Monetary Policy Targeting the Risk-Taking Channel: The Bank of Japan's REIT Purchase*

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Abstract

This is the first study to estimate the flow effect of the Bank of Japan's (BOJ) purchases of real estate investment trusts (REITs) on their returns. The BOJ purchases REITs after observing a negative cumulative return of REITs during the overnight and morning hours. Using this timing of purchases, we find that BOJ's purchase of REITs has a significant positive effect on the lunchtime and afternoon returns of the target REITs. The effect is larger during Covid-19. In addition, a REIT that faces a greater demand from the BOJ is more likely to offer equity shares and invest the raised capital in real assets. The BOJ's unique countercyclical equity intervention program prevents risk premiums from rising and affects the real economy through corporate capital investment.

JEL codes: E52, E58, R33

Keywords: large-scale asset purchases (LSAP), quantitative easing (QE), central banking, real estate investment trust, unconventional monetary policy

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1. Introduction

The Bank of Japan (BOJ) began purchasing real estate investment trust (REIT) shares and equity exchange-traded funds (ETFs) in October 2010 as part of its large-scale asset purchase (LSAP) program, in addition to its open market operations for Japanese government bonds (JGBs). These programs augmented the BOJ's zero-interest-rate policy (starting in 1999) and bond-LSAP (starting in 2001), which preceded other central banks' LSAP programs (Krishnamurthy and Vissing-Jorgensen, 2013). In April 2013, the BOJ increased the asset purchase amount under a new policy regime called quantitative and qualitative monetary easing (QQE). After a decade of REIT purchases, the BOJ has become one of the largest owners of public REITs and disclosed its holdings of more than 5% of the outstanding shares of 20 REITs in its Report of Possession of Large Volume, as of December 2020.[1]

The BOJ's REIT/ETF purchase program is unique because it explicitly aims to impact investors' risk-taking. Monetary policy works through traditional neoclassical channels (i.e., cost-of-capital effects, wealth effects, and exchange-rate effects) as well as the more recently identified credit channel and risk-taking channel (Bauer et al., 2023). Most central banks' LSAPs target cost-of-capital and credit channels by directly impacting the yield of long-term government bonds and mortgage-backed securities (MBS) when the short-term policy rate is near the zero lower bound (ZLB). In contrast, the primary objective of the BOJ's REIT/ETF purchase program is to "reduce risk premiums for financial assets and stabilize the economy by attracting more funds into the

[1] These equity purchases were an unprecedented move in the history of central banking. Although the Swiss National Bank also holds US corporate shares, its aim is to control foreign exchange rates rather than interest rates and risk premiums.

financial markets" (Shirakawa, 2010). In addition, the REIT purchase program can have a sizable effect through credit channel in Japan because Japanese banks primarily require real estate collateral for corporate and personal loans (e.g., Peek and Rosengren, 2000; Gan, 2007). The REIT program can also have a larger wealth effect than the ETF program because REITs are owned more by domestic investors, particularly by individuals, than common shares. The BOJ's REIT program deviates from the standard view that central banks should not attempt to influence asset prices (Bernanke and Gertler, 2001).

Our study is the first to provide evidence that the BOJ's REIT purchase program mitigates an increase in risk premia after an unanticipated adverse shock to REIT share prices and encourages REITs to make capital investments. In effect, the BOJ is providing investors with a put option—analogous to the "Fed Put"—rather than actively raising stock prices. Our goal is to document the detailed pattern of the BOJ's REIT purchases and assess whether they have the intended effect on REIT share prices. Specifically, we unveil the BOJ's REIT purchase rule, test whether the BOJ's purchases have a positive effect on REIT share prices, and test whether the BOJ's purchase affects REIT public offerings (POs) and subsequent capital investment.

There are several advantages to using the Japanese REIT data. First, the BOJ purchases individual REIT equity shares (officially called investment units), as opposed to purchasing diversified ETFs to indirectly influence corporate equity returns. Second, REITs issue shares frequently and time the market, unlike corporations, which issue shares infrequently and inelastically. Thus, REIT behavior may be more responsive to policy interventions. Third, REITs announce the exact use of funds and the expected schedule of expenditures on the same day as the equity offering. For example, Nippon Building Fund announced the new issue and secondary

offering of investment units on October 9, 2020. On the same day, it published "Notice of Acquisition and Commencement of Lease of Domestic Assets (Acquisition of Shinjuku Mitsui Building and Gran Tokyo South Tower)".[2] For all REITs, equity issuance is closely linked to capital expenditures and property acquisitions.

However, it is challenging to identify the effect of BOJ's REIT program—and other QQE programs such as ETF purchase and yield curve control—because the counterfactual state of the capital market is unclear due to the BOJ's intervenes contingent on a negative shock to asset prices (Hattori and Yoshida, 2022, 2023a, 2023b). Our identification utilizes two features of the BOJ's purchase behavior. First, we reveal that the BOJ purchases REIT shares after observing a significantly negative cumulative index return during the overnight and morning periods. Thus, we to estimate the effect of the BOJ's purchase on lunchtime and afternoon returns. Second, because the BOJ purchases only a subset of REITs, we contrast the treatment group of target REITs with the control group of remaining REITs. We first identify the effect of the BOJ's purchase by using the difference-in-differences (DID) method. That is, we measure the change in return differences between the treatment and control groups after the BOJ's purchase. Second, we follow Barbon and Gianinazzi (2019) and Hattori and Yoshida (2023a) and construct a measure of the BOJ's purchase demand for each target REIT. Using the demand measure, we estimate the effect of the BOJ's purchase on lunchtime and afternoon returns.

Overall, we find that the BOJ's REIT purchase program provides downside protection to REIT investors through countercyclical intervention. The BOJ's downside protection in the equity market prevents an increase in the cost of capital for REIT equity and potentially improves risk

[2] These notices are posted on https://www.nbf-m.com/nbf_e/ir/index.html?cate=1&year=2020.

sharing among agents with limited participation in segmented markets (Peng and Zervou, 2022).

Specifically, the effect of the BOJ's purchases on the lunchtime REIT return is positive and increases during the COVID-19 period. Our study shows that the BOJ's purchases have an immediate flow effect on REIT prices when the counterfactual return without the BOJ's intervention is negative. Moreover, the BOJ's REIT program helps REITs issue shares and invest the raised capital in real assets. Conditional on the BOJ's purchase, REITs that had a greater security demand from the BOJ are more likely to issue equity shares.

This monetary program shares a common feature with the BOJ's other unconventional policy measures, such as yield curve control, in that it provides downside protection to securities prices through a contingent intervention rule (Hattori and Yoshida, 2023b). While it is beyond the scope of our study to identify a long-run causal relationship between the REIT program and the cost of capital for REITs, a commitment to provide downside protection may be an effective tool for central banks to mitigate investor concerns during a crisis (e.g., Galariotis et al., 2018; Lutz, 2015).

