, the thicker is the arrow.

Chart 9. Connectedness of foreign and domestic financial markets



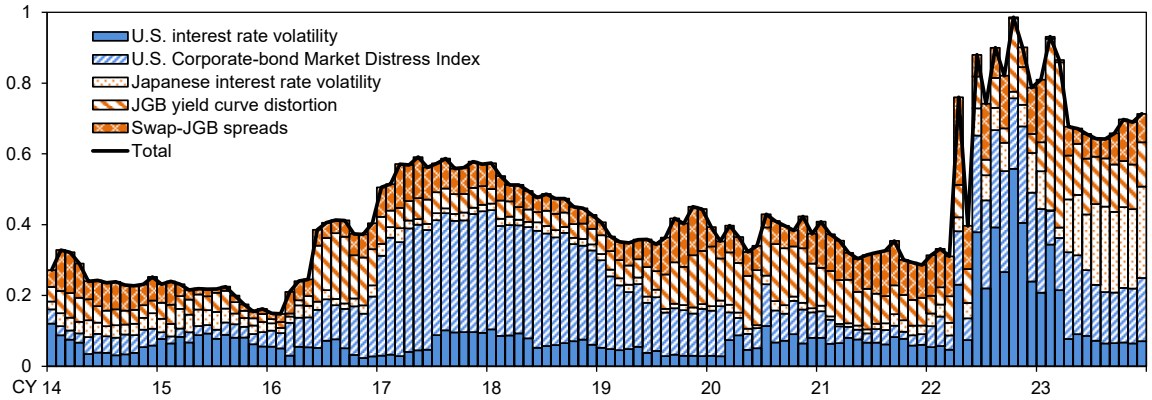
Note: Based on the connectedness analysis following the framework proposed by Diebold and Yilmaz [2012, 2014].

The network diagram shows that financial conditions in the United States have a strong influence on financial markets in Japan. Japan's corporate bond markets are affected not only directly by financial conditions in the United States but also indirectly through the JGB market. Moreover, while both the primary and the secondary market are affected by domestic and foreign financial variables, there is also an arrow pointing from the secondary to the primary market, suggesting that an idiosyncratic shock to the secondary market is relatively likely to have an impact on the primary market.

[23] Ando et al. [2022] and Chatziantoniou et al. [2021], who use a similar methodology to examine international exchange rate spillovers, report that large upward and downward shocks have larger spillover effects, and that larger shocks enable them to capture the influence of shocks more clearly than median-sized shock. In this paper, we set the lag to two quarters. The estimation period is from January 2005 to December 2023. The variance decomposition is based on the value 30 quarters ahead.

Next, Chart 10 shows changes in Japanese corporate bond markets' "total directional connectedness" ($TC^{H}_{i\leftarrow\bullet}$) with domestic and foreign financial markets over time. The chart shows the average value of the spillover effects on the primary and secondary markets based on the results of rolling estimations with a 5-year (60-month) window. The results show on the whole that Japanese corporate bond markets are susceptible to U.S. financial conditions. The impact of "U.S. interest rate volatility" and "U.S. Corporate-bond Market Distress Index" were high during the periods of U.S. policy rate hikes from 2017 to 2019 and from 2022 to 2023, with the impact from mid-2022 to early 2023 being particularly notable.

Chart 10. Impact of foreign and domestic financial conditions on the functioning of Japanese corporate bond markets



Note: The figure shows the average of the spillover effects on the primary and secondary markets based on the results of rolling estimations with a 5-year (60-month) window.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; LSEG, ICE Data Indices; Bank of Japan.

Turning to the influence of the JGB market on the corporate bond market in Japan, the impact of "JGB yield curve distortion" and "Japanese interest rate volatility" increased notably from 2022 to 2023. This may reflect upward pressure on Japanese long-term yields due to the interest rate hikes by foreign central banks and the increase in the domestic inflation rate and the BOJ's fixed-rate purchase operations for consecutive days conducted to strictly restrain rises in long-term yields under the Yield Curve Control framework. While increases in long-term interest rates were contained, the JGB yield curve became distorted, especially for remaining maturities of less than 10 years, and the linkage of the JGB market with the futures and interest rate swaps markets declined, so that the functioning of the JGB market deteriorated in some respects. Similar to the JGB market, the corporate bond market also faced yield curve distortions. Market participants pointed out there had been no convergence in investors' and issuers' interest rate outlook, leading to a deterioration in the bond issuance environment.

4.2. The CBMFI and the real economy: Impact on business fixed investment

Since a functioning corporate bond market makes it possible for firms to smoothly raise funds for business fixed investment or mergers and acquisitions, it should have a positive effect on the real economy. In this section, we conduct quantitative analyses to examine this point.

Methodology

Looking at previous studies examining the influence of corporate bond market conditions on business fixed investment, Gilchrist and Zakrajšek [2012], for example, estimate a standard VAR model using seven macroeconomic variables including the U.S. excess bond premium and find that a shock to the excess bond premium pushes down industrial production and business fixed investment in a statistically significant manner. Similarly, Boyarchenko et al. [2022b] show that the "U.S. Corporate-bond Market Distress Index" they construct has significant predictive power with regard to future changes in business fixed investment after controlling for variables such as real interest rates and term spreads. In addition, it should be noted that, as shown in the analysis of factors underlying the market functioning indexes in Section 4.1, corporate bond market conditions potentially also strongly reflect domestic and foreign financial conditions overall, such as investors' risk sentiment. That is, a strong correlation between the market functioning indexes and business fixed investment can mean two things: that the market functioning indexes reflect information incorporated by financial markets, or that it reflects the importance of the corporate bond market as a source of funding for business fixed investment.[24]

Taking these points into account, we examine the role of the CBMFI as an indicator of firms' funding conditions by estimating the following business fixed investment function, in which we control for various variables:

$$IK_t = \alpha + \boldsymbol{\beta} \cdot CBMFI_{t-1} + \boldsymbol{\gamma} \cdot Controls_t + \epsilon_t \qquad (8)$$

where IK_t is the ratio of business fixed investment to the capital stock (I/K ratio), which is obtained by dividing real private nonresidential investment (obtained from the Cabinet Office) by real private nonresidential fixed assets (also obtained from the Cabinet Office). The ratio thus obtained is then seasonally adjusted. Next, $CBMFI_{t-1}$ is the CBMFI we constructed in the previous section. As control variables in the baseline specification, we include (1) the real interest rate (calculated by subtracting firms' expectations for general prices in the *Tankan* from JGB yields),[25] (2) the expected growth rate (measured by the

[24] In general, information gleaned from financial markets is often useful for forecasting developments in the real economy, since prices in financial markets reflect market participants' expectations with regard to the future (Stock and Watson [2003]).

[25] Specifically, we use 3-year government bond yields and 3-year expectations for general prices. Values for firms' inflation expectations before January 2014 are taken from the series estimated by Nakajima [2023]).

potential growth rate estimated by the BOJ's Research and Statistics Department), and (3) the operating ratio (measured by the output gap estimated by the BOJ's Research and Statistics Department) as indicators of the marginal productivity of capital and of capital costs based on Tobin's q theory of investment. In addition to these variables, we include the following variables, which potentially help to explain short-term fluctuations in business fixed investment: (4) firms' cash flow (the 4-quarter moving average of operating profit plus depreciation, divided by total assets), and (5) the Japan Economic Policy Uncertainty Index (the Japanese index following Baker et al.'s [2016] methodology[26]).[27] The estimation period is from 2005/Q1 to 2023/Q4, i.e., the period for which we have calculated the CBMFI (see Appendix D for details on the data used for the analysis).

Empirical results

Chart 11 shows the estimation results. In the results for Model (1), which includes the control variables only, all explanatory variables have the expected sign, and the adjusted R-squared is about 0.8. Specifically, a decline in the real interest rate, an improvement in the output gap, and an increase in firms' cash flow all significantly push up business fixed investment. On the other hand, the coefficient on the expected growth rate is positive, as expected, but insignificant. Meanwhile, a rise in economic uncertainty tends to push down investment, as in previous studies. Turning to Model (2), which includes the CBMFI as an explanatory variable, we find that greater bond market functioning is associated with more business fixed investment after controlling other factors.

Next, we look at the functioning of the primary and secondary markets separately. In Model (3), the coefficient on the PMFI is positive and significant, indicating that a smoother functioning of the primary market pushes up business fixed investment. On the other hand, the coefficient on the SMFI in Model (4) is not significant, suggesting that the degree of functioning of the secondary market does not have an impact on investment. Next, in Model (5), which includes both sub-indexes, the coefficient on the PMFI is again positive and significant, while the coefficient on the SMFI now is negative and significant. However, this result may be due to multicollinearity, since the PMFI and SMFI show similar movements. To deal with this issue, we conduct a regression with the two orthogonal factors of the PMFI and the SMFI obtained in the principal component analysis in Model (6). The result shows

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[26] The data for the Japan Economic Policy Uncertainty Index are obtained from the Research Institute of Economy, Trade and Industry. Arbatli et al. [2022] construct the Japanese index by extracting articles from four national newspapers (Asahi, Nikkei, Mainichi, and Yomiuri) that include at least one term pertaining to the economy, policy matters, and uncertainty, and dividing the number of these articles by the total number of articles.

