The Bank of Japan as a Real Estate Tycoon: Large-Scale REIT Purchases

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Abstract

This is the first study to analyze the Bank of Japan's (BOJ) purchase of real estate investment trusts (REITs) since 2010 as part of enhanced unconventional monetary policy. The BOJ purchases REIT shares after observing a significantly negative return over the previous night and during the morning market. The BOJ continues daily purchases until the overnight and morning REIT returns become positive. On the day of the BOJ's purchase, the lunchtime and afternoon returns are more likely to be positive. This counter-cyclical behavior is consistent with the objective of decreasing risk premiums. Our study sheds light on the unique program of a central bank's equity purchases.

JEL codes: E52, E58, G12, 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) enhanced its unconventional monetary policy in October 2010 by purchasing equity exchange-traded funds (ETFs) and public real estate investment trusts (REITs) in addition to the open market operations of Japanese Government Bonds (JGBs). These equity purchase programs are unprecedented in the history of central banking.[1] In April 2013, the BOJ started the new policy regime called quantitative and qualitative monetary easing (QQE), in which the BOJ further increased the asset purchase amount and started new fixed-price JGB purchase operations (Hattori and Yoshida, 2020). After ten years of continued REIT purchases, the BOJ has become one of the largest owners of public REITs. The BOJ has issued the Report of Possession of Large Volume to 21 REITs by February 6, 2020, because it owns more than 5% of the outstanding shares. However, the BOJ's specific purchase behavior is not publicly known.

The objective of our study is to unveil the BOJ's behavior of purchasing REIT shares. We use both the BOJ's daily purchase report and intraday REIT return data. Using the linear probability model and the Cox hazard model with time-varying covariates, we find that the BOJ tends to start purchasing REIT shares when it observes a significantly negative REIT return over the previous night and during the morning market on the Tokyo Stock Exchange (TSE). In particular, the BOJ strongly responds to a REIT return below the 30^{th} percentile of historical overnight and morning returns. The BOJ continues purchasing REIT shares daily until either overnight or morning returns become positive. Thus, we conclude that the BOJ applies a counter-cyclical intervention rule based on the overnight and morning returns. However, general stock market returns do not impact the BOJ's REIT purchase decisions. Furthermore, we find that the

[1] The Swiss National Bank also holds US corporate shares, but its aim is to control foreign exchange rates rather than interest rates and risk premiums.

lunchtime and afternoon returns are more likely to be positive on the day of the BOJ's intervention. This result suggests that the BOJ's purchase orders positively affect REIT returns after the morning market.

The BOJ's program to purchase REITs and ETFs is unique among central banks' large-scale asset purchase (LSAP) programs. Most LSAPs—first deployed by the BOJ in 2001—are targeted to long-maturity bonds such as government bonds and mortgage-backed securities (MBSs). These LSAPs are used to lower long-term interest rates and stimulate firms' and consumers' spending when the short-term policy rate is near the zero lower bound (ZLB). However, both REIT shares and ETFs are risky equity securities traded on a stock exchange. The primary objective of REIT/ETF purchases is to decrease various risk premiums by attracting more funds into the financial markets and stabilizing the economy (Shirakawa, 2010). Thus, this program can be understood as an extension of LSAPs that aim to decrease risk premiums.[2]

Although the BOJ does not discuss the specific mechanism to decrease risk premiums, 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). 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

[2] A major difference is that the BOJ has been making advance announcements of the exact date of JGB auctions since March 2017, whereas the BOJ purchases REITs and ETFs without announcements.

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).

The BOJ can potentially reduce REIT risk premiums further through additional channels. For example, if the marginal REIT investor is less diversified than the marginal ETF investor, the BOJ's REIT purchases can reduce the marginal investor's exposure to REIT risks and thus the equilibrium price of REIT risks. This channel is analogous to the capital-constraints channel for the Fed's purchase of mortgage-backed securities (MBSs). When MBS investors are capital-constrained, MBS yields include premiums corresponding to under-diversification. When a central bank purchases MBSs, these capital-constraint premiums will decrease (Krishnamurthy and Vissing-Jorgensen, 2013). Also, REIT share purchases can decrease REITs' credit risk by reducing leverage (i.e., the default risk channel).

Our finding that the BOJ purchases REIT shares after observing a significant negative return suggests that the BOJ aims to mitigate large decreases in REIT share prices. Moreover, REIT shares are more likely to increase after the morning market on the day of the BOJ's purchase operation. This purchasing behavior and the intraday price dynamics are consistent with the BOJ's key objective to decrease various risk premiums because a higher REIT share price is associated with a lower expected REIT equity premium. However, the program may create a side-effect on the price discovery function of the financial market. If REIT market prices do not incorporate negative information fully, investors' assessment of the economic condition may be biased.

The remainder of this paper is organized as follows. Section 2 describes the BOJ's unconventional monetary policy, and Section 3 explains the Japanese REIT market. After Section

4 describes the data, Section 5 details our empirical strategy. Section 6 presents our empirical results. Section 7 concludes.

2. Bank of Japan's unconventional monetary policy

The BOJ pioneered in adopting an unconventional monetary policy. It was the first central bank to use forward guidance in 1999 when it adopted the zero-interest-rate policy. After the global financial crisis, the BOJ set up in October 2010 the fund to purchase REITs and ETFs. The BOJ states three objectives of 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.

In April 2013, the BOJ started the quantitative and qualitative monetary easing to achieve a 2% inflation rate measured by the consumer price index. The "quantitative" component corresponds to the change in the BOJ's target from the uncollateralized overnight call rate (i.e., price) to the monetary base (i.e., quantity). The BOJ targeted to increase the monetary base by approximately 60–70 trillion JPY each year.[3] Two years after starting QQE, the BOJ almost doubled the monetary base by holding more JGBs on its balance sheet. Subsequently, the BOJ further accelerated the monetary-base growth from October 2014.

[3] 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.

The "qualitative" component corresponds to open-market operations for almost all securities except for municipal, government-guaranteed, and government agency bonds. For example, the BOJ purchases longer-term government bonds, commercial papers, corporate bonds, ETFs, and REITs. The BOJ also applied negative ten bps to private banks' current accounts at the BOJ (January 2016) and launched a new fixed-price JGB purchase program in September 2016 (Hattori and Yoshida, 2020).