We contribute to future monetary policy discussions by analyzing how a central bank can directly impact the risk-taking channel through interventions in the real estate equity market, especially during an unforeseen crisis such as the COVID-19 pandemic. This study extends the analysis of Hattori and Yoshida (2022), who find that the BOJ tends to start purchasing REIT shares when it observes a significantly negative REIT return over the previous night or during the morning market on the Tokyo Stock Exchange (TSE). They also show that the BOJ continues purchasing REIT shares daily until either overnight or morning returns become positive. However, they do not analyze the effect of the BOJ's purchase on REIT returns.

In contrast, extant studies suggest that the BOJ's ETF purchases can reduce equity risk premiums by increasing stock prices (Barbon and Gianinazzi, 2019; Charoenwong et al., 2019; Harada and Okimoto, 2019; Hattori and Yoshida, 2023a). A higher stock price implies a lower risk premium if the risk-free rate is unchanged around the zero lower bound. For the BOJ's operations to affect stock prices, there must be limits to arbitrage between the stock market and other financial markets. Otherwise, the BOJ's additional demand for stocks will be spread across all financial markets through arbitrage. Thus, this stock price impact is analogous to LSAP's effect through the scarcity channel (D'Amico et al., 2012; Krishnamurthy and Vissing-Jorgensen, 2011, 2013; Hamilton, 2018). The scarcity channel hypothesis states that a central bank's LSAP can affect long-term bond prices if bond markets are segmented by investors' preferred maturity habitats (Modigliani and Sutch, 1966; Wallace, 1981; Vayanos and Vila, 2009; Greenwood and Vayanos 2014). We follow Barbon and Gianinazzi (2019) and Hattori and Yoshida (2023a) and estimate the flow effect of REIT purchase.

Policy measures that directly intervene in equity markets are rare because monetary policy affects a wide range of capital markets without direct intervention: for example, corporate bond markets (Guidolin et al., 2017; Nozawa and Qiu, forthcoming), bank lending (Kapoor and Peia, 2021), bond collaterals (Avouyi-Dovi and Idier, 2012), foreign bond markets (Neely, 2015), foreign exchange (Claus et al., 2018; Ferrari, 2021), gold (Claus et al., 2018), and equities and REITs (Claus et al., 2018; Jansen and Zervou, 2017; Kholodilin et al., 2009; Henseler and Rapp, 2018).

The BOJ's unique ETF purchases are analyzed by several studies, which find positive price effects stemming from the BOJ's equity demand (Barbon and Gianinazzi, 2019;

Charoenwong et al., 2021; Harada and Okimoto, 2021; Hattori and Yoshida, 2023a). These studies use pre-pandemic data and find that the BOJ's equity purchases significantly affect share prices. However, they do not consider whether counterfactual returns without the BOJ's purchases are positive or negative.[3] In contrast, our study clearly demonstrates that returns would have been significantly negative without the BOJ's purchasing.[4]

Another program that targets real estate securities is the Fed's MBS purchase. Hancock and Passmore (2011) find that the purchase program put significant downward pressure on mortgage rates through announcement effects during the financial crisis and portfolio rebalancing effects. Krishnamurthy and Vissing-Jorgensen (2011) find evidence for a signaling channel, a unique demand for long-term safe assets, an inflation channel, an MBS prepayment channel, and a corporate bond default risk channel. However, Stroebel and Taylor (2012) do not find evidence of the statistically significant effect of the MBS purchase program once controlling for simultaneous changes in prepayment and default risks. Even when announcement of the program appears to have lowered spreads, they find no separate effect of the size of the stock of MBS purchased by the Fed. Furthermore, Chakraborty et al. (2019) find that MBS purchases increased mortgage origination but resulted in reduced commercial lending, suggesting distortionary effects across banks and firms. Among MBS, Boyarchenko et al. (2019) study variation in MBS spreads in the time series and across securities and show that spreads on lower-coupon MBS declined sharply upon announcement whereas spreads on higher-coupon MBS widened. Kandrac (2018) shows that the Federal Reserve's MBS purchases adversely affected volumes, trade sizes, and

[3] conducts difference in differences since the BOJ tends to purchase ETF under negative return of stock market but they do not explicit investigate the ETF purchase behavior by the BOJ.
[4] Hattori and Yoshida (2023a) also demonstrate negative counterfactual returns related to the BOJ's purchase of exchange-traded funds.

implied financing rates in dollar roll transactions, while bid-ask spreads remained mostly unaffected.

The remainder of this paper is organized as follows. Section 2 describes the BOJ's unconventional monetary policy, and Section 3 and 4 analyze the effect of the BOJ's purchase on the return on target REITs. Section 5 concludes.

2. Bank of Japan's unconventional monetary policy

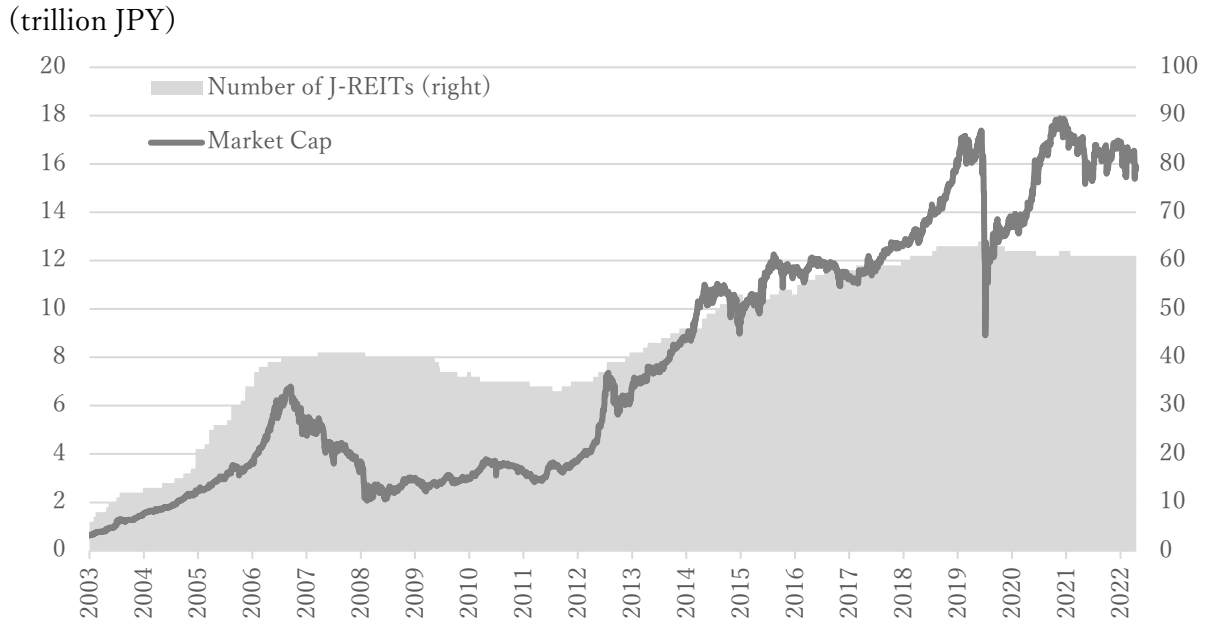
2.1 The Japanese REIT market

The establishment of Japanese REITs was facilitated by the 2000 amendment to the Act on Investment Trusts and Investment Corporations, as outlined by Hattori and Yoshida (2022). The first two REITs, Nippon Building Fund and Japan Real Estate, were listed on the Tokyo Stock Exchange (TSE) in September 2001.