[27] For theoretical and empirical developments with regard to the business fixed investment function, see Miyagawa and Tanaka [2009]. Specifications often rely on Tobin's q in addition to the influence of liquidity constraints and uncertainty. See Appendix C for robustness checks based on a specification using Tobin's q on a macro basis.

that both indicators have a positive impact on business fixed investment. The first principal component, which represents the common factor causing fluctuations in the PMFI and the SMFI, which we interpret as being driven by the shocks from domestic and foreign financial markets shown in Section 4.1, and shows that the more accommodative financial conditions are, the more business fixed investment increases (Chart 12).[28] Also, the second principal component, which we interpret as indicating the degree of functioning of the primary market relative to the secondary market, has a significant effect, implying that an improvement in firms' funding environment in the primary market is an important transmission channel to the real economy.

Chart 11. Baseline estimation results: The CBMFI and business fixed investment

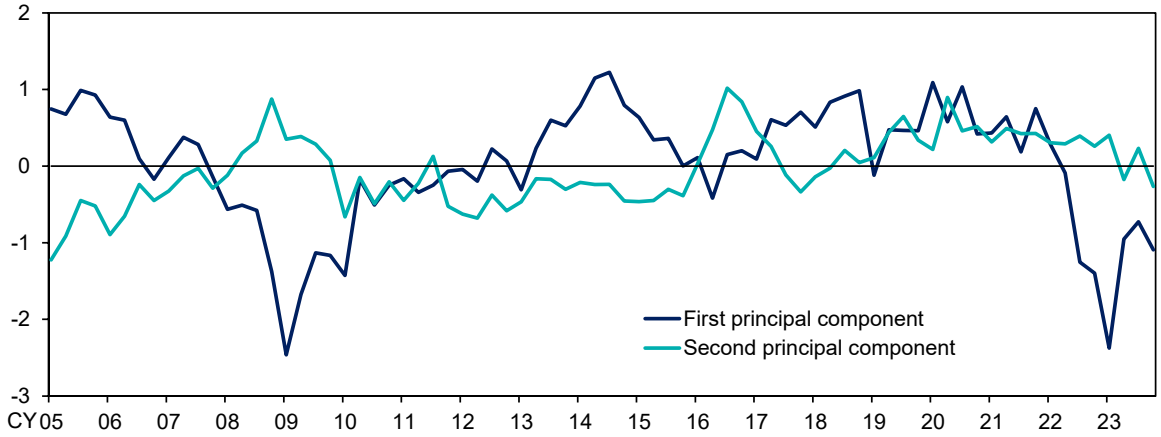
	(1)	(2)	(3)	(4)	(5)	(6)
Real interest rate	-0.114***	-0.114***	-0.100***	-0.116***	-0.088***	-0.088***
	(0.014)	(0.014)	(0.013)	(0.014)	(0.014)	(0.014)
Potential growth rate	0.006	-0.011	0.016	0.000	0.059*	0.059*
	(0.034)	(0.034)	(0.031)	(0.038)	(0.036)	(0.036)
Output gap	0.025**	0.021**	0.025***	0.024**	0.033***	0.033***
	(0.011)	(0.011)	(0.010)	(0.011)	(0.010)	(0.010)
Cash flow to total assets ratio	0.603***	0.591***	0.524***	0.607***	0.464***	0.464***
	(0.107)	(0.105)	(0.100)	(0.109)	(0.101)	(0.101)
Economic policy uncertainty index	-0.001	0.000	0.000	-0.001	-0.001	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Corporate Bond Market Functioning Index (CBMFI)		0.043**				
		(0.020)				
Sub-index for the Primary Market (PMFI)			0.065***		0.091***	
			(0.017)		(0.020)	
Sub-index for the Secondary Market (SMFI)				0.007	-0.046**	
				(0.019)	(0.020)	
First principal component of PMFI and SMFI						0.032**
						(0.013)
Second principal component of PMFI and SMFI						0.097***
						(0.026)
Adjusted R-squared	0.790	0.800	0.825	0.787	0.835	0.835
Number of observations	75	75	75	75	75	75

Note: The dependent variable is "I/K ratio." The "Cash flow to total asset ratio," the "Corporate Bond Market Functioning Index," the "Sub-index for the Primary Market (PMFI)," the "Sub-index for the Secondary Market (SMFI)," the "First principal component of the PMFI and SMFI," and the "Second principal component of the PMFI and SMFI" are lagged by one quarter. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Figures in parentheses represent standard errors. The estimation period is from 2005/Q1 to 2023/Q4.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; RIETI; Ministry of Finance; Cabinet Office; Bank of Japan.

[28] See Appendix C (Chart C.4) for the correlation between these principal components and domestic and foreign financial variables.

Chart 12. Decomposition of the CBMFI: Principal components of the primary- and secondary-market sub-indexes



Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; LSEG; ICE Data Indices; Bank of Japan.

Next, Chart 13 show the estimation results with domestic and foreign financial variables as control variables.[29] Consistent with the results obtained in Chart 11, the results in Model (3) show that the explanatory power of the first principal component diminishes, while that of the second principal component remains unchanged. Both results suggest that the first principle component of the market functioning indexes reflects market conditions affected by domestic and foreign financial markets, as described in Section 4, and thus contains information about future economic activity, while the second principle component of the market functioning indexes contains additional information that is not captured by the global and domestic financial market variables. These results are in line with those obtained by Boyarchenko et al. [2022b].

Finally, in Models (4) to (6), we include BOJ corporate bond holdings and purchases as explanatory variables. The results show that BOJ corporate bond holdings have a statistically significant upward effect on business fixed investment. On the other hand, the explanatory power of the second principal component of the PMFI and SMFI declines. This implies that BOJ corporate bond holdings and corporate bond market conditions as represented by the second principal component of the PMFI and the SMFI have a positive effect on investment through an improvement in funding conditions in the primary market. The coefficients on both principal components are not statistically significant but still positive. We thus find a tendency that an improvement in corporate bond market conditions that is unexplained by financial market variables and outright purchases and holdings pushes up business fixed investment.

[29] In Appendix C, we check the robustness of the obtained results by testing other models than those discussed here.

Chart 13. Estimation results with financial variables: The CBMFI and business fixed investment

	(1)	(2)	(3)	(4)	(5)	(6)
Real interest rate	-0.219***	-0.178***	-0.178***	-0.081**	-0.078*	-0.078*
	(0.026)	(0.030)	(0.030)	(0.041)	(0.041)	(0.041)
Potential growth rate	-0.120***	-0.047	-0.047	-0.096***	-0.074*	-0.074*
	(0.037)	(0.044)	(0.044)	(0.032)	(0.041)	(0.041)
Output gap	0.029**	0.037***	0.037***	0.045***	0.048***	0.048***
	(0.014)	(0.013)	(0.013)	(0.012)	(0.013)	(0.013)
Cash flow to total assets ratio	0.663***	0.540***	0.539***	0.513***	0.454***	0.454***
	(0.129)	(0.141)	(0.141)	(0.119)	(0.140)	(0.140)
Economic policy uncertainty index	-0.001	-0.001	-0.001	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Japanese interest rate volatility	0.005	-0.005	-0.005	0.025	0.023	0.023
	(0.020)	(0.021)	(0.021)	(0.018)	(0.020)	(0.020)
JGB yield curve distortion	-0.028*	-0.016	-0.016	-0.023*	-0.016	-0.016
	(0.016)	(0.017)	(0.017)	(0.013)	(0.016)	(0.016)
Swap-JGB spreads	-0.006	-0.002	-0.002	0.015	0.015	0.015
	(0.018)	(0.017)	(0.017)	(0.016)	(0.016)	(0.016)
U.S. interest rate volatility	-0.092***	-0.071***	-0.071***	-0.062***	-0.055**	-0.055**
	(0.021)	(0.023)	(0.023)	(0.020)	(0.022)	(0.022)
U.S. Corporate-bond Market Distress Index	0.090***	0.067***	0.067***	0.026	0.023	0.023
	(0.024)	(0.025)	(0.025)	(0.024)	(0.025)	(0.025)
U.S. excess bond premium	0.019	0.021	0.021	0.051***	0.050**	0.050**
	(0.021)	(0.021)	(0.021)	(0.019)	(0.020)	(0.020)
BOJ corporate bond holdings				0.032***	0.030***	0.030***
				(0.009)	(0.010)	(0.010)
BOJ outright corporate bond purchases				0.150	0.119	0.119
				(0.103)	(0.110)	(0.110)
Primary Market Functioning Index (PMFI)		0.054**			0.025	
		(0.025)			(0.024)	
Secondary Market Functioning Index (SMFI)		-0.048**			-0.009	
		(0.024)			(0.024)	
First principal component of PMFI and SMFI			0.004			0.011
			(0.022)			(0.021)
Second principal component of PMFI and SMFI			0.072***			0.024
			(0.027)			(0.027)
Adjusted R-squared	0.885	0.896	0.896	0.920	0.919	0.919
Number of observations	63	63	63	63	63	63

Note: The dependent variable is "I/K ratio." The "Cash flow to total asset ratio," the "Primary Market Functioning Index (PMFI)," the "Secondary Market Functioning Index (SMFI)," the "First principal component of the PMFI and SMFI," and the "Second principal component of PMFI and SMFI" are lagged by a quarter. "Japanese interest rate volatility," "JGB yield curve distortion," "Swap-JGB spreads," "U.S. interest rate volatility," the "U.S. Corporate Bond Market Distress Index," and the "U.S. excess bond premium" are standardized to mean 0 and variance 1. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Figures in parentheses represent standard errors. The estimation period is from 2005/Q1 to 2023/Q4.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; corporate financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; FRB; LSEG; ICE Data Indices; RIETI; Ministry of Finance; Cabinet Office; Bank of Japan.