The BOJ started purchasing 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 starting in 2013, 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. The BOJ's REIT holdings and ownership ratio increased significantly during QQE2 (Figure 1). In 2019, the BOJ's ownership ratio became approximately 3.5% of the 16-trillion yen market capitalization of REITs. The maximum ownership proportion for each REIT is 10%, which was increased in December 2015 from 5%. The BOJ holds all assets it purchased under QQE, including ETFs, REITs, and JGBs. This buy-and-hold policy is not unique to the BOJ; for example, the Fed did not sell bonds or MBSs under QEs until it started to decrease its balance sheet in October 2017. The BOJ is still increasing its asset base because it has not achieved its inflation rate target yet. Thus, the BOJ does not consider tapering or "quantitative tightening."

The BOJ sets several conditions for the REIT to be purchased. It must trade for more than 200 days with an annual trading value of 20 billion JPY or larger. The BOJ also applies the collateral standards set forth in the Guidelines on Eligible Collateral (Policy Board Decision on

October 13, 2000):[4] (1) Publicly-offered bonds issued by a firm must be rated AA or higher by an eligible rating agency, and (2) principal investment objects of a firm should be real estate (including leaseholds, superficies, and asset-backed securities).

The BOJ does not make an advance notice about the specific date of a REIT purchase operation, although it announces the annual budget and the daily ex-post purchase record. The BOJ submits a REIT purchase order through the designated trust banks without public notice. This operation method contrasts with the BOJ's regular JGB auctions, for which the BOJ makes each month the announcement of the purchase amount and frequency for the following month (Hattori, 2020).

3. The Japanese REIT market

Japanese REITs were established in 2000 by the amendment to the Act on Investment Trusts and Investment Corporations. The first two REITs—Nippon Building Fund and Japan Real Estate—were listed on the Tokyo Stock Exchange (TSE) in September 2001. Figure 2 depicts the growth of the Japanese public REIT market in terms of the number of listed REITs and their market capitalization. The initial growth period until 2007 was 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 has been another period of steady market growth since 2012. As of January 31, 2020, 64 REITs were listed with the total market capitalization of 17 trillion JPY, which accounts for approximately 3% of the market capitalization of TOPIX. The Japanese REIT market is now the second-largest REIT market in the world after the US REIT market. Of the 19.2

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

trillion-yen asset under management, office properties are 41.6%, retail properties are 17.6%, industrial properties are 16.0%, residential properties are 14.4%, and hotel properties are 8.4%.

Figure 3 depicts the TOPIX and the TSE-REIT Index (ex-dividends) between 2003 and 2020. After a sharp decrease between 2007 and 2008, the REIT Index generally exhibits an upward trend until 2019. Two indexes generally moved in tandem, but they started to diverge since around 2014.

Figure 4 depicts the net purchase amount by investor type between 2013 and 2019. Throughout this period, individuals have been net sellers, whereas foreign investors have been net buyers since 2016. Other institutions have been increasing the net purchase amount since 2015. In 2019, sellers were individuals (338 billion JPY) and financial institutions (47 billion JPY), whereas buyers were mutual funds (81 billion JPY), foreign firms (69 billion JPY), and others (208 billion JPY). The BOJ's annual net purchase amount of 90 billion JPY is sizable in the market.

4. Data

We obtain the date and amount of the BOJ's REIT purchase operations from the BOJ's website. Figure 5 depicts the size of daily operation (Panel A) and the number of operations for each month (Panel B). Before QQE2 (i.e., until September 2014), the size of each operation varied significantly, and the operations were irregular. Under QQE2, the size of each operation became almost constant at 1.2 billion JPY, and more than one operation took place almost every month. The average number of operations is 2.5 before QQE2 and 5.3 under QQE2.

We use TSE-REIT Index to compute REIT returns from April 2013 to December 2019. We divide each trading day into four 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 lunchtime (from 11:30 to 12:30), and the afternoon market (from 12:30 to 15:00). Table 1 shows the descriptive statistics of the TSE-REIT Index ex-dividend returns. The mean daily return is 2.1 bps, with a standard deviation of 95.7 bps. Periodic returns tend to be slightly lower and less volatile while the market is closed (overnight and lunchtime) than while the market is open.

Table 2 shows the deciles of TSE-REIT Index returns for each subperiod. For our empirical analysis, we construct a dummy variable for each decile group: e.g., returns less than the 10^{th} percentile, returns greater than or equal to the 10^{th} percentile and less than the 20^{th} percentile, etc.

5. Empirical strategy

5.1 Linear probability model (LPM)

We first estimate the following linear probability model (LPM) to analyze the BOJ's REIT purchase decisions by using the daily data.

$$\mathbb{I}_t = \alpha_1 + \sum_{i=\{N,A,L,P\}} \beta_1^i \, r_t^i + \varepsilon_{1,t}, \quad (1)$$

where $\mathbb{I}_t$ denotes the dummy variable that takes a value of one if the BOJ purchases REIT shares at date t and takes zero otherwise. The explanatory variable r_t^i denotes TSE-REIT Index returns during subperiod i, as defined in Section 4. The subperiods consist of the overnight period (N), the morning market (A), the lunchtime (L), and the afternoon market (P). $\varepsilon_{1,t}$ denotes the error term. A negative coefficient β_1^i indicates that the BOJ is more likely to purchase REIT shares on date t if a REIT return is smaller (i.e., more negative) during subperiod i.

The second variation includes lagged REIT returns:

$$\mathbb{I}_t = \alpha_2 + \sum_{i=\{N,A,L,P\}} \beta_2^i \, r_t^i + \gamma_2^i \, r_{t-1}^i + \varepsilon_{2,t}. \qquad (2)$$

By testing the statistical significance of β_2^i and γ_2^i, we can identify whether the BOJ responds to returns on the same day or the previous day.