Figure *1* shows the growth of the Japanese public REIT market in terms of the number of listed REITs and market capitalization. The market experienced an initial growth period until 2007, followed by a contraction period between 2010 and 2012 due to the global financial crisis starting in 2007 and the Great East Japan earthquake in 2011. However, there was another period of steady growth from 2012 to 2018. After 2018, the number of listed REITs stabilized at around 60. As of December 31, 2022, there were 61 listed REITs with a total market capitalization of JPY 16 trillion, which constituted approximately 2% of the TOPIX market capitalization at the end of the year. The Japanese REIT market is now the second largest in the world after the US REIT market. Of the JPY 15.8 trillion in assets under management, office REITs comprised 27.3%, diversified REITs 25.2%, industrial REITs 20.1%, residential REITs 10.1%, hotel and resort REITs 8.4%, and

health care REITs.

Figure 1 Number and Market Capitalization of REITs



Source: Bloomberg

Figure *2* depicts the TOPIX and the TSE-REIT Index (ex-dividends) between 2003 and 2022. After a sharp decrease between 2007 and 2008, the REIT Index generally exhibits an upward trend until 2019. During the COVID pandemic, the TSE-REIT Index dropped more sharply compared with TOPIX. This reflects that the COVID pandemic requires social distance, which negatively impacts the real estate industry.

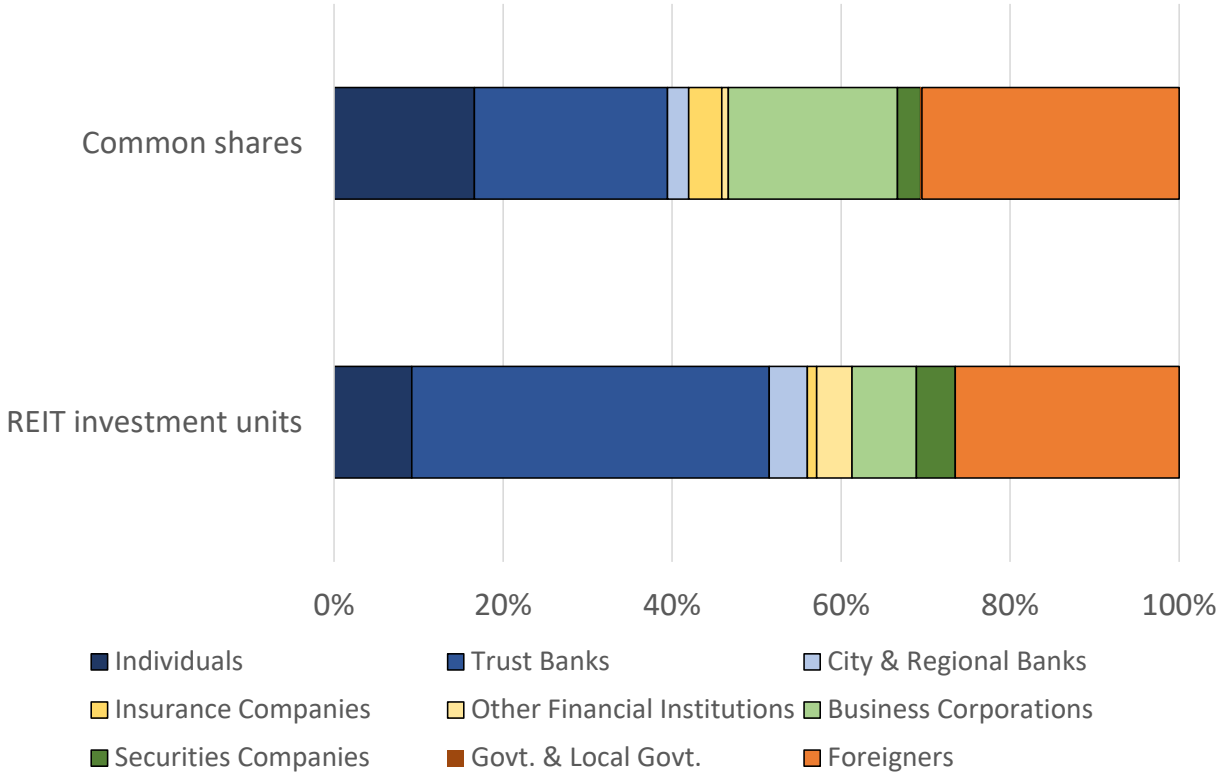
Figure 2 TOPIX and REIT price returns

Source: Bloomberg

Figure *3* shows the proportion of each investor type in the number of corporate common shares (in March 2022) and in the number of REIT investment units (in February 2022). An important characteristic of the Japanese REIT market is that foreign investors' share is smaller than common shares. The share of foreign investors is 26.5% for REITs as compared to 30.4% for common shares. Thus, Japanese REITs are primarily owned by domestic investors. Another important characteristic is a large share of individual holdings. The share for direct individual ownership is small for REITs (9.2%), but indirect ownership through trust banks is large. Trust banks own the largest share of REIT investment units (42.3%), most of which are for investment and annuity trust accounts (33.8%). The sum of trusts and direct individual holdings accounts for 43.6% of REITs as compared to 27.4% for common shares. Thus, REIT share prices affect

individual wealth more directly than stocks.

Figure 3 Corporate and REIT investor types



Source: Japan Exchange Group

2.2 The BOJ's REIT purchase program

We briefly summarize the BOJ's REIT purchase program based on Hattori and Yoshida (2022). After the global financial crisis, the BOJ set up the fund in October 2010 and has started purchasing REITs and ETFs. The BOJ states three objectives for purchasing risky assets. First, the BOJ aims to stimulate both firms' and households' spending by decreasing funding costs through the reduction of long-term interest rates and various risk premiums. Second, the BOJ expects investors

and financial institutions to increase their portfolio allocations to risky assets such as stocks, REITs, and loans to ease the private sector's funding. Third, the BOJ aims to eliminate deflationary expectations and decrease real interest rates. The Fed purchases MBS but the BOJ is the only central bank that purchases REIT as far as we know.

The BOJ has strengthened REIT purchases under Quantitative and Qualitative Easing (QQE), which started in April 2013. Under QQE, the "quantitative" means the change in the BOJ's target from the uncollateralized overnight call rate to the monetary base. The BOJ targeted to increase the monetary base by approximately 60–70 trillion JPY each year.[5] Two years after starting QQE, the BOJ almost doubled the monetary base by holding more JGBs on its balance sheet. The BOJ also applied negative ten bps to private banks' current accounts at the BOJ (January 2016) and in September 2016. After October 2016, the BOJ implemented Yield Curve Control (YCC) to launch a new fixed-price JGB purchase program (Hattori and Yoshida, 2023b).