5. Conclusion

In this paper, we constructed a composite index to comprehensively assess the functioning of Japanese corporate bond markets by aggregating information on prices, volumes, and the trading environment in both the primary and secondary markets.

The CBMFI constructed in this paper shows that, first, during the Global Financial Crisis from 2008 to 2009 and the period of global monetary tightening from 2022 to 2023, the functioning of corporate bond markets deteriorated sharply. The empirical analysis on the source of the developments in corporate bond market functioning suggests that, in addition to domestic factors, the tightening of foreign financial conditions played a role by leading to a deterioration in investors' risk sentiment. Second, while the CBMFI remained relatively stable in the period from 2013 onward, the sub-indexes for the primary and secondary markets showed somewhat different movements. This partly reflects the fact that the large-scale monetary easing by the Bank of Japan, including outright purchases of corporate bonds, primarily improved the functioning of the primary market. Third, in terms of the link to the real economy, improvements in the CBMFI were associated with increases in business fixed investment. The empirical results suggest that the functioning of the primary market is important for the real economy, as it directly affects firms' funding conditions. These effects remain statistically significant even after controlling for financial market variables that contain useful information about future economic activity, in line with the results of Boyarchenko et al. [2022b].

The results in this paper also provide some evidence on the positive effects and negative side effects of the BOJ's large-scale monetary easing. That is, on the positive side, the decline in corporate bond yields brought about by the portfolio balance effect of large-scale monetary easing, including JGB and corporate bond purchases, has a positive impact on the real economy by improving firms' funding conditions in the primary market and raising business fixed investment. On the other hand, although outright corporate bond purchases did have a positive direct effect on the functioning of the secondary market, this was more than offset by the negative effect of the BOJ's holding of corporate bonds. Especially after the introduction of the negative interest rate policy, it is very likely that there were side effects in the secondary market in terms of a deterioration of market liquidity due to disagreement on prices among market participants, reflecting the deterioration in the functioning of JGB markets at this period due to large-scale monetary easing (as reported in Bank of Japan Financial Market Department [2023], for instance). Although the empirical evidence in this paper does not suggest that such side effect in the secondary market has direct negative effects on the real economy such as pushing down business fixed investment, a better functioning of both the primary and secondary markets is essential since both markets are closely connected, as shown by our connectedness analysis indicating that

shocks to the secondary market tend to spread to the primary market.[30] The importance of the functioning of the secondary market is also discussed in Boyarchenko et al.'s [2022b] study on the United States, which reports that the functioning of the secondary market plays an important role in supporting new issuance and refinancing in the primary market. Further research is needed for Japan.[31]

In sum, the CBMFI constructed in this paper is a useful indicator for assessing the functioning of corporate bond markets, which is one of the transmission channels of monetary policy, in a comprehensive and timely manner, taking various aspects such as prices, volumes, and the trading environment into account. The composite index can be used for analyses over relatively long periods and has several advantages for use as a monitoring tool, as it is based on information published on a daily or monthly basis and reflects the latest data in a timely manner. It should be noted, however, that the data available for Japanese corporate bond markets is limited, and our index therefore is constructed using limited data. Therefore, a variety of approaches, including the use of qualitative information, in addition to the quantitative approach proposed in this paper, should be used to monitor corporate bond markets. Over the longer term, we hope that as efforts to revitalize Japanese corporate bond markets make progress and the base of issuers and investors expands, the importance of Japanese corporate bond markets increases and more data becomes available.

[30] Japan Securities Dealers Association [2010] describes liquidity in the primary and secondary markets as a "chicken or the egg situation."

[31] It is also important to take the functioning of the banking system and the substitutability between bond issuance and bank loans into account. If bank loans can substitute for bond issuance when the functioning of corporate bond markets deteriorates substantially, the adverse impact on the real economy may be mitigated. On the other hand, spillovers from the corporate bond market to the banking system may spark a banking crisis. For discussions of these issues, see, e.g., Adrian et al. [2013], Catalan and Hoffmaister [2023], Nagahata and Sekine [2002], and Uchino [2011].

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Appendix A. Estimation Method for *Default-Adjusted Spreads*

A.1. *Default-adjusted spreads*

The *default-adjusted spreads* we use in this paper represent the part of corporate bond spreads at issuance that is affected by market conditions and are calculated as the residuals of credit spreads for individual issues after issue-specific fluctuations and issuers' credit risk have been removed. Gilchrist and Zakrajšek [2012] call this part the "excess bond premium." This appendix provides an overview of the estimation methodology, data, and calculation results for *default-adjusted spreads*.

A.2. Data and Estimation Methodology

First of all, as the corporate bond spread of issue i at time t ($Spread_{i,t}$), we use the difference between the yield on a specific corporate bond and JGB yields using granular issue-level data provided by Capital Eye.[32] We focus on publicly offered corporate bonds issued by listed firms between January 2005 and December 2023, since financial data that we use in the estimation models described later is available for these issues only. However, we exclude (1) corporate bonds issued by firms in the financial sector,[33] for which the assessment of credit risk differs from that for other issuers, (2) subordinated bonds, which are highly heterogeneous across issues, (3) issues with an initial maturity of 15 years or longer, and (4) retail corporate bonds.[34]

We estimate *default-adjusted spreads* as a time dummy ($RiskAdjustedSpread_t$) using a fixed-effect model in which the spread for each issue ($Spread_{i,t}$) is used as the dependent variable:

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[32] While some issues are priced against LIBOR, or at yield levels without any reference rates, we calculate spreads against JGB yields for all issues. When an issuer launched multiple issues within the same month, we take the simple average of the spread of each issue.

[33] Specifically, our analysis covers corporate bonds issued by domestic firms other than banks and other financial institutions. However, we include issues of automobile sales finance companies, since there are some cases where such companies take on the role of financing group companies, including automakers.

[34] The pricing of subordinated loans differs from that of straight bonds, since subordinated loans are subject to subordination covenants. That is, subordinated loans fall in the middle between corporate straight bonds, which have the highest priority, and equity, which has the lowest priority, in terms of the order of repayment of residual assets in the event of a subordination, such as the bankruptcy or commencement of corporate reorganization proceedings. The pricing of issues with extremely long initial maturity also differs from that of straight bonds, since they are highly heterogeneous among issues. Further, the pricing of retail corporate bonds differs from straight bonds, since they are issued in smaller lots with a minimum purchase unit of about 1 million yen, and fluctuations in their spreads differ from issues for institutional investors. Regarding this point, Hashimoto and Koga [2010] pointed out that retail corporate bonds require higher fees due to the fact that they require a bond manager.

$$Spread_{i,t} = \boldsymbol{\alpha} \cdot CreditRiskFactors_{i,t} + \boldsymbol{\beta} \cdot IssueSpecificFactors_{i,t} + \boldsymbol{\gamma} \cdot OtherFactors_{i,t} + RiskAdjustedSpread_t + \epsilon_{i,t} \quad \text{(A-1)}$$

As explanatory variables, we take (1) issuers' credit risk ($CreditRiskFactors_{i,t}$), (2) issue-specific factors ($BondSpecificFactors_{i,t}$), and (3) other technical factors ($OtherFactors_{i,t}$) observed in the primary market in specific periods into account. Previous studies use a similar framework for analyzing credit spreads (see, e.g., Gilchrist and Zakrajšek [2012]; Ohyama and Hongo [2010]; Suganuma and Ueno [2018]).[35]

Specifically, as variables to capture issuers' credit risk, previous studies have used the corporate value, book value of debt, volatility of market value, and the distance to default[36] calculated from these variables. Moreover, as variables to capture issue-specific factors, the maturity, outstanding amount, coupon rate, and term to maturity of corporate bonds, as well as dummy variables for callable bonds, the industry of the issuer, and the credit rating of the issue have been used. For this paper, we select variables following these studies, while also taking the availability of data into account. Details of the data we use are as follows.

(1) Variables regarding issuers' credit risk ($CreditRiskFactors_{i,t}$)

- $ROA_{i,t}$: We calculate the return on assets (ROA) as net income divided by average total assets and then take the 12-month moving average. We expect the sign on this variable to be negative, since higher profitability should be associated with a smaller bond spread. Since the original data are on a quarterly basis, we convert them into monthly data through linear interpolation and assume that the most recent value is unchanged from that in latest month for which accounting data is available.
- $DEratio_{i,t}$ represents the debt-equity ratio, which we calculate by dividing the sum of short- and long-term debt outstanding by the market capitalization. The higher a firm's debt-equity ratio, the higher is its credit risk, so that we expect the sign on this variable to be positive. Since the original data are on a quarterly basis, we convert them into monthly data through linear interpolation and assume that the most recent value is unchanged from that in latest month for which accounting data is available.
- $vol_{i,t}$ is the historical volatility of the equity value of firm i over the last 30 days. We expect the sign on this variable to be positive, since a lower volatility in a firm's market

[35] That said, Gilchrist and Zakrajšek [2012] estimate a model without fixed effects and then calculate the "excess bond premium" by aggregating the deviations between the actual and the estimated values. With regard to our data for Japan, we obtain superior results in the estimation with a time dummy, as presented below.

[36] The idea that a firm's credit risk is reflected in its spread is based on the study by Merton [1974], who applies an option pricing model to corporate bonds and calculates the theoretical price using non-arbitrage conditions for corporate assets, liabilities, and equity. In this model, the worse the financial position of a firm and the greater the volatility of its assets, the higher is its corporate bond spread.

capitalization and a more stable market value mean that it is less likely that the firm's market value will fall below its liabilities, so that its default risk will be lower.