The third variation includes TOPIX returns to test whether the BOJ responds to REIT returns or stock returns:

$$\mathbb{I}_t = \alpha_3 + \sum_{i=\{N,A,L,P\}} \beta_3^i \, r_t^i + \delta_3^i \, s_t^i + \varepsilon_{3,t}. \qquad (3)$$

where s_t^i denotes TOPIX returns for subperiod i. A statistically significant coefficient β_3^i indicates that the BOJ responds to REIT returns after controlling for the response to TOPIX returns. The fourth variation includes lagged terms for both REIT and TOPIX returns.

$$\mathbb{I}_t = \alpha_4 + \sum_{i=\{N,A,L,P\}} \beta_4^i \, r_t^i + \gamma_4^i \, r_{t-1}^i + \delta_4^i \, s_t^i + \theta_4^i \, s_{t-1}^i + \varepsilon_{4,t}. \qquad (4)$$

In the previous specifications, the estimated coefficient β^i is a local linear approximation of the potentially non-linear effect of REIT returns. To estimate a non-linear effect, we use the return-decile dummy variables that we define in Section 4. By using the sixth-decile group (i.e., between the 50th and 60$^{\text{th}}$ percentiles) as the reference group, we estimate the following equation for each subperiod $i = \{N, A, L, P\}$:

$$\mathbb{I}_t = \alpha_5^i + \sum_{d=\{1,\ldots,5,7,\ldots,10\}} \beta_5^{i,d} \, \mathbb{r}_t^{i,d} + \varepsilon_{5,t}^i, \qquad (5)$$

where $\mathbb{r}_t^{i,d}$ denotes the dummy variable that takes a value of one if a subperiod-i return on date t is in decile-group d and takes zero otherwise. Thus, the coefficient $\beta_5^{i,d}$ represents the

incremental probability of the BOJ's purchase when a return is in the dth-decile group as opposed to the sixth-decile group.

5.2 Cox hazard model with time-dependent covariates

An issue with a linear probability model is that it ignores the conditional nature of the BOJ's decision making. In other words, it does not distinguish consecutive daily purchases from a single purchase. To analyze the BOJ's decision conditional on a sequence of its past decisions, we estimate the Cox hazard model (Cox, 1972). When T denotes the random failure time after a period of survival, the survival function of time t is defined as:

$$S(t) \equiv \Pr(T \geq t) = \int_t^{\infty} f(u)du,$$

where $f(u) \equiv \lim_{\Delta u \to 0} \frac{1}{\Delta u} \Pr(u \leq T < u + \Delta u)$ is the density function. Then, the hazard function that represents an instantaneous rate of failure conditional on survival up to t is defined as:

$$\lambda(t) \equiv \lim_{\Delta t \to 0} \frac{1}{\Delta t} \Pr(t \leq T < t + \Delta t | T \geq t) = \frac{f(t)}{S(t)}.$$

When covariates impact the failure time, most studies assume a Cox proportional hazard model with time-invariant covariate vector $\boldsymbol{X}$:

$$\lambda(t|\boldsymbol{X}) = \lambda_0(t) e^{\boldsymbol{X}\boldsymbol{\beta}},$$

where $\lambda_0(t)$ denotes the baseline hazard function. We allow for a time-dependent covariate vector $\boldsymbol{X}(t)$ (e.g., Fisher and Lin, 1999; Zhang et al., 2018; Dirick et al., 2019):

$$\lambda\big(t\big|\boldsymbol{X}(t)\big) = \lambda_0(t) e^{\boldsymbol{X}(t)\boldsymbol{\beta_6}}. \qquad (6)$$

For covariates, we use contemporaneous and lagged TSE-REIT subperiod returns as in Equation (2): $\boldsymbol{X}(t)\boldsymbol{\beta_6} = \sum_{i=\{N,A,L,P\}} \beta_6^i \, r_t^i + \gamma_6^i \, r_{t-1}^i$.

We analyze both starting and stopping decisions by defining two different failure events. To analyze the BOJ's starting decision, we treat a consecutive period of BOJ inaction as survival and the first day of REIT purchases as a failure. In this specification, a negative coefficient β_6^i indicates that a lower (i.e., more negative) return is associated with a larger hazard rate of starting purchases conditional on no-purchases up to the previous day. In the second specification to analyze stopping decision, we reverse survival and failure; we treat a consecutive period of BOJ purchases as survival and the first day of inaction as a failure. In this specification, a positive coefficient β_6^i indicates that a higher (i.e., more positive) return is associated with a larger hazard rate of stopping purchases conditional on a series of purchases up to the previous day.

6. REIT purchase behavior

In analyzing the BOJ's REIT purchase behavior, we primarily focus on the coefficient on overnight returns because it clearly represents a causal relationship. We also use the coefficient on morning returns because we believe the BOJ submits REIT purchase orders during lunchtime. Although the data do not allow us to determine precisely when the BOJ submits orders, it is likely before the afternoon market opens because the BOJ conducts other JGB open-market operations at either 09:20 or 12:50. As we discuss below, our estimation result suggests that the BOJ submits orders during lunchtime.

Table 3 shows the estimation results of the LPM (equations 1, 2, 3, and 4). Column (1) shows that the probability of BOJ purchases is strongly negatively associated with overnight and morning returns (-39.118 and -30.372, respectively). These negative associations do not change when we include lagged REIT returns (Column (2)), TOPIX returns (Column (3)), and

lagged REIT and TOPIX returns (Column (4)). Lagged returns largely have insignificant coefficients. Because returns are measured in percentage points, a one percentage-point lower return during the overnight period and the morning market is associated with 39 and 30 percentage-points larger probability of purchases, respectively. This negative coefficient for overnight returns indicates a causal relationship because an overnight return is determined at the beginning of the morning market. A comparable magnitude of the coefficient on morning returns suggest that the BOJ also observes returns during the morning market before making a purchase decision.

Table 4 shows the estimation results of Equation (4) by three subperiods. Before QQE (from October 2010 to March 2013), the negative coefficients on overnight and morning returns were smaller in magnitude than those for the entire sample period. The size of these coefficients became significantly larger under QQE (from April 2013 and September 2016), and even larger under the yield curve control (YCC) regime (from October 2016 and December 2019). TOPIX and lagged returns are not associated with the BOJ's purchase decision in any subperiod. The BOJ seems to have established and strengthened its purchase rule overtime.