Under "qualitative" easing, the BOJ started to purchase unconventional assets such as longer-term government bonds, commercial papers, corporate bonds, ETFs, and REITs. The BOJ does not provide any prior notice regarding its purchase, such as the specific date and amount, unlike Japanese government bond (JGB) auctions, as observed by Hattori (2020) and Hattori and Takahashi (2022). Before QQE, the BOJ began to purchase REITs through trust in October 2010 up to a limit of 50 billion JPY, which was increased later by 10 billion JPY in April 2012. Under QQE, the BOJ changed the limit to an annual purchase amount of 30 billion JPY. From October 2014, the BOJ tripled the annual purchase amount to 90 billion JPY under QQE2. During the

[5] This description is based on the release in April 2013. For more information, see https://www.boj.or.jp/en/announcements/release_2013/k130404a.pdf and https://www.boj.or.jp/en/announcements/press/koen_2013/data/ko130412a1.pdf.

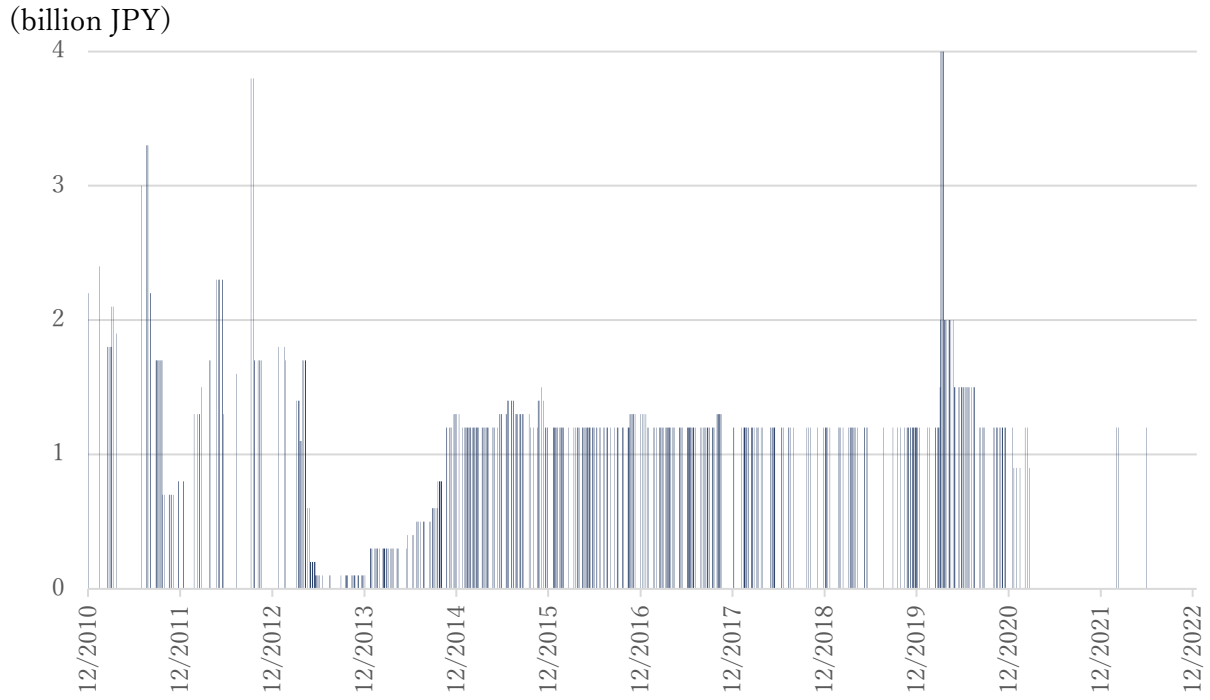
COVID pandemic, the BOJ doubled the limit to 180 billion.

The BOJ imposes several conditions for the purchase of REITs. For a REIT to be eligible for purchase, the BOJ purchases the REIT with an AA or higher credit rating. More especially, according to "Guidelines on Eligible Collateral", the BOJ purchases the REIT issued by a firm that must be rated AA or higher by a recognized rating agency. For the identification of the empirical analysis.[6] REIT management companies tend to take credit ratings from R&I and JCR, the Japanese rating agencies.

Figure 4 shows the amount of daily REIT purchases. The BOJ purchased approximately 1.2 billion JPY of REIT shares for each operation between November 2014 to the end of 2019 but temporarily increased the amount during the COVID pandemic. The BOJ's REIT holdings and ownership ratio increased significantly during QQE2.

[6] Additionally, the BOJ must have traded for over 200 days with an annual trading value of JPY 20 billion or more.

Figure 4 The BOJ's REIT purchase operations



Source: Bank of Japan

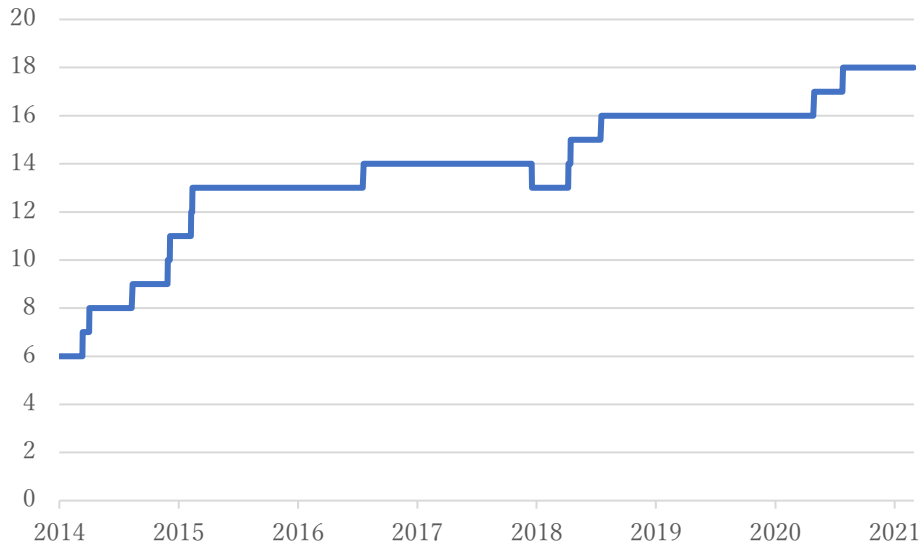
However, the frequency of the BOJ purchase decreased significantly in 2021 and 2022. The main reason is that the BOJ's ownership shares of individual REITs became significant by 2020. The BOJ purchases the share of individual REITs instead of index funds. After ten years of active REIT purchases, in 2019, the BOJ's total REIT holdings accounted for approximately 3.5% of the the total market capitalization of approximately 16 trillion JPY. The largest ownership share reached 10% in 2019.

2.3 The descriptive statistics

The BOJ purchases the REIT with AA or higher credit ratings. Figure *5* shows the number of REITs with AA or higher credit ratings. At the end of December 2021, 62 RIETs were listed

while 18 REITs were AA or higher credit ratio, so about 30% of the REIT is the target of the BOJ purchase.