- ω_i is a firm fixed effect that captures firm-specific factors that do not change over time such as industry and firm size.

(2) Variables regarding issue-specific factors ($IssueSpecificFactors_{i,t}$)

- $rating_{i,t}$ is a set of dummy variables representing the rating a bond was assigned at issuance. The rating categories are AAA, AA, A, and BBB or unrated. We use the rating information provided by Japan Credit Rating Agency, Ltd.[37]

- $maturity_{i,t}$ denotes the initial maturity of bonds. The longer the term to maturity, the higher the liquidity premium investors require is, so that the spread also tends to be larger. We therefore expect this variable to have a positive sign.

(3) Variables regarding other technical factors ($OtherFactors_{i,t}$)

- $negative_t$ is the 5-year JGB yield when yields are negative and takes 0 otherwise. The reason for including this variable is that when JGB yields, the reference yield for corporate bond issuance rates, were below 0 percent, investors tended to focus more on the absolute yield of corporate bonds than on spreads. In other words, there existed a zero lower bound for corporate bond yields, even as JGB yields fell into negative territory, meaning that, technically, corporate bond spreads widened. Since this tendency was particularly pronounced for higher-rated bonds with relatively low yields, we also include interaction terms with the rating category dummies as independent variables.

- $power\_dummy_{i,t}$ is a dummy variable that takes 1 for issues by electric power firms after February 2011, and takes 0 otherwise. The variable captures the upward shift in spreads on such bonds after the Great East Japan Earthquake.

Charts A.1 and A.2 present descriptive statistics and a correlation matrix for the variables used in the estimations. Looking at the correlation between corporate bond spreads and the other variables, we find that the coefficient on initial maturity is negative, which is contrary to expectation. Possible explanations of the negative correlation are that firms with a low credit risk can issue longer-maturity bonds, and that firms issue shorter-maturity bonds in times of financial crisis, when investors require higher term premiums and demand for longer-maturity bonds falls. Taking these possible explanations into account, we obtain estimation results in line with expectations when we control for issuers' credit risk and include a time dummy to control for factors common to all bond issues especially during periods of stress in the estimations presented below.

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[37] We do not take differences within rating categories or the rating outlook into account. For example, we regard bonds with an "A+/Positive" and "A-/Stable" to have the same rating, i.e., A.

Chart A.1. Descriptive statistics

	N	Mean	Standard deviation	Median	Min	Max	Skewness	Kurtosis
Corporate bond spreads (bps)	3,539	39.54	28.32	33.80	5.00	434.50	3.51	24.28
ROA (%)	3,539	2.30	2.71	2.26	-22.40	19.16	-0.35	7.40
Debt-equity ratio	3,539	1.68	1.92	1.04	0.02	16.47	3.01	12.30
Historical volatility of equity value (pt)	3,539	29.18	12.75	26.81	0.88	130.88	1.56	4.49
Initial maturity (years)	3,539	7.22	2.35	7.00	2.00	14.00	-0.05	-1.20

Note: The calculation period is from January 2005 to December 2023.
Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases.

Chart A.2. Correlation matrix

	Corporate bond spreads	ROA	Debt-equity ratio	Historical volatility of equity value	Initial maturity
Corporate bond spreads (bps)	-	-0.06 ***	0.12 ***	0.19 ***	-0.24 ***
ROA (%)	-0.06 ***	-	-0.40 ***	-0.08 ***	-0.03
Debt-equity ratio	0.12 ***	-0.40 ***	-	0.02	0.08 ***
Historical volatility of equity value (pt)	0.19 ***	-0.08 ***	0.02	-	-0.19 ***
Initial maturity (years)	-0.24 ***	-0.03	0.08 ***	-0.19 ***	-

Note: The calculation period is from January 2005 to December 2023. The number of observations is 3,539. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.
Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases.

A.3. Estimation results

Chart A.3 shows the estimation results of six different specifications of our regression model for issuance spreads. To calculate *default-adjusted spreads*, we use the results of Model (5) (the baseline model), which includes a time dummy. We estimate Model (6), which includes retail corporate bonds and bonds with an initial maturity of 15 years or more, to check the robustness of Model (5).

Chart A.3. Estimation results: Corporate bond spreads at issuance

	(1)	(2)	(3)	(4)	(5)	(6)
ROA (%)	-0.25	-1.21***	-1.30***	-1.30***	-1.19***	-1.19***
	(0.16)	(0.15)	(0.15)	(0.15)	(0.14)	(0.15)
Debt-equity ratio	1.61***	2.50***	2.43***	2.44***	2.08***	1.76***
	(0.23)	(0.32)	(0.31)	(0.33)	(0.33)	(0.32)
Historical volatility of equity value (pt)	0.25***	0.27***	0.28***	0.28***	0.25***	0.25***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
Dummy for credit rating: AA	13.62***	12.84***	11.28***	11.40***	13.68***	11.44***
	(1.99)	(2.00)	(2.06)	(2.29)	(2.11)	(2.01)
Dummy for credit rating: A	22.13***	25.43***	23.78***	23.90***	28.41***	27.66***
	(2.00)	(2.47)	(2.51)	(2.70)	(2.51)	(2.48)
Dummy for credit rating: BBB and unrated	55.10***	45.84***	45.63***	45.75***	52.45***	51.65***
	(2.35)	(3.23)	(3.23)	(3.38)	(3.18)	(3.12)
Initial maturity (years)	-0.78***	-0.10	-0.22	-0.22	0.44***	0.38***
	(0.19)	(0.18)	(0.18)	(0.18)	(0.17)	(0.08)
Negative 5-year JGB yields * Dummy for credit rating: AAA			-0.78	-0.79	-1.89***	-1.31***
			(0.48)	(0.48)	(0.47)	(0.41)
Negative 5-year JGB yields * Dummy for credit rating: AA			-0.28***	-0.28***	-0.94***	-0.91***
			(0.07)	(0.07)	(0.17)	(0.17)
Negative 5-year JGB yields * Dummy for credit rating: A			-0.25***	-0.25***	-0.86***	-0.82***
			(0.06)	(0.06)	(0.17)	(0.17)
Dummy for bonds issued by electric power firms after February 2011				-0.26	9.66***	8.15***
				(2.10)	(2.05)	(2.01)
Firm fixed effects		✓	✓	✓	✓	✓
Month fixed effects					✓	✓
Adjusted R-squared	0.275	0.054	0.064	0.064	0.278	0.252
Number of observations	3,539	3,539	3,539	3,539	3,539	4,033
Retail corporate bonds						✓
Bonds with initial maturity of 15 years or longer						✓

Note: The dependent variable is corporate bond spreads at issuance (bps). Model (6) includes retail bonds and bonds with an initial maturity of 15 years or longer. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Figures in parentheses represent standard errors. The estimation period is from January 2005 to December 2023.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases.

First, all models show a significant positive link between credit risk and corporate bond spreads. That is, a lower ROA, a higher debt-equity ratio, and a higher volatility of firm value are all associated with higher corporate bond spreads. Moreover, there is a stable relationship between the rating categories and credit spreads, indicating that bonds by firms with a higher rating (i.e., with a lower default probability) have lower credit spreads.[38]

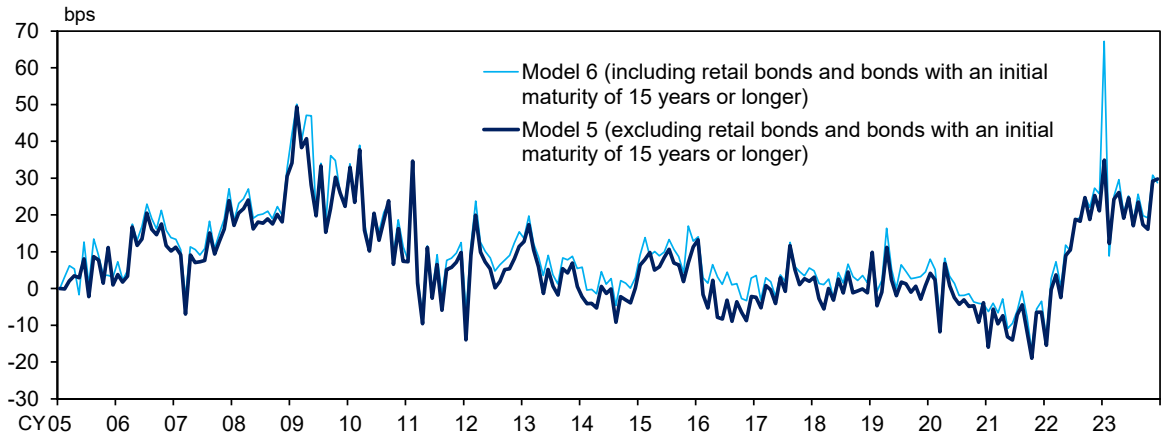
Second, the coefficient on the initial maturity variable has the wrong sign in Model (1)

[38] The reference category for the rating dummies is AAA, meaning that the coefficients on the rating dummies indicate the difference in spreads vis-à-vis bonds with an AAA rating. For the interaction terms with negative 5-years JGB yields, the reference category is bonds falling into the BBB or unrated category.

and is insignificant in Models (2) to (4). However, in Models (5) and (6), the coefficient has the expected sign -- indicating that the longer the initial maturity, the higher is the corporate bond spread -- and is statistically significant. Since Models (1) to (4) do not include month fixed effects, the coefficient estimates in these models may reflect that firms launch shorter-than-normal maturity bonds when spreads are wider such as during a financial crisis. Taking time fixed effects into account makes it possible to correctly identify the link between maturity and corporate bond spreads, since time fixed effects control for market conditions in periods in which all firms are subject to stress.