Table 5 and Figure 6 show the estimation result of Equation (5) regarding the non-linear effect of returns on the BOJ's behavior. For overnight returns, the estimated coefficients are positive and statistically significant for the first, second, and third decile groups. When an overnight return is significantly negative and in the first decile grop, the BOJ is 52.6 percentage points more likely to purchase REITs than in the reference case of the sixth decile group. In the second and third decile groups, the coefficients monotonically decrease to 0.287 and 0.166, respectively. In contrast, the coefficients for the seventh through tenth decile groups are negative and statistically significant. Thus, when an overnight return is significantly positive, the BOJ is

less likely to purchase REITs. A similar result is obtained for morning returns. The coefficients are positive and monotonically decreasing for the first (0.560) through the fourth (0.081) decile groups, whereas they are negative and decreasing for the seventh (-0.063) through the tenth (-0.143) decile groups.

Table 6 shows the estimated coefficient vector $\boldsymbol{\beta_6}$ in Equation (6) for the Cox hazard model of starting decisions (i.e., when a failure is defined as the start of the BOJ's REIT purchases). The reported coefficients are the natural logarithm of the hazard ratio for a one basis-point higher return. Consistent with the results from the LPMs, overnight returns and morning returns have negative coefficients that are statistically significant at the 1% level. Thus, after a period of inaction, the BOJ is more likely to start purchasing REIT shares when overnight and morning returns are negative. For a one-basis-point lower return during the overnight period and the morning market, the hazard function is 1.8 and 1.1% larger, respectively (i.e., the log hazard ratio is 0.018 and 0.011, respectively). No lagged return is statistically significant.

Table 7 shows the estimated coefficient vector $\boldsymbol{\beta_6}$ in Equation (6) for the Cox hazard model of stopping decisions (i.e., when a failure is defined as the end of consecutive REIT purchases). The coefficients on overnight and morning returns are positive and statistically significant at the 1% level. Thus, after consecutive daily purchases, the BOJ is more likely to stop operations when overnight and morning returns are positive. For a one-basis-point higher return, the hazard function is 0.4% larger (i.e., the log hazard ratio is 0.004). The coefficient is statistically insignificant for lagged returns.

7. The effect on REIT share prices

We use the same empirical models from equations (1) to (6) to infer the effect of the BOJ's purchases on REIT share prices. As we have discussed in the previous section, the BOJ is likely to submit orders during lunchtime. Thus, the coefficients on lunchtime and afternoon returns are likely driven by the causal effect of the BOJ purchases on REIT share prices.

Table 3 (i.e., equations 1, 2, 3, and 4) shows that the coefficient on lunchtime returns is positive and statistically significant. A one-percentage-point larger lunchtime return is associated with a 33.8 percentage-point larger probability of a BOJ operation. This positive association suggests that the afternoon market tends to start at a higher REIT share prices after the BOJ submits a purchase order during lunchtime. This positive association between BOJ operations and lunchtime returns is observed only under QQE (Table 4). With this linear specification, the coefficient on afternoon returns is positive but statistically insignificant regardless of periods.

Based on return decile groups (Table 5 and Figure 6), the coefficients are significantly positive for large returns during lunchtime and the afternoon market. For example, in the tenth decile group of lunchtime returns, the coefficient is 0.303 and statistically significant at the 1% level. Similarly, the coefficient on the tenth decile group of afternoon returns is 0.098 and statistically significant at the 10% level. Thus, the BOJ's REIT purchases are likely to cause unusually large positive returns, especially during lunchtime.

Furthermore, Table 6 shows that the start of daily REIT purchases after a period of inaction causes significantly positive lunchtime returns. The first of consecutive purchases probably has a large price effect because investors update their conditional expectations of subsequent purchases. Table 7 shows that the end of consecutive REIT purchases does not have a significantly negative effect on REIT share prices during lunchtime or afternoon. This is probably

because the BOJ stops purchasing REIT shares only after they observe significantly positive returns overnight and in the morning market. This result implies that the BOJ's operation is effective not only on the day of operation but rather persistent.

8. Conclusion

Our study is the first to analyze the BOJ's REIT share purchase program. It is an unprecedented program among other large-scale asset purchase programs around the world. Our main finding is that the BOJ purchases REIT shares in a highly discretionary manner rather than on a regular schedule. Using a linear probability model and the Cox proportional hazard model with time-varying covariates, we find that the BOJ tends to start purchasing REIT shares when it observes a significantly negative return over the previous night and during the morning market on the Tokyo Stock Exchange. The BOJ stops purchasing REIT shares when either overnight or morning returns become significantly positive. Furthermore, the BOJ's REIT share purchases are associated with significantly positive REIT returns during lunchtime and the afternoon market, suggesting a significant effect on REIT share prices. Moreover, the price effect is persistent because stopping consecutive purchases does not affect REIT share prices negatively. This study contributes to the literature by revealing how the BOJ affects real estate equity prices as part of its unconventional monetary policy.

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Table 1
Tokyo Stock Exchange REIT Index returns

Periods	Obs	Mean	Std. Dev.	Min	Max
Daily	1,654	0.00021	0.00957	-0.07340	0.05713
Overnight (15:00–9:00)	1,654	-0.00027	0.00423	-0.02002	0.02028
Morning Market (9:00–11:30)	1,654	0.00016	0.00567	-0.03282	0.05087
Lunchtime (11:30–12:30)	1,654	-0.00018	0.00116	-0.01029	0.00642
Afternoon Market (12:30–15:00)	1,654	0.00049	0.00585	-0.04671	0.05772

Note: This table shows the descriptive statistics of the TSE-REIT Index returns from April 2013 to December 2019. Source: Bloomberg

Table 2
Percentiles of Tokyo Stock Exchange REIT Index returns

Percentiles	Daily	Overnight (15:00–9:00)	Morning Market (9:00–11:30)	Lunchtime (11:30–12:30)	Afternoon Market (12:30–15:00)
10th	-0.00909	-0.00457	-0.00555	-0.00139	-0.00514
20th	-0.00547	-0.00249	-0.00315	-0.00092	-0.00318
30th	-0.00329	-0.00158	-0.00180	-0.00061	-0.00185
40th	-0.00162	-0.00080	-0.00081	-0.00037	-0.00071
50th	0.00017	-0.00012	0.00014	-0.00016	0.00036
60th	0.00172	0.00057	0.00104	0.00006	0.00144
70th	0.00341	0.00129	0.00218	0.00028	0.00261
80th	0.00596	0.00225	0.00346	0.00058	0.00395
90th	0.00946	0.00386	0.00556	0.00103	0.00631