Figure 5 The number of AA credit ratings of REIT



This figure depicts the number of REITs that are rated AA or above. The sample consists of REITs that were listed on TSE at the end of December 2021.

Table 1 shows the descriptive statistics of the dummy variable for the BOJ's REIT purchase. The mean value represents the empirical probability of purchase for each year. The BOJ's purchase operations occurred on less than 20% of trading days between 2012 and 2014 but on more than 30% of trading days between 2014 and 2016. In 2020, the proportion increased to 43.9% due to the COVID pandemic. However, it sharply decreased to 2% in 2021. Since the BOJ increased the purchase amount of REITs after November 2014, while the number of REIT has been stable after November 2014, our main regression covers the data from November 2014 to December 2021.

Table 2 shows the descriptive statistics of REIT returns.

Table 1 The descriptive statistics of the REIT purchase dummy variable

Year	Obs.	Mean	Std.dev.
2010	13	0.169	0.610
2011	260	0.247	0.655
2012	261	0.171	0.586
2013	261	0.115	0.360
2014	261	0.143	0.298
2015	261	0.353	0.569
2016	257	0.345	0.549
2017	252	0.356	0.554
2018	260	0.217	0.463
2019	260	0.203	0.451
2020	261	0.439	0.817
2021	260	0.023	0.152
All	3,137	0.218	0.519

This table shows the number of observations (trading days) and the mean and standard deviation of the dummy variable for REIT purchases in our sample between 2010 and 2021. The mean value represents the empirical probability of the BOJ's REIT purchase for each year.

Table 2 Descriptive statistics of REIT returns

	Obs.	Mean	Std.dev.	Min.	Max.
Daily (15:00 previous day–15:00)	85,120	0.0003	0.0213	-0.4839	0.7372
Overnight and morning (15:00 previous day–11:30)	85,200	0.0000	0.0095	-0.1681	0.1599
Lunchtime (11:30–12:30)	85,200	-0.0001	0.0029	-0.1048	0.0886
Afternoon (12:30–15:00)	85,200	0.0002	0.0091	-0.1746	0.1516

This table shows the descriptive statistics of pooled REIT returns in our sample between 2010 and 2021.

3. The BOJ's REIT purchase rule

The BOJ does not make advance notice regarding the date and amount of its REIT purchase, unlike Japanese government bond (JGB) auctions (Hattori, 2020; Hattori and Takahashi, 2022). Instead, the BOJ publicly discloses the ex-post aggregate amount of REIT purchase, as depicted in Figure 4. However, the BOJ does not disclose its purchase amount for each REIT or the specific time of purchase. Thus, we estimate the BOJ's purchase rule using a linear probability model, by following Hattori and Yoshida (2022). We divide each trading day into five subperiods: the overnight period (from 15:00 on the previous trading day to 09:00), the morning market (from 09:00 to 11:30), the combined overnight and morning period (from 15:00 on the previous trading day to 11:30), the lunchtime (from 11:30 to 12:30), and the afternoon market (from 12:30 to 15:00). For each subperiod $i = \{overnight\ (N), morning\ (A), overnight\ \&\ morning\ (OA), lunchtime\ (L), afternoon\ (P)\}$, we estimate:

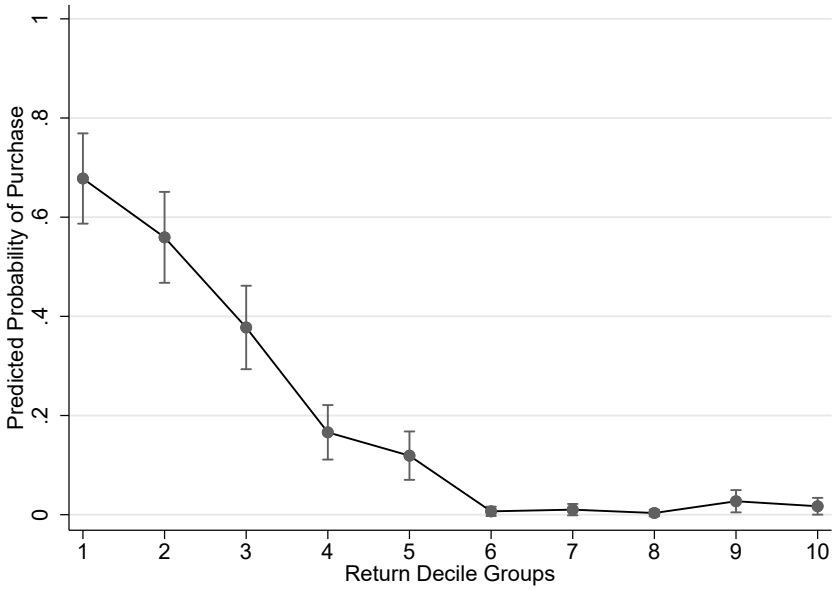
$$\mathbb{I}_t = \alpha_1^i + \sum_{d=\{1,\ldots,5,7,\ldots,10\}} \beta_1^{i,d}\, \mathbb{r}_t^{i,d} + \varepsilon_{1,t}^i, \tag{1}$$

where $\mathbb{I}_t$ denotes a dummy variable for a REIT purchase on date t, and $\mathbb{r}_t^{i,d}$ denotes a dummy variable for decile-group d of a subperiod-i REIT index return on date t. We use the sixth-decile group as the reference group. Using the TSE-REIT Index obtained from Bloomberg, we compute REIT returns from April 2013 to December 2021.

Figure 6 shows the predicted purchase probabilities for the return decile groups based on

Eq. (1) for the combined overnight and morning period.[7] The results demonstrate a clear contingency of REIT purchases on the cumulative overnight and morning return. The probability of purchase is approximately 0.7 when the cumulative return is in the first decile. The probability monotonically and almost linearly decreases to 0.00 for the sixth return decile group. The purchase probability is consistently about zero for the sixth to tenth deciles. This result strongly suggests that the BOJ's REIT purchase decision is based on the cumulative return during the overnight and morning period. Because lunchtime and afternoon returns do not exhibit this downward-sloping pattern, we conclude that the BOJ submits REIT purchase orders during lunchtime.

Figure 6 Purchase probability by return decile groups



This figure depicts the predicted probability of the Bank of Japan's REIT purchase corresponding to 10 decile groups of cumulative REIT index returns during the overnight and morning periods. The first decile represents the lowest (negative) return, whereas the tenth decile represents the highest return. The linear probability model is specified in Eq. (1). The sample period is December 15, 2010, to December 31, 2020. The 95% confidence intervals are based on Newey and West's (1987) standard errors.

[7] The results for other subperiods are available upon request. The results are almost identical to those in Hattori and Yoshida (2022).

The decile groups 1-5 roughly correspond to negative returns, whereas groups 6-10 roughly correspond to positive returns. We further analyze the sign of combined (cumulative) returns during the overnight and morning periods (the return from 15:00 on the previous day to 11:30). In particular, we pay particular attention to cases when an overnight return and the subsequent morning return have the opposite signs. Because Hattori and Yoshida (2023a) demonstrate that the BOJ's ETF purchase decision depends on cumulative overnight and morning returns instead of overnight returns or morning returns separately, we anticipate the same decision rule for REIT purchases.