Third, the results obtained in Model (5) hold when retail bonds and bonds with an initial maturity of 15 years or more are included in the estimation (Model (6)). Chart A.4 presents developments in *default-adjusted spreads* during the estimation period based on the results of Models (5) and (6). The chart shows that, generally speaking, they follow similar trends. However, at certain times, the results based on Model (6) show sharp spikes, such as in early 2023. These spikes are caused by the issuance of a few retail corporate bonds with extremely high yields (not explained by the model) during these periods. Moreover, during the period from mid-2022 to 2023, individual issuances had a much larger impact on market averages since there were few issues, reflecting the fact that there was little convergence in investors' yield expectations due to the tightening of foreign financial conditions and the decline in the functioning of the JGB market, in addition to seasonal factors due to the beginning of the year.[39]

Chart A.4. *Default-adjusted spreads*



Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases.

[39] See Ochi and Osada [2023] for details on reasons for recent fluctuations in default-adjusted spreads in Japan (in the article, default-adjusted spreads are called "across-issue common factors").

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Appendix B. Indicators of Disagreement on Prices in the Secondary Market

In this paper, to gauge disagreement on prices in the secondary market, we use the following two metrics: (1) the "yield curve distortion" for corporate bonds to monitor whether inter-maturity arbitrage is working smoothly, and (2) "disagreement on prices across multiple market makers," which indicates how much investors' views on prices for the same issue differ.

B.1. Yield curve distortion

Yield curve distortion indexes are often used as a way to measure the liquidity and functioning of government bond markets (e.g., Tanemura et al. [2003]; Hattori [2023]). For example, in this paper, we use the yield curve distortion index calculated by Bloomberg to represent the functioning of the government bond market. Meanwhile, Bank of Japan Financial Markets Department [2023] conducts panels estimations using a distortion index based on issue-level data to estimate the effect of large-scale monetary easing on the functioning of JGB markets.

The corporate bond yield curve distortion index is calculated based on the same general approach as distortion indexes for the government bond market and referring to the method employed in Goldberg and Nozawa [2021]. Specifically, our distortion index is calculated by (1) estimating a smoothed yield curve using the spline function against actual yield curve data and then (2) aggregating the differences between actual yields and the estimated values.[40] Since in the corporate bond market yields for the same maturity vary substantially across issuers, we decided not to directly calculate a distortion index for the overall yield curve of the corporate bond markets but to construct an overall index by calculating a distortion index for the bond yields for each issuer and then aggregating these indexes. That said, because the number of data points for some issuers is extremely small, we use data for issuers that have at least 10 issues outstanding in the secondary market for each point in time. In addition, in the calculation of the aggregate index, we take the median instead of the average to avoid discontinuous movements when issuers included in the calculation change due to new issues or redemptions.

Specifically, "yield curve distortion" is calculated based on the following steps. We start by calculating the difference $\epsilon_{p,t}$ between the corporate yield $y_{i,p,t}$ for remaining maturity p and the estimate obtained from the spline function, $\hat{y}_{i,p,t}$:

[40] While the spline function is often used for the estimation of yield curves in practice, in academic research structural models that make assumptions regarding the term structure of interest rates, such as the Nelson-Siegel model, are frequently used (see, e.g., Goldberg and Nozawa [2021]; Miyake and Hattori [2016]). Here, we do not use the latter approach since the factors that cause distortions depend on the assumptions made in the model.

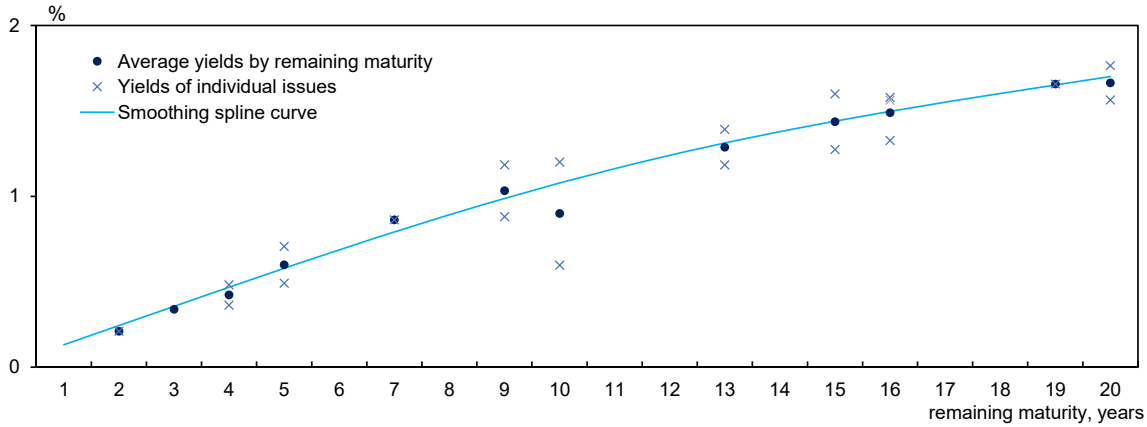
$$\epsilon_{i,p,t} = y_{i,p,t} - \hat{y}_{i,p,t}. \tag{B.1}$$

We then construct the yield curve distortion index for corporate bonds ($D_{i,t}$) issued by firm *i* traded in the secondary market by aggregating the $\epsilon_{i,p,t}$ as follows:

$$D_{i,t} = \sqrt{\frac{\sum_p \epsilon_{i,p,t}^2}{n_{i,t}}} \tag{B.2}$$

It should be noted that firms do not necessarily have bonds outstanding for all remaining maturities. We therefore only aggregate data for maturities for which issues exist. $n_{i,t}$ denotes the number of maturities used for calculation. Conversely, when there are multiple issues for a given maturity, we take the average of the differences before the aggregation.

Chart B.1. Conceptual diagram of yield curve distortion



The "yield curve distortion" of the overall secondary corporate bond market, D_t, is defined as the median of $D_{i,t}$. As described above, we focus only on issuers that (a) have launched at least 10 issues in each period and for which yield data is available and (b) have bonds with remaining maturities of both less than 10 years and 10 or more years outstanding to maintain a sufficiently large sample and obtain stable estimates. The remaining maturities we use for calculating the distortion index range from 2 to 20 years ($2 \leq p \leq 20$).

We calculate distortion index D_t on a daily basis using information from the OTC bond trading reference statistics released by the JSDA on each business day. We then convert the daily data to monthly data by calculating the simple average for each calendar month. As of December 29, 2023, there were 64 issuers meeting the various criteria mentioned. For the estimation period overall from July 2002 onward, there are 142 such issuers in total.

B.2. Disagreement on prices across multiple market makers

In a highly liquid market, investors' views on prices should converge. This means that information on disagreement on prices across multiple market makers potentially provides a useful indicator of market functioning. A frequently used indicator of such disagreement on prices is bid-ask spreads, which represent the actually observed divergence between sellers' ask prices and buyers' bid prices. For the secondary corporate bond market in Japan, a similar indicator can be constructed using information from the OTC bond trading reference statistics released by the JSDA.

Specifically, the JSDA releases on a daily basis the indicative quoted prices reported by securities companies for issues in the secondary market. We make use of this information and create an index of disagreement by calculating the differences between the maximum and minimum indicative quoted prices for each issue and then taking the median of these differences across all issues.[41] Since there are likely to be differences in yields by maturity, in the calculation we only use issues with a remaining maturity of 5 or more years but less than 10 years.

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[41] This indicator is also used by Miyakawa and Watanabe [2010]. As for other studies using similar indicators, Fujiwara [2022] regard the difference between the actual unit price of a contract and the indicative quoted price from the OTC bond trading reference statistics as a proxy for transaction costs, following the effective spread approach (the effective spread is an indicator that regards the difference between the best quote mid-price just before execution and the execution price as the transaction cost implicitly agreed by investors). However, we do not use this indicator in this paper, since data on execution prices is only available after October 2015.

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Appendix C. Robustness Checks

C.1. Specification of the business fixed investment function

While the estimation of the business fixed investment function in this paper used variables related to Tobin's q (such as the real interest rate, the expected growth rate, and the operating ratio to represent the marginal product of capital and capital costs) as explanatory variables, another possibility would be to conduct the estimation directly using Tobin's q derived from macro indicators. As Tobin's q is defined as the ratio of a firm's market value to the replacement cost of its assets (e.g. Tobin [1969]; Hayashi [1982]), macro-based Tobin's q can be calculated by dividing the sum of the total stock market capitalization of listed firms and total debt outstanding of all firms (after subtracting inventories, and converting everything into real terms) by the total fixed capital stock in the economy (Hirakata et al. [2019]).[42]

Chart C.1 shows the results obtained when adding Tobin's q to the baseline estimation in Chart 11. We find that the findings obtained in the baseline estimation generally hold. That is, in Model (1) using the control variables only, the coefficients other than that on the economic policy uncertainty index have the expected sign, although the size of the coefficients on some variables differ somewhat. Next, turning to the results in Models (3) and (4), which in addition to the control variables include the sub-indexes for the primary and the secondary market, we find that, just like in the baseline estimation, corporate bond market conditions as represented by the PMFI push up business investments significantly and the SMFI does not have significant impact on business investments.