Note: This table shows TSE-REIT Index return deciles for each of the four subperiods. The sample period is from April 2013 to December 2019. Source: Bloomberg

Table 3
Linear probability model for the entire sample period

	(1)	(2)	(3)	(4)
TSE REIT Index				
Overnight	-39.118 ***	-38.180 ***	-40.066 ***	-38.734 ***
	(-11.549)	(-11.937)	(-9.957)	(-10.487)
Mornig	-30.372 ***	-30.258 ***	-30.251 ***	-30.419 ***
	(-8.560)	(-8.539)	(-8.986)	(-9.241)
Lunchtime	33.814 ***	34.318 ***	37.120 ***	37.825 ***
	(3.424)	(3.510)	(3.889)	(4.071)
Afternoon	0.948	1.225	1.115	1.227
	(0.657)	(0.855)	(0.689)	(0.769)
Lagged Overnight		-5.696 ***		-3.921
		(-2.569)		(-1.447)
Lagged Morning		-2.464		-1.700
		(-1.369)		(-0.924)
Lagged Lunchtime		-12.949		-15.712
		(-1.445)		(-1.664) *
Lagged Afternnon		3.622		3.452
		(1.319)		(1.327)
TOPIX				
Overnight			1.006	0.530
			(0.592)	(0.311)
Mornig			-0.015	-0.016
			(-0.009)	(-0.010)
Lunchtime			-5.325	-5.993
			(-0.977)	(-1.085)
Afternoon			-0.156	0.247
			(-0.089)	(0.147)
Lagged Overnight				-1.229
				(-0.833)
Lagged Morning				-2.997 *
				(-1.951)
Lagged Lunchtime				5.151
				(1.054)
Lagged Afternnon				0.434
				(0.201)
N	1654	1654	1654	1654
Adjusted R-squared	0.336	0.341	0.335	0.341

Note: This table shows the estimation results of Equations (1) through (4). The dependent variable is the dummy variable for the BOJ's REIT purchases. The covariates are TSE-REIT Index and TOPIX returns during the overnight period (from 15:00 on the previous trading day to 09:00), the morning market (from 09:00 to 11:30), the lunchtime (from 11:30 to 12:30), and the afternoon market (from 12:30 to 15:00). Lagged returns are for the previous trading day. The sample period is from April 2013 to December 2019. The t-statistics are in parentheses based on Newey-West (1987) standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4
Linear probability model by sub-period

	Before QQE Oct. 2010-Mar. 2013	QQE before YCC Apr. 2013-Sep. 2016	QQE under YCC Oct. 2016-Dec. 2019
TSE REIT Index			
Overnight	-26.676 ***	-33.194 ***	-55.492 ***
	(-5.820)	(-9.038)	(-7.983)
Mornig	-6.664 *	-24.426 ***	-55.162 ***
	(-1.783)	(-9.256)	(-12.014)
Lunchtime	-3.742	34.285 ***	34.306 ***
	(-0.560)	(3.079)	(2.414)
Afternoon	9.331	0.618	3.496
	(1.629)	(0.351)	(0.935)
Lagged Overnight	2.089	-4.405	-3.489
	(0.530)	(-1.497)	(-0.740)
Lagged Morning	2.043	-0.434	-5.242
	(1.079)	(-0.214)	(-1.466)
Lagged Lunchtime	1.860	-19.957 *	1.278
	(0.374)	(-1.916)	(0.072)
Lagged Afternnon	4.770	3.714	-2.625
	(1.061)	(1.389)	(-0.793)
TOPIX			
Overnight	-4.498 *	-2.086	3.368
	(-1.929)	(-0.986)	(1.468)
Mornig	-4.597	0.380	-0.617
	(-1.610)	(0.211)	(-0.221)
Lunchtime	-5.200	-7.560	2.084
	(-0.740)	(-0.999)	(0.285)
Afternoon	3.631	0.685	-3.768
	(0.989)	(0.377)	(-0.862)
Lagged Overnight	-2.459	-2.141	0.534
	(-1.255)	(-1.162)	(0.269)
Lagged Morning	-1.192	-2.503	-2.319
	(-0.442)	(-1.334)	(-0.813)
Lagged Lunchtime	2.932	2.832	6.094
	(0.344)	(0.485)	(0.768)
Lagged Afternnon	-1.841	0.577	-1.656
	(-0.529)	(0.257)	(-0.410)
N	560	859	793
Adjusted R-squared	0.266	0.354	0.395

Note: This table shows the estimation results of Equation (4) by three subperiods. The dependent variable is the dummy variable for the BOJ's REIT purchases. The covariates are TSE-REIT Index and TOPIX returns during the overnight period (from 15:00 on the previous trading day to 09:00), the morning market (from 09:00 to 11:30), the lunchtime (from 11:30 to 12:30), and the afternoon market (from 12:30 to 15:00). Lagged returns are for the previous trading day. The sample period is from April 2013 to December 2019. The t-statistics are in parentheses based on Newey-West (1987) standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5

Linear probability model based on return decile dummies

Return Decile Groups	Overnight	Morning	Lunchtime	Afternoon
< 10th	0.526 ***	0.560 ***	0.152 ***	0.031
	(10.92)	(10.08)	(2.17)	(0.57)
10th-20th	0.287 ***	0.503 ***	0.015	-0.044
	(5.98)	(10.21)	(0.35)	(-0.91)
20th-30th	0.166 ***	0.256 ***	0.013	0.003
	(3.60)	(5.14)	(0.33)	(0.06)
30th-40th	0.026	0.081 **	0.035	-0.051
	(0.63)	(2.14)	(0.90)	(-1.08)
40th-50th	0.032	-0.002	0.075	-0.091 *
	(0.65)	(-0.06)	(1.77)	(-1.91)
50th-60th	Reference	Reference	Reference	Reference
	(omitted)	(omitted)	(omitted)	(omitted)
60th-70th	-0.123 ***	-0.063 **	0.069	0.006
	(-3.13)	(-2.16)	(1.62)	(0.12)
70th-80th	-0.133 ***	-0.109 ***	0.163 ***	0.004
	(-3.46)	(-3.73)	(4.00)	(0.08)
80th-90th	-0.126 ***	-0.119 ***	0.235 ***	0.049
	(-3.30)	(-3.79)	(4.92)	(0.96)
> 90th	-0.161 ***	-0.143 ***	0.303 ***	0.098 *
	(-3.82)	(-4.44)	(3.99)	(1.90)
N	1654	1654	1654	1654
Adjusted R-squared	0.210	0.272	0.032	0.008