We estimate the mean purchase frequency α^i from the estimation equation for subsample i with different combinations of overnight and morning returns.as below:

$$\mathbb{I}_t = \alpha_2^i + \varepsilon_{2,t}^i. \tag{2}$$

We consider four subsamples: (1) the cumulative return is positive, but the overnight return is negative, (2) the cumulative return is positive, but the morning return is negative, (3) the cumulative return is negative, but the overnight return is positive, and (4) the cumulative return is negative but the morning return is positive.

Table 3 presents the result. In columns (1) and (2), the purchase frequency is zero regardless of return combinations. In other words, the BOJ does not purchase REITs as long as the overnight-to-morning cumulative return is positive, even if either an overnight return or a morning return is negative. In contrast, when an overnight-to-morning cumulative return is negative (columns (3) and (4)), the BOJ's purchase frequency is significantly different from zero, even if

either an overnight return or a morning return is positive. Thus, it is clear that the BOJ's decision is based on the cumulative overnight and morning REIT return.

Table 3 The average frequency of REIT purchases by the sign of cumulative returns

	(1)	(2)	(3)	(4)
Cumulative Return	Positive		Negative	
Overnight Return	Negative	Positive	Positive	Negative
Morning Return	Positive	Negative	Negative	Positive
REIT Purchase Frequency	0.0000	0.0000	0.2936***	0.3611***
			(0.0336)	(0.0364)
Observations	312	227	361	252

Note: This table shows the mean of the REIT purchase dummy variable for the subsamples with different combinations of overnight and morning REIT returns. Columns (1) and (2) show the results for subsamples with positive cumulative returns, which include a sample with negative overnight and positive morning returns (column (1)) and a sample with positive overnight and negative morning returns (column (2)). Similarly, columns (3) and (4) show the results for subsamples with negative cumulative returns, including a sample with positive overnight and negative morning returns (Column (3)) and a sample with negative overnight and positive morning returns (column (4)). Newey and West's (1987) standard errors are shown in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

4. (Tobin's q) The effect of BOJ's purchase on REIT returns

4.1 DID

We first estimate the effect of BOJ's REIT purchase on returns by the difference-in-differences (DID) method, following Harada and Okimoto (2022). Because the BOJ purchases REITs that are rated AA or above, the BOJ's purchase creates security demand only for these REITs. We use this cross-sectional variation in identifying the effect of the BOJ's purchase. However, a simple regression of daily returns on the BOJ purchase dummy is subject to an endogeneity issue

because the BOJ's purchase is contingent on a negative cumulative overnight and morning REIT return. We address this endogeneity issue by using lunchtime and afternoon returns. We have found that the BOJ decides to purchase REITs after the morning market closes. Furthermore, Hattori and Yoshida (2023a) find that the BOJ's similar ETF program increases trades only at the opening of the afternoon market (12:30). Because lunchtime orders are cleared at the beginning of the afternoon session, we primarily focus on lunchtime returns (11:30-12:30). However, we also estimate the effect on afternoon returns (12:30-15:00) to capture continued price adjustments.

We run a panel regression for REIT i percentage return r_{it}^{k} on w_{it} and $purchase_t$ for subperiod $k = \{lunchtime\ (11{:}30 \text{ to } 12{:}30), afternoon\ (12{:}30 \text{ to } 15{:}00)\}$ on date t between November 2014 and December 2021:

$$r_{it}^{k} = \alpha_3^k + \beta_3^k w_{it} + \gamma_3^k purchase_t + \delta_3^k w_{it} \times purchase_t + \eta_i + \varepsilon_{3,it}. \qquad (3)$$

Because the BOJ's REIT purchase order is allocated to target REITs, w_{it} denotes the market capitalization weight for target REIT i, while it takes the value of zero for non-target REITs. $purchase_t$ denotes the amount of the BOJ's purchase in trillion JPY. REIT ticker fixed effects η_i capture time-invariant heterogeneity in risk, liquidity, and other characteristics. $\varepsilon_{3,it}$ denotes the error term.

Table 4 shows the estimation result. Column (1) shows the result when we use the lunchtime return as a dependent variable. The coefficients on $purchase$ and $w \times purchase$ are both positive and statistically significant at least at the 5% level. Thus, after controlling for the unconditional mean return differences by REITs, a one-trillion JPY purchase increases the lunchtime return by 0.337 percentage points for the entire REIT market and additional 0.0361

percentage points for a target REIT that has a 1% weight. Column (2) shows a similar but larger effect on afternoon returns. The estimated coefficients suggest that a one-trillion JPY purchase increases REIT prices further in the afternoon by 0.553 percentage points and additionally by 0.116 percentage points for a target REIT with a 1% weight. This suggests that the BOJ's REIT purchase increases REIT prices after the REIT market experiences negative overnight and morning returns.

Table 4 Difference-in-differences estimation result

	(1) Lunchtime returns	(2) Afternoon returns
w	-0.00114	-0.00551
	(0.00143)	(0.00459)
purchase	0.337***	0.553***
	(0.0489)	(0.149)
w × purchase	3.611**	11.64*
	(1.749)	(6.948)
Constant	-0.000256***	4.69e-05
	(2.35e-05)	(7.50e-05)
REIT fixed effects	Yes	Yes
Observations	74,160	74,160
R-squared	0.007	0.003

Note: This table shows the results of the panel regressions for lunchtime returns and afternoon returns (Eq. (3)). The data is from November 2014 to December 2021. Robust standard errors are shown in parentheses.

4.2 The flow effect of BOJ's purchase on REIT returns

Barbon and Gianinazzi (2019) theoretically demonstrate that equity returns are linearly related to the measure of BOJ's security demand, which is defined as the product of the purchase amount and the return variance-covariance matrix. Intuitively, the variance adjustment is made

because a more volatile stock responds more significantly to the BOJ's purchase. Thus, our research hypothesis is:

Hypothesis: *Lunchtime stock returns are positively related to the BOJ's security demand π in the cross-section on the day of the actual intervention.*

We define the REIT purchase amount $u_{\mathrm{i}} \equiv w_i \times purchase_t$ and the BOJ's security demand measure $\pi \equiv \Sigma u$, where Σ is the variance-covariance matrix of asset returns. We test the hypothesis by regressing lunchtime and afternoon returns on the purchase amount and the demand measure:

$$r_{it}^k = \alpha_4^k + \beta_4^k \pi_{it} + \gamma_4^k u_{it} + \delta_4^k \pi_{it} \times Covid + \phi_4^k u_{it} \times Covid + \eta_i + \varepsilon_{4,it}, \qquad (4)$$

where $Covid$ denotes a dummy variable for the COVID-19 period (March 1, 2020–December 30, 2020), η_{i} denotes REIT ticker fixed effects, and $\varepsilon_{4,it}$ denotes the error term. As Hattori and Yoshida (2023a), we estimate both the unconditional and conditional versions of Eq. (4). The unconditional version includes all trading days with or without the BOJ's REIT purchase, while the conditional version is restricted to the days with the BOJ's purchases.