Looking at the results of Model (6) using the principal components of the PMFI and SMFI, we find that the coefficient on the first principal component is still positive but no longer statistically significant. A possible reason is that the stock prices used to calculate Tobin's q also contain information on the market environment that pertains to both the primary and secondary corporate bond markets. On the other hand, the coefficient on the second principal component, which can be regarded as representing firms' funding conditions, is still positive and statistically significant. This confirms that funding conditions play an important role in the primary market.

[42] There are numerous empirical analyses of business investment using Tobin's q (e.g., Fukuda et al. [2005]). Fazzari et al. [1988] for the United States as well as Asako et al. [1989] and Hayashi and Inoue [1991] for Japan show that there is a positive relationship between Tobin's q and the growth rate of capital using micro-based estimations. While it has been pointed out that the fit of Tobin's q at the macro level is generally poor (Miyagawa and Tanaka [2009]), Tobin's q is used in the Bank of Japan's macroeconomic model (Q-JEM: see, Hirakata et al. [2019]), and we obtain statistically significant results in our analysis.

Chart C.1. Estimation results with Tobin's q: The CBMFI and business fixed investment

	(1)	(2)	(3)	(4)	(5)	(6)
Tobin's q	0.396***	0.382***	0.352***	0.396***	0.335***	0.335***
	(0.053)	(0.054)	(0.055)	(0.054)	(0.057)	(0.057)
Real interest rate	-0.015	-0.018	-0.019	-0.016	-0.017	-0.017
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Potential growth rate	0.113***	0.101***	0.106***	0.108***	0.120***	0.120***
	(0.029)	(0.030)	(0.028)	(0.032)	(0.031)	(0.031)
Output gap	0.028***	0.027***	0.028***	0.027***	0.031***	0.031***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Cash flow to total assets ratio	0.348***	0.351***	0.337***	0.352***	0.320***	0.320***
	(0.087)	(0.087)	(0.085)	(0.088)	(0.086)	(0.086)
Economic policy uncertainty index	0.001**	0.001**	0.001*	0.001**	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Corporate Bond Market Functioning Index (CBMFI)		0.021				
		(0.016)				
Sub-index for the Primary Market (PMFI)			0.033**		0.045**	
			(0.014)		(0.018)	
Sub-index for the Secondary Market (SMFI)				0.007	-0.020	
				(0.014)	(0.017)	
First principal component of PMFI and SMFI						0.018
						(0.011)
Second principal component of PMFI and SMFI						0.046**
						(0.023)
Adjusted R-squared	0.883	0.884	0.889	0.881	0.890	0.890
Number of observations	75	75	75	75	75	75

Note: The dependent variable is "I/K ratio." "Tobin's q" is calculated based on the following steps: We (1) take the sum of total stock market capitalization of listed firms and total debt outstanding of all firms and convert them into real terms using the GDP deflator, (2) subtract real private inventories, then (3) divide the result by the fixed capital stock. The "Cash flow to total assets ratio," "Corporate Bond Market Functioning Index," "Sub-index for the Primary Market (PMFI)," "Sub-index for the Secondary Market (SMFI)," "First principal component of PMFI and SMFI," and "Second principal component of PMFI and SMFI" are lagged by a quarter. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Figures in parentheses represent standard errors. The estimation period is from 2005/1Q to 2023/4Q.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; Japan Exchange Group; RIETI; Ministry of Finance; Cabinet Office; Bank of Japan.

C.2. Specification with sub-indexes and principal components of the CBMFI

While the estimation of the business fixed investment function in the main text uses the aggregate CBMFI as an explanatory variable, another possibility would be to use the investment functions of the six category-level indexes instead.

Chart C.2 shows the results of regressing the investment to capital stock ratio on the six category-level indexes as well as control variables. The coefficients on the indexes related to the primary market such as "P2 Primary market issuance" and "P3 Maturity at issuance" are statistically significant, which implies that funding conditions in the primary corporate

bond markets as measured by these indicators push up business fixed investment. On the other hand, the coefficients for the secondary market-related indexes are either insignificant (S2 Transaction volume and S3 Disagreement on prices) or have the wrong sign (S1 Secondary market spreads). These results are in line with those in Charts 11 and 13 in the main text, where we divide the CBMFI into the PMFI and the SMFI, including the fact that the results for the primary market are no longer significant when the various financial market variables are added.

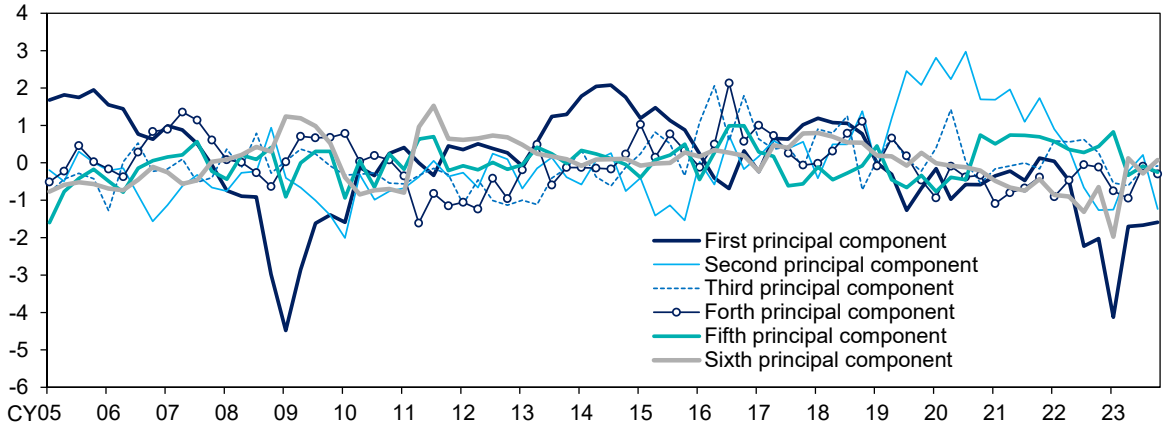
Chart C.2. Estimation results: The sub-indexes of the CBMFI and business fixed investment

	Corporate Bond Market Functioning Index (CBMFI)	By market		By category					
		Primary Market Functioning Index (PMFI)	Secondary Market Functioning Index (SMFI)	P1 Primary market spread	P2 Primary market issuance	P3 Maturity at issuance	S1 Secondary market spread	S2 Transaction volume	S3 Disagreement on prices
Base line	0.04 **	0.07 ***	0.01	0.02	0.04 **	0.07 ***	-0.03 *	0.01	0.00
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
Including financial variables	0.01	0.02	0.00	0.00	0.00	0.03	0.00	-0.02 **	0.04 **
	(0.03)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)

Note: The dependent variable is the "I/K ratio." Control variables such as the "real interest rate," "potential growth rate," "output gap," "cash flow to total assets ratio," and "economic policy uncertainty index" are included in the estimation of the baseline model. In addition, "Japanese interest rate volatility," "JGB yield curve distortion," "swap-JGB spreads," "U.S. interest rate volatility," "U.S. corporate bond market distress index," "U.S. excess bond premium," "BOJ corporate bond holdings," and "BOJ outright corporate bond purchases" are included in the estimation of the model including the financial variables. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Figures in parentheses represent standard errors. The estimation period is from 2005/1Q to 2023/4Q.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; FRB; LSEG; ICE Data Indices; RIETI; Ministry of Finance; Cabinet Office; Bank of Japan.

Chart C.3. Principal components of the category-level sub-indexes



Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases; Japan Securities Depository Center; Japan Securities Dealers Association.

While Charts 11 and 13 show the estimation results with the first and second principal components of the PMFI and the SMFI, it is also possible to derive the six principal components for the six category-level indexes and use them for estimation. The principal components are shown in Chart C.3.

Meanwhile, Chart C.4 presents the correlations between the principal components of the PMFI and the SMFI and the other variables. We find that the first principal component shows a high correlation with all the financial variables, which suggests that the component captures factors that are common to the primary and the secondary market. On the other hand, the second principal component does not show significant correlations with any of the financial variables, but instead shows high correlations with primary market issuance and maturity at issue, and therefore can be regarded as capturing the degree of functioning of the primary market specifically, such as firms' funding conditions. Next, turning to the correlation coefficients of the principal components of the six category-level indexes, we find that the first principal component is correlated with variables related to financial conditions in the United States, the second principal component is correlated with variables related to financial conditions in Japan, and the third and fourth principal components are correlated with variables other than spreads, such as maturity at issuance and disagreement on prices.