Note: This table shows the estimation result of Equation (5). The dependent variable is the dummy for REIT purchases, and the independent variables are dummy variables for return decile groups. Return decile groups are calculated for each of the overnight period (from 15:00 on the previous trading day to 09:00), the morning market (from 09:00 to 11:30), the lunchtime (from 11:30 to 12:30), and the afternoon market (from 12:30 to 15:00). The sample period is from April 2013 to December 2019. The t-statistics are in parentheses based on Newey-West (1987) standard errors.

Table 6
Cox Hazard Model of Starting Decisions

	(1)		(2)	
Overnight	-0.018	***	-0.018	***
	(-12.93)		(-12.13)	
Morning	-0.011	***	-0.011	***
	(-11.51)		(-11.03)	
Lunchtime	0.014	***	0.014	***
	(2.48)		(2.39)	
Afternoon	-0.001		-0.001	
	(-0.83)		(-0.79)	
Lagged Overnight			-0.002	
			(-1.34)	
Lagged Morning			0.000	
			(-0.37)	
Lagged Lunchtime			0.001	
			(0.36)	
Lagged Afternoon			-0.001	
			(-1.01)	
N	1,222		1,222	

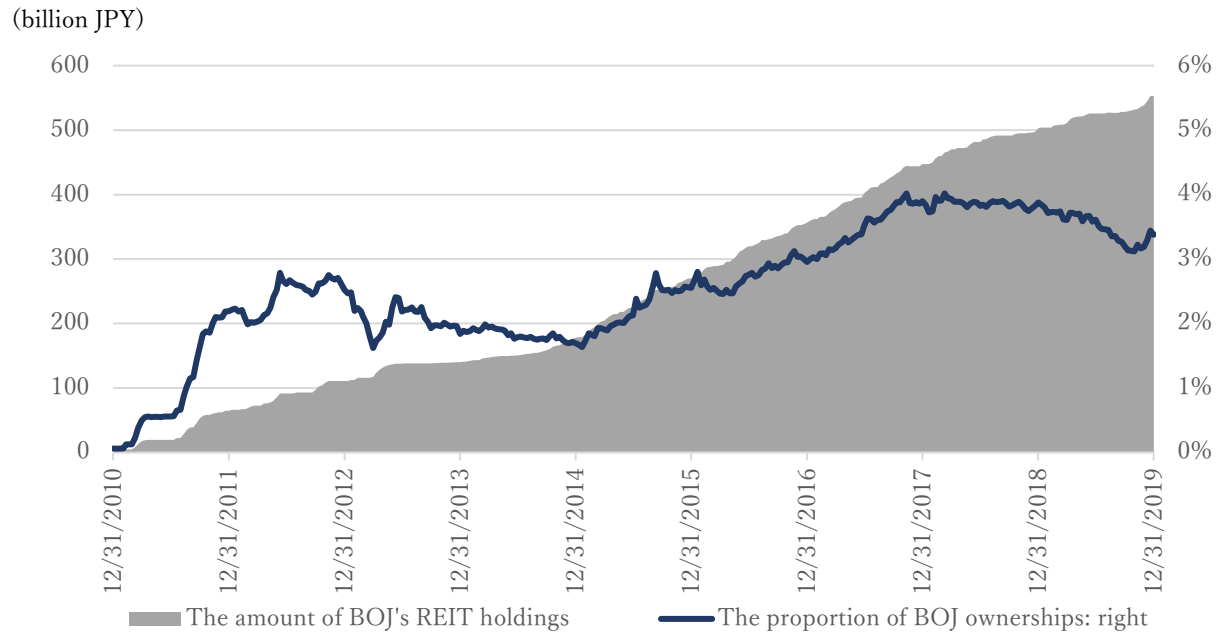
Note: This table shows the estimation result of Equation (6) for the Cox hazard model of starting decisions. A failure is defined as the start of the BOJ's REIT purchases after a period of inaction. REIT returns are measured in basis points. The sample period is from April 2013 to December 2019. The z-statistics are in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7
Cox Hazard Model of Stopping Decisions

	(1)	(2)
Overnight	0.004 ***	0.005 ***
	(3.47)	(3.81)
Morning	0.004 ***	0.004 ***
	(4.81)	(5.00)
Lunchtime	-0.001	-0.002
	(-0.12)	(-0.28)
Afternoon	0.000	0.000
	(-0.07)	(-0.38)
Lagged Overnight		0.003 **
		(1.97)
Lagged Morning		0.002
		(1.25)
Lagged Lunchtime		0.006
		(1.27)
Lagged Afternoon		-0.001
		(-1.50)
N	431	431