Table 5 shows the estimation result of Eq. (8) when we use the lunchtime return as a dependent variable. Columns (1) and (2) show the result of unconditional estimation, where u_{it} and π_{it} take a value of zero when there is no REIT purchase. The coefficient on the BOJ's security demand π is positive and statistically significant at the 1% level. There is no direct interpretation of the coefficient because π is scaled by the variance-covariance matrix. Furthermore, the coefficient on the interaction term between π and *Covid* is also positive and statistically significant

at the 1% level. Comparing these coefficients, the effect of the BOJ's purchase is 4.7 times larger in the Covid-19 period than in the other period. For the conditional estimation by excluding no intervention days (columns (3) and (4)), we find qualitatively similar results: Lunchtime returns are proportionally larger for a larger value of the BOJ demand π, and the effect is larger during the Covid-19 period. Thus, consistent with the Hypothesis, the flow effect of REIT purchases on REIT returns is positive, and the effect is amplified during the COVID-19 pandemic period.

Table 5 The flow effect of BOJ's REIT purchase on lunchtime returns

	Unconditional		Conditional	
	(1)	(2)	(3)	(4)
π	0.618***	0.192**	0.724***	0.376***
	(0.0823)	(0.0808)	(0.114)	(0.102)
π × Covid		0.906***		0.671***
		(0.133)		(0.203)
u	-0.000857	-0.00343*	-0.00281	-0.00538
	(0.00185)	(0.00196)	(0.00545)	(0.00316)
u × Covid		0.00138		0.00234
		(0.00114)		(0.00147)
Constant	-0.000265***	-0.000206***	-0.000176	-8.08e-05
	(2.95e-05)	(2.68e-05)	(0.000232)	(0.000124)
REIT fixed effects	Yes	Yes	Yes	Yes
Observations	74,160	74,160	23,939	23,939
R-squared	0.008	0.012	0.010	0.014

Note: This table shows the results of the panel regressions when lunchtime return is used as the dependent variable. u_{it} denotes the amount of the BOJ's purchase for each REIT, and π_i denotes the BOJ's security demand measure adjusted for the variance-covariance matrix. Standard errors, clustered by stock tickers, are shown in parentheses. Covid denotes the dummy variable which takes the value of one between March 1, 2020 to December 30, 2020. The period is from November 2014 to December 2021.

Table 6 shows the estimation result of Eq. (4) when we use the afternoon return as a dependent variable. The unconditional flow effect is larger for afternoon returns than for lunchtime

returns (the coefficient on π in columns (1) and (2)). The average effect on afternoon returns for the entire sample period is 1.127 (column (1)), which is 1.82 times larger than the effect on lunchtime returns. Thus, the effect of the BOJ's purchase continues throughout the afternoon market. The result is similar when we exclude the trading days without intervention (columns (3) and (4)).

Table 6 The flow effect of BOJ's REIT purchase on afternoon returns

	Unconditional		Conditional	
	(1)	(2)	(3)	(4)
π	1.127***	0.938***	1.561***	1.102***
	(0.194)	(0.145)	(0.255)	(0.212)
π × Covid		0.398		0.882*
		(0.388)		(0.500)
u	-0.00360	0.00872	0.0290	0.0482**
	(0.00923)	(0.00795)	(0.0321)	(0.0170)
u × Covid		-0.0207***		-0.0233***
		(0.00475)		(0.00519)
Constant	1.43e-05	-4.19e-05	-0.00140	-0.00182**
	(0.000132)	(0.000110)	(0.00130)	(0.000699)
REIT fixed effects	Yes	Yes	Yes	Yes
Observations	74,160	74,160	23,939	23,939
R-squared	0.004	0.004	0.007	0.009

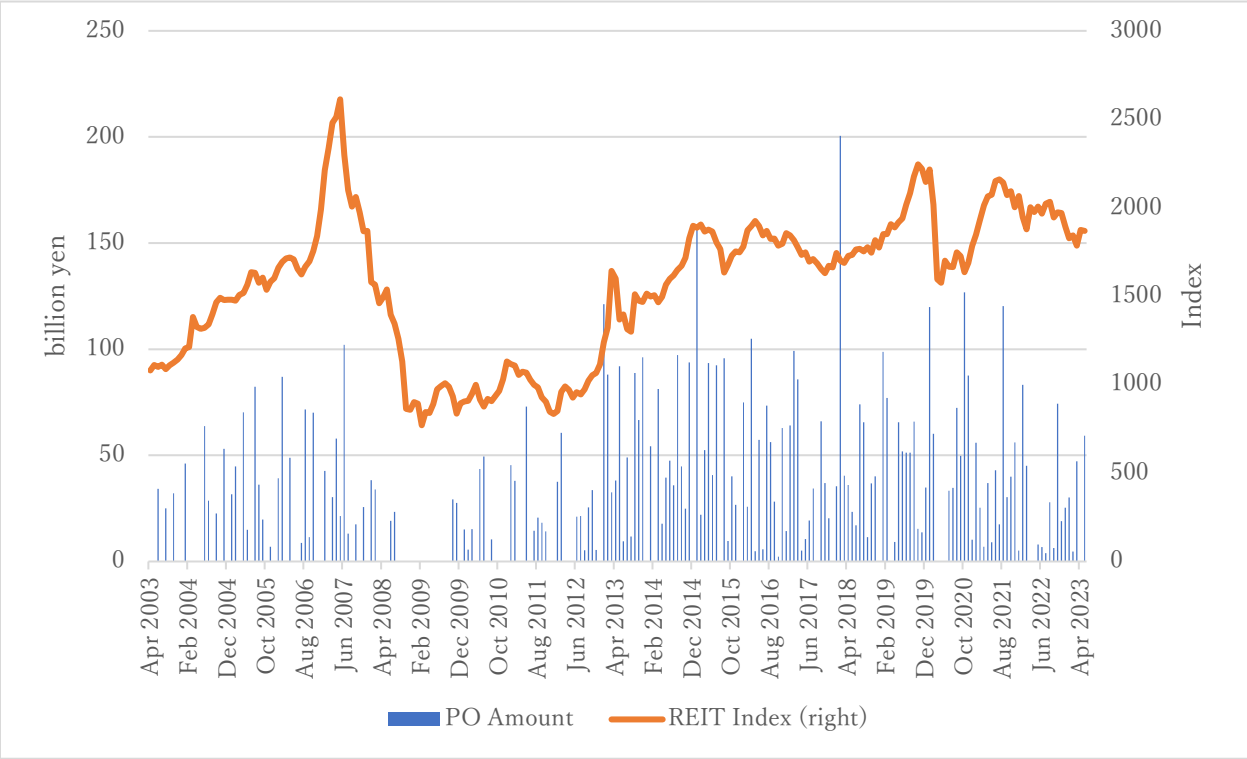
Note: This table shows the results of the panel regressions when afternoon return is used as the dependent variable. U_{it} denotes the amount of the BOJ's purchase for each REIT, and π_i denotes the BOJ's security demand measure adjusted for the variance-covariance matrix. Standard errors, clustered by stock tickers, are shown in parentheses. Covid denotes the dummy variable which takes the value of one between March 1, 2020 to December 30, 2020. The period is from November 2014 to December 2021.