Chart C.4. Correlation matrix of principal components of the CBMFI and financial indicators

	Corporate Bond Market Functioning Index (CBMFI)	By market		By category					
		Primary Market Functioning Index (PMFI)	Secondary Market Functioning Index (SMFI)	First principal component	Second principal component	Third principal component	Fourth principal component	Fifth principal component	Sixth principal component
P1 Primary market spreads	0.87 ***	0.88 ***	-0.06	0.82 ***	0.42 ***	0.04	-0.19	0.37 ***	0.10
P2 Primary market issuance	0.21 *	0.24 *	0.60 ***	-0.20	0.70 ***	-0.09	0.38 ***	0.05	-0.07
P3 Maturity at issuance	0.45 ***	0.48 ***	0.62 ***	0.10	0.65 ***	0.77 ***	0.32 **	-0.17	-0.04
S1 Secondary market spreads	0.66 ***	0.64 ***	-0.53 ***	0.84 ***	-0.13	-0.09	0.11	0.04	-0.36 ***
S2 Transaction volume	0.52 ***	0.52 ***	0.02	0.18	0.80 ***	-0.35 ***	-0.59 ***	-0.25 **	0.06
S3 Disagreement on prices	0.59 ***	0.58 ***	-0.56 ***	0.82 ***	-0.20	0.03	0.33 ***	-0.24 *	0.58 ***
Japanese interest rate volatility	-0.71 ***	-0.70 ***	0.07	-0.57 ***	-0.40 ***	-0.10	-0.04	0.00	0.04
JGB yield curve distortion	-0.80 ***	-0.81 ***	0.01	-0.67 ***	-0.46 ***	-0.23 *	-0.12	0.02	-0.30 **
Swap-JGB spreads	-0.52 ***	-0.53 ***	-0.10	-0.34 ***	-0.51 ***	0.00	0.21 *	-0.14	-0.10
U.S. interest rate volatility	-0.77 ***	-0.78 ***	0.15	-0.68 ***	-0.36 ***	-0.03	-0.11	0.01	-0.08
U.S. Corporate-bond Market Distress Index	-0.56 ***	-0.56 ***	0.17	-0.54 ***	-0.18	0.05	-0.02	-0.13	0.27 **
BOJ corporate bond holdings	0.33 ***	0.33 ***	0.23 *	0.15	0.33 ***	0.12	-0.14	0.32 **	-0.44 ***
BOJ outright corporate bond purchases	0.48 ***	0.49 ***	0.10	0.26 **	0.54 ***	-0.06	-0.30 **	0.12	0.08
Contribution		72.0	28.0	32.6	24.1	15.5	13.1	7.9	6.8

Note: The calculation period is from January 2008 to December 2023. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; LSEG; ICE Data Indices; Bank of Japan.

The estimation results using the six principal components of the category-level indexes are presented in Chart C.5. They show that changes in corporate bond market conditions as

measured by the first principal component have no significant effect on business fixes investment, implying that overseas financial conditions do not have a direct effect on business fixed investment in Japan. On the other hand, the coefficient on the second principal component, which is strongly correlated with domestic financial conditions, is positive and significant, indicating that domestic financial conditions have a significant impact on business fixed investment.[43] However, when the financial variables are included in the estimation as control variables, the coefficient becomes insignificant, meaning that the variation in the second principal component is generally captured by the financial variables.

Next, a notable result regarding the third and fourth principal components is that the coefficients are significant not only in the baseline estimation but also in the estimation including the financial variables. This indicates that variations in maturity at issuance and disagreement on prices, which are strongly correlated with theses principal components, contain information on corporate bond market characteristics that are not captured by prices and volumes, suggesting that is useful to take these indexes into account when assessing the functioning of corporate bond markets in terms of the impact on business fixed investment.

Chart C.5. Estimation results: The principal components of the CBMFI and business fixed investment

	Corporate Bond Market Functioning Index (CBMFI)	By market		By category					
		Primary Market Functioning Index (PMFI)	Secondary Market Functioning Index (SMFI)	First principal component	Second principal component	Third principal component	Fourth principal component	Fifth principal component	Sixth principal component
Base line	0.04 **	0.03 **	0.10 ***	0.00	0.04 ***	0.06 ***	0.02	0.00	0.02
	(0.02)	(0.01)	(0.03)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Including financial variables	0.01	0.01	0.02	0.01	-0.01	0.03 **	0.04 ***	0.02	0.02
	(0.03)	(0.02)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)

Note: The dependent variable is the "I/K ratio." Control variables such as the "real interest rate," "potential growth rate," "output gap," "cash flow to total assets ratio," and "economic policy uncertainty index" are included in the estimation of the baseline model. In addition, "Japanese interest rate volatility," "JGB yield curve distortion," "swap-JGB spreads," "U.S. interest rate volatility," "U.S. corporate bond market distress index," "U.S. excess bond premium," "BOJ corporate bond holdings," and "BOJ outright corporate bond purchases" are included in the estimation of the model including the financial variables. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Figures in parentheses represent standard errors. The estimation period is from 2005/1Q to 2023/4Q.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; FRB; LSEG; ICE Data Indices; RIETI; Ministry of Finance; Cabinet Office; Bank of Japan.

[43] It should be noted that the second principal component appears to include indirect effects of overseas financial conditions through domestic financial conditions.

C.3. Specification with *default-adjusted spreads*

Boyarchenko et al. [2022b] investigate if the U.S. *Corporate-bond Market Distress Index* they calculated contains useful information (1) by examining, using regression analysis, its predictive power with regard to future real economic activity, and (2) by examining if the index contains additional information over the "excess bond premium," which is generally considered to be a highly useful indicator. In the following, we examine the usefulness of the CBMFI in a similar manner by adding *default-adjusted spreads* to the estimations in Chart 11 in the main text.

Chart C.6. Estimation results with *default-adjusted spreads*: The CBMFI and business fixed investment

	(1)	(2)	(3)	(4)	(5)	(6)
Default-adjusted spreads	-0.003***	-0.004***	-0.001	-0.005***	-0.002	-0.002
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Corporate Bond Market Functioning Index (CBMFI)		-0.029				
		(0.033)				
Sub-index for the Primary Market (PMFI)			0.056*		0.066**	
			(0.033)		(0.032)	
Sub-index for the Secondary Market (SMFI)				-0.047**	-0.052**	
				(0.022)	(0.021)	
First principal component of PMFI and SMFI						0.009
						(0.025)
Second principal component of PMFI and SMFI						0.084***
						(0.029)
Adjusted R-squared	0.818	0.817	0.823	0.827	0.835	0.835
Number of observations	75	75	75	75	75	75

Note: The dependent variable is the "I/K ratio." Control variables such as the "real interest rate," "potential growth rate," "output gap," "cash flow to total assets ratio," and "economic policy uncertainty index" are included in the estimation of the baseline model. ***, **, and * denotes statistical significance at the 1%, 5%, and 10% levels, respectively. Figures in parentheses represent standard errors. The estimation period is from 2005/1Q to 2023/4Q.

Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases; Japan Securities Depository Center; Japan Securities Dealers Association; RIETI; Ministry of Finance; Cabinet Office; Bank of Japan.

The results are provided in Chart C.6 and show that the coefficients on *default-adjusted spreads* are negative, in many cases significant and stable in size in the estimations both with and without the corporate bond market functioning indexes, suggesting that *default-adjusted spreads* provide useful information. Next, comparing the results for the market functioning indexes with those in Chart 11 shows that the coefficient on the CBMFI in Model (2) becomes insignificant, the coefficient on the SMFI in Model (4) is negative, and the coefficient on the first principal component in Model (5) is also no longer significant. These differences may be due to the fact that *default-adjusted spreads*, like the SMFI and the first principal component, are closely linked with domestic and international financial conditions, and therefore generally move in a similar manner. On the other hand, the coefficients on the PMFI in Models (3) and (5), and on the second principal components of the PMFI and the SMFI in Model (6) remain positive and significant even when *default-adjusted spreads* are

included in the estimations. The results thus confirm that the corporate bond market functioning index provides useful information (in addition to the information provided by the "excess bond premium") that reflects primary market-specific factors, such as those represented by the second principal component, and thus captures market conditions affecting business fixed investment.