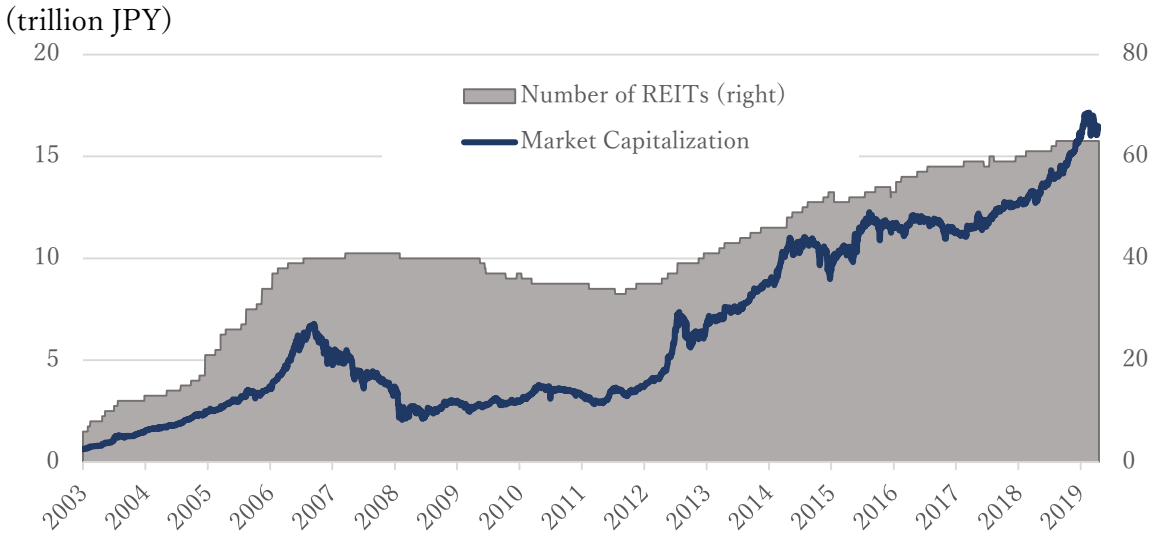
Note: This table shows the estimation result of Equation (6) for the Cox hazard model of stopping decisions. A failure is defined by the end of the BOJ's REIT purchases after consecutive daily purchases. REIT returns are measured in basis points. The sample period is from April 2013 to December 2019. The z-statistics are in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Figure 1
The BOJ's REIT holdings