5. REIT Equity Public Offerings

We test whether REIT public offerings are associated with the measure of BOJ's security demand π after controlling for REIT fixed effects. If REITs change their PO activity in response

to the BOJ's REIT purchases, it provides direct evidence that this unconventional monetary program has a real effect on corporate activity. An advantage of using REIT POs is that, unlike listed corporations, REITs specify detailed investment plans for each PO. Thus, POs are explicitly linked to capital investment. Another advantage is that each REIT offers REIT shares several times during the sample period, while listed corporations did not make many public offerings during the unconventional monetary policy. Figure 7 shows active POs by REITs between April 2003 and May 2023. With the exception of the global financial crisis, there have been active issuances of REIT shares with significant variations in the amounts.

Figure 7 REIT Public Offerings and REIT Index



This figure depicts the amount of REITs' share public offerings (blue bars) and REIT Index (The orange line on the right axis) between April 2003 and May 2023.

We estimate the following equation:

$$PO_{it}^{k} = \alpha_5^k + \beta_5^k \hat{\pi}_{it} + \eta_i + \tau_t + \varepsilon_{4,it}, \qquad (5)$$

where PO_{it}^{k} denotes the amount of a public offering by REIT i during month t, $\hat{\pi}_{it}$ denotes the average BOJ security demand for REIT i during month t, and η_i and τ_t denote REIT and year-month fixed effects, respectively.

One obvious challenge is the BOJ's endogenous purchase rule; the BOJ only buys REIT shares when stock prices are falling, precisely when REITs are trying to avoid public offerings. Thus, we expect a negative relationship between POs and BOJ's purchases when we compute the unconditional average of the BOJ demand measure for both purchase and non-purchase days within each month.

Table 7 shows the result. For the contemporaneous relationship, the estimated coefficient is not statistically different from zero. However, for the one-month lagged relationship, the coefficient is negative and statistically significant at the 10% level. Thus, as we predict, we tend to observe a smaller amount of POs in the month when the BOJ purchases REITs more frequently. This is a natural result of the BOJ's countercyclical intervention rule.

Table 7 REIT public offerings and the unconditional average of BOJ's REIT demand measure

	(1)	(2)	(3)	(4)
π	-52,943	307,724	-174,093	233,684
	(-0.149)	(0.701)	(-0.557)	(0.549)
L.π		-718,457*		-794,861*
		(-1.910)		(-1.923)
Constant	863.5***	911.4***	885.2***	938.6***
	(8.630)	(8.268)	(15.80)	(16.76)
REIT fixed effects	No	No	Yes	Yes
Observations	3,440	3,400	3,440	3,400
R-squared	0.000	0.000	0.025	0.026

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: This table shows the results of the panel regression for the amount of monthly REIT public offerings on the monthly average REIT demand measure by BOJ between November 2014 and May 2023. π_i denotes the average of BOJ's security demand measure adjusted for the variance-covariance matrix for both purchase and non-purchase dates. Standard errors, clustered by REIT tickers, are shown in parentheses.

In addition, we compute a conditional average $\hat{\pi}_{it}$ only for purchase days. Conditional on an intervention, a greater security demand by BOJ may increase the probability of POs through increased REIT prices (or a reduced risk premium). With regular investment opportunities in the pipeline, REITs are likely to time the market for a PO. A REIT may choose to issue equity shares when the BOJ creates a large demand for the REIT's shares.

Table 8 shows the results. In columns (1) through (3), the coefficient on the BOJ's security demand $\hat{\pi}_{it}$ is positive and statistically significant at the 1% or 5% level, regardless of whether year-month fixed effects and REIT fixed effects are included. In addition, columns (4) through (6) show that the coefficients on the BOJ's security demand are almost unchanged when lagged demand is included. The result is also consistent when we replace the dependent variable with a

dummy variable for PO. Thus, conditional on the BOJ's purchase, a REIT is more likely to make a PO if it has a large $\hat{\pi}_{it}$. Because the amount of each purchase by BOJ has been relatively stable since 2014, the variation in $\hat{\pi}_{it}$ is determined by the REIT market capitalization and return covariances with other REITs. Thus, a REIT with a larger market capitalization or larger covariances with other REITs is more likely to respond to the BOJ's purchase and issue shares. This result is reasonable given the fixed costs associated with public offerings. Thus, this monetary program has a heterogeneous effect on capital investment through equity financing.

Table 8 REIT public offerings and the conditional average of BOJ's REIT demand measure

	(1)	(2)	(3)	(4)	(5)	(6)
π	5.499**	6.611***	17.44***	4.123*	4.799**	13.17*
	(2.597)	(2.557)	(6.201)	(2.362)	(2.374)	(6.961)
L.π				2.131	2.874	5.075
				(2.504)	(2.494)	(7.885)
Constant	5.281***	4.622***	-1.794	4.638***	3.792**	-2.499
	(1.399)	(1.386)	(3.428)	(1.652)	(1.642)	(4.103)
Year-month fixed effects	NO	No	Yes	NO	No	Yes
REIT fixed effects	No	Yes	Yes	No	Yes	Yes
Observations	3,440	3,440	3,440	3,400	3,400	3,400
R-squared	0.001	0.027	0.057	0.001	0.028	0.058

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: This table shows the results of the panel regression for the amount of monthly REIT public offerings on the monthly average REIT demand measure by BOJ between November 2014 and May 2023. π_i denotes the average, conditional on BOJ's purchase, of security demand measure adjusted for the variance-covariance matrix. Standard errors, clustered by REIT tickers, are shown in parentheses.

6. Conclusion

The Bank of Japan's REIT share purchase program has a unique objective compared to other large-scale asset purchases, in that it aims to affect the real economy by influencing investors' risk taking. In our study, we analyze the effect of this program by addressing the challenge of identifying the counterfactual state of the capital market in the absence of intervention. Our research shows that the BOJ selectively intervenes in the REIT market during lunchtime, only when the morning market closes with a significantly negative cumulative overnight and morning return. Using lunchtime and afternoon returns on the day of BOJ intervention, we find that the BOJ's actual purchase of REITs has a significant flow effect on REIT share prices, especially during the COVID-19 pandemic. Although we did not test for long-run side effects on the price discovery function of the financial market, our study contributes to the literature by establishing the basis for a central bank's downside protection of security prices through state-contingent intervention. Furthermore, we find that BOJ's REIT purchase has a real effect on REIT activity. Conditional on the BOJ's purchase, a REIT is more likely to issue shares if it is exposed to greater demand for securities from the BOJ. Because REIT share offerings are closely related to capital investment such as real estate purchases and capital expenditures, this finding provides a significant result on the real effect of unconventional monetary policy.

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