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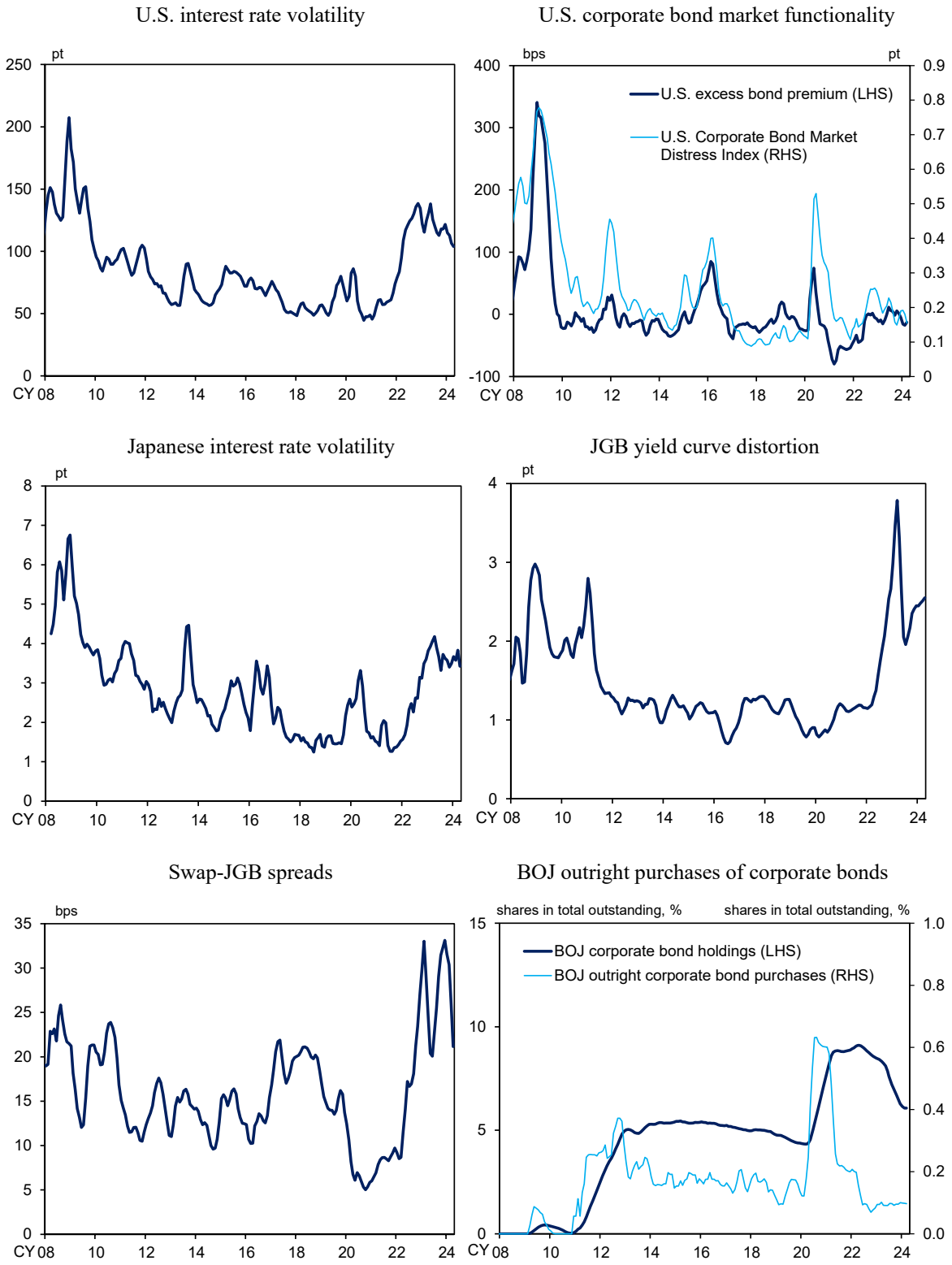
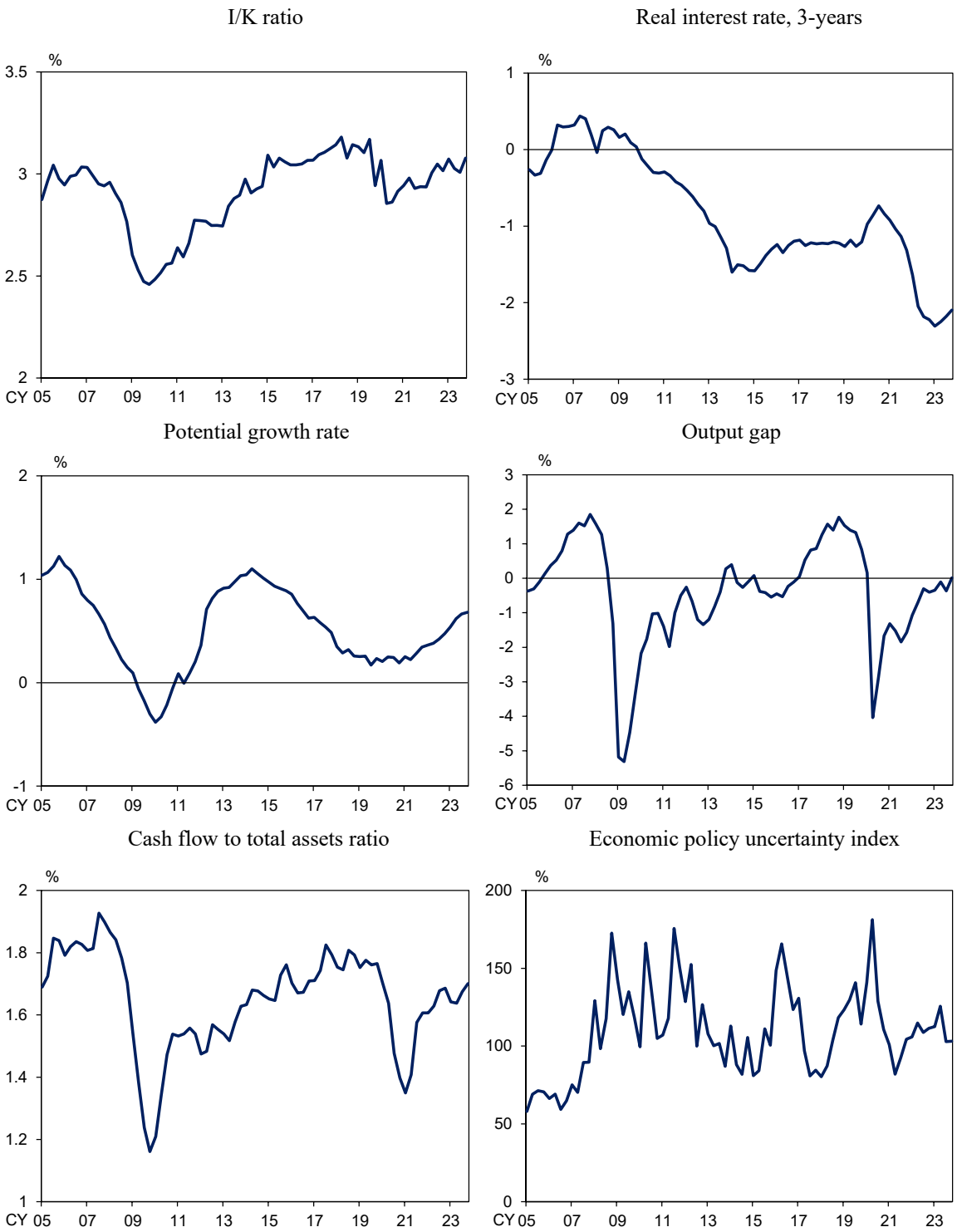
Appendix D. Data for the Econometric Analysis

Chart D.1. Determinants of the functioning of corporate bond markets



Sources: Bloomberg; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; FRB; LSEG; ICE Data Indices; Bank of Japan.

Chart D.2. Variables used for the estimation of the business fixed investment function



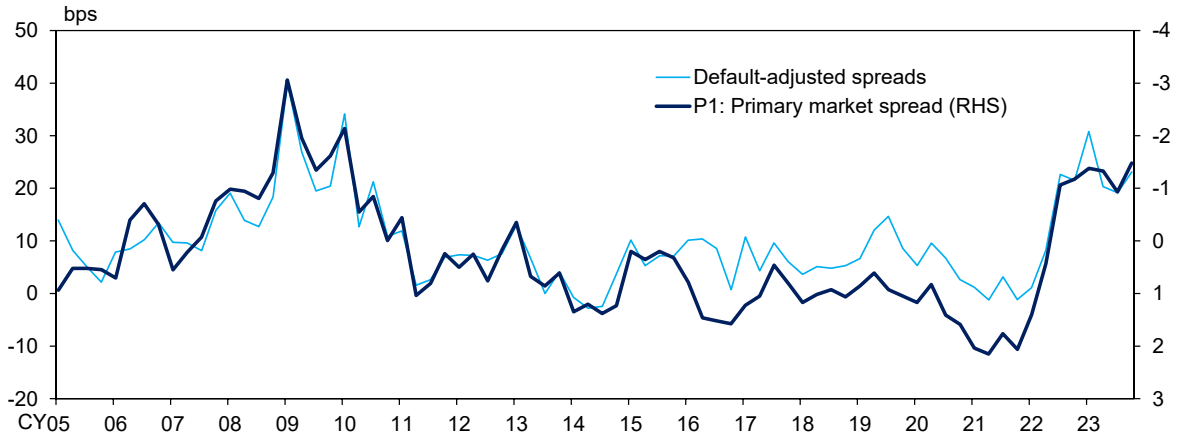
Sources: Bloomberg; RIETI; Ministry of Finance; Cabinet Office; Bank of Japan.

Chart D.3. Summary statistics

	N	Mean	Standard deviation	Median	Min	Max	Skewness	Kurtosis
Japanese interest rate volatility	64	2.80	1.14	2.62	1.36	6.75	1.00	1.16
JGB yield curve distortion	65	1.47	0.60	1.23	0.71	3.79	1.45	2.06
Swap-JGB spreads	76	15.49	5.75	15.06	5.32	33.12	0.57	0.21
U.S. interest rate volatility	76	83.89	30.65	74.60	44.56	207.33	1.35	2.04
U.S. Corporate-bond Market Distress Index	76	0.27	0.15	0.23	0.09	0.77	1.39	1.59
U.S. excess bond premium	76	1.29	65.94	-14.04	-79.88	340.63	3.19	12.22
BOJ corporate bond holdings	76	3.81	3.04	4.90	0.00	9.10	0.01	-1.26
BOJ outright corporate bond purchases	76	0.14	0.14	0.15	0.00	0.62	1.43	2.75
I/K ratio	76	2.92	0.18	2.96	2.46	3.18	-0.96	0.01
Real interest rate	76	-0.84	0.75	-0.99	-2.31	0.44	0.01	-0.95
Potential growth rate	76	0.52	0.40	0.51	-0.38	1.22	-0.19	-0.87
Output gap	76	-0.42	1.52	-0.31	-5.32	1.85	-1.10	1.61
Cash flow to total assets ratio	76	1.65	0.16	1.68	1.16	1.93	-0.87	0.55
Economic policy uncertainty index	76	109.37	28.47	106.42	58.02	181.20	0.42	-0.26

Note: The calculation period is from January 2005 to December 2023.
Sources: Bloomberg; Japan Securities Depository Center; Japan Securities Dealers Association; FRB NY; FRB; LSEG; ICE Data Indices; RIETI; Ministry of Finance; Cabinet Office; Bank of Japan.

Chart D.4. *Default-adjusted spreads*



Note: The chart shows quarterly values obtained by taking the simple average of monthly data.
Sources: Capital Eye; I-N Information Systems; QUICK; Bloomberg; companies' financial releases; Japan Securities Depository Center; Japan Securities Dealers Association.