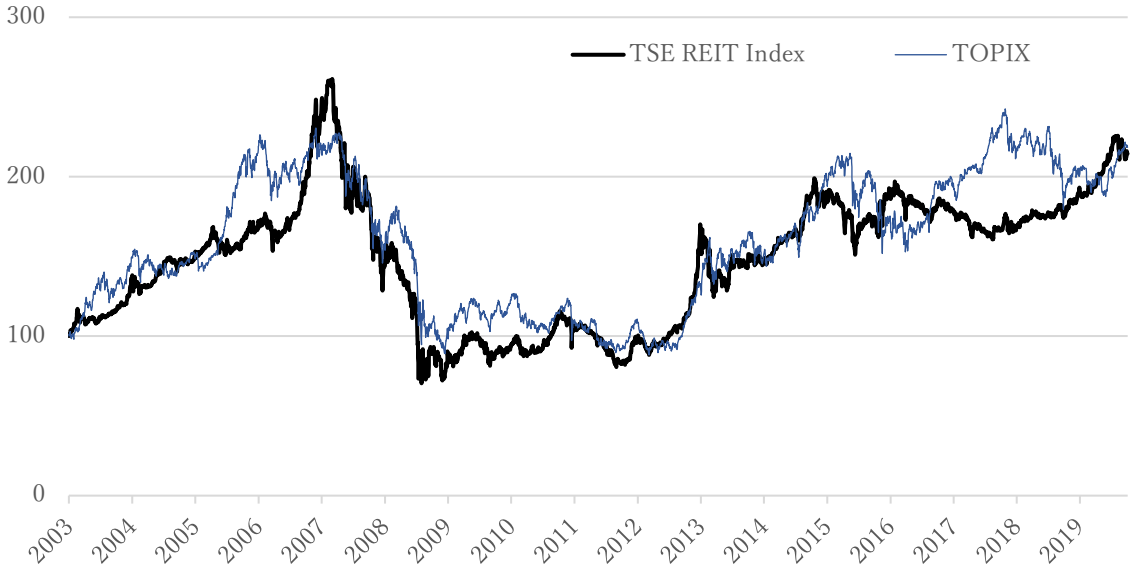
Source: Bloomberg

Figure 2
Number and Market Capitalization of REITs



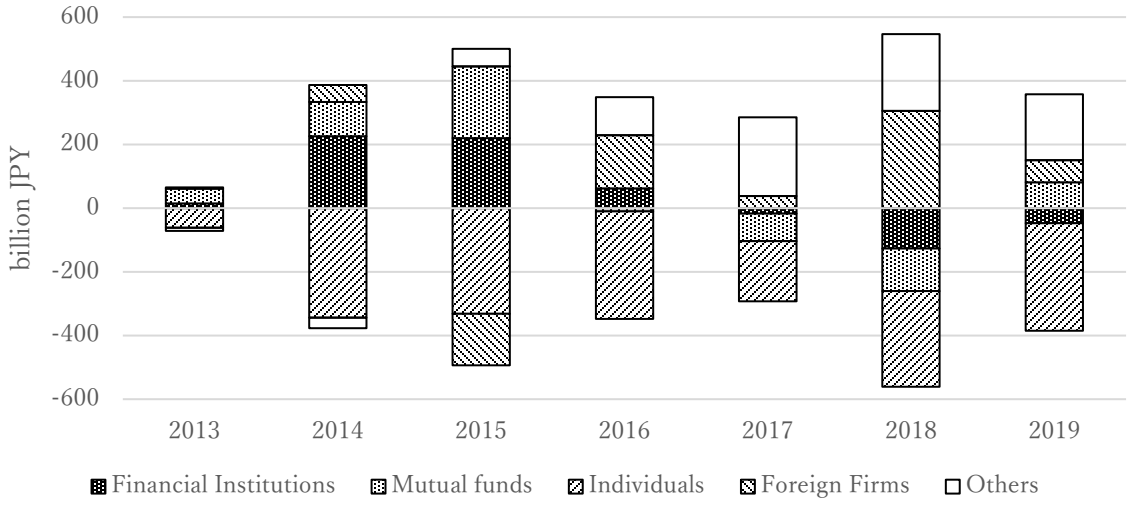
Source: Bloomberg

Figure 3
TOPIX and REIT price returns



Source: Bloomberg

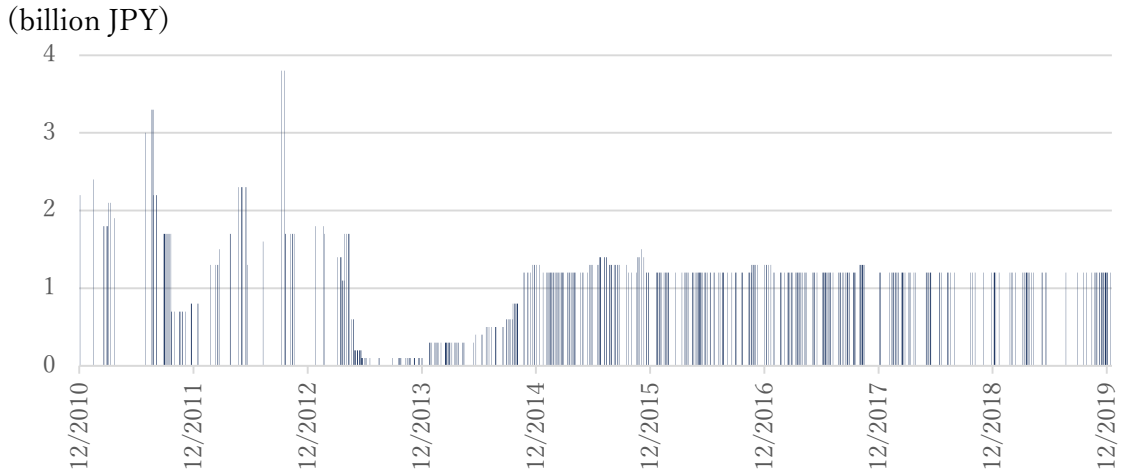
Figure 4
Net purchase amount by investor type



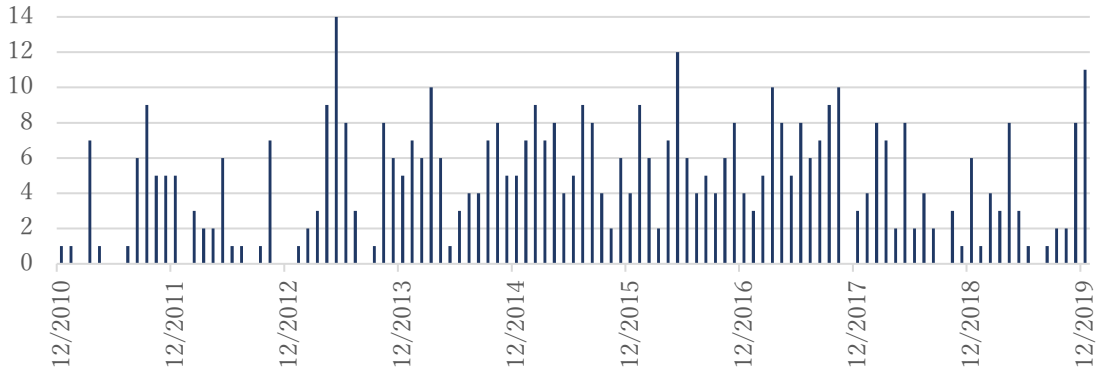
Source: Bloomberg

Figure 5
BOJ's REIT purchase operations

A. The size of daily operation



B. The number of operations for each month

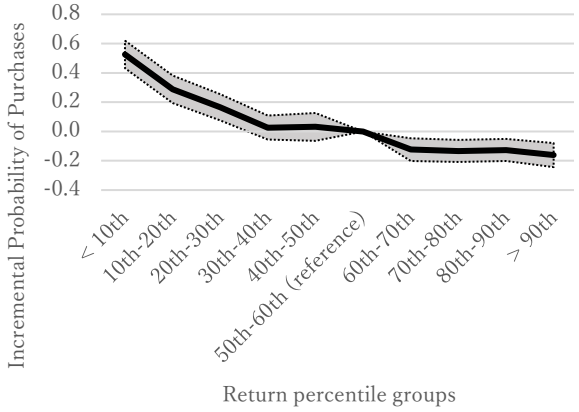


Source: BOJ

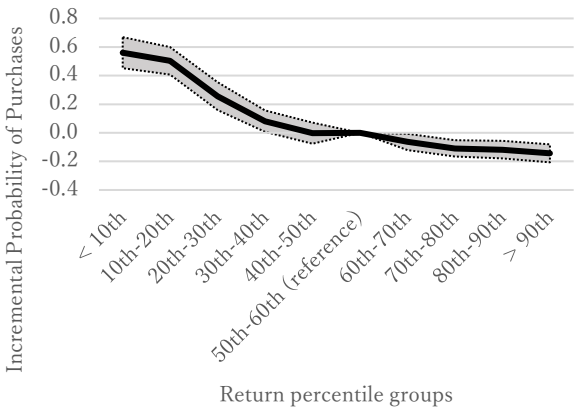
Figure 6

Incremental probability of purchases by return decile groups

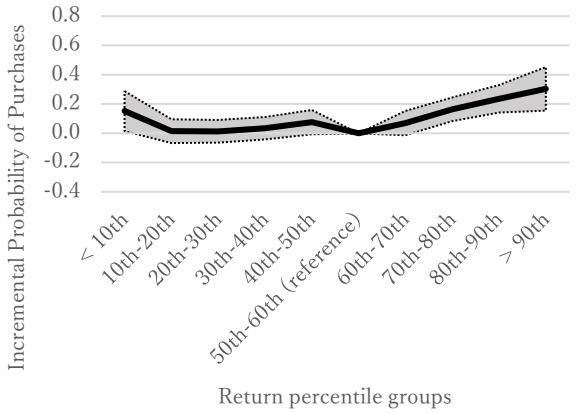
A. Overnight returns



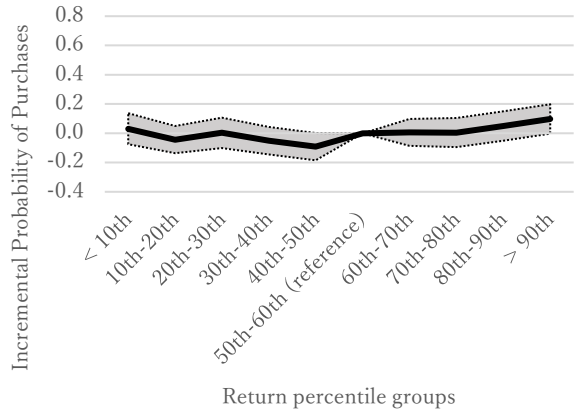
B. Morning returns



C. Lunchtime returns



D. Afternoon returns



Note: This figure depicts the estimated coefficients from Table 5. The vertical axis shows the incremental probability of BOJ's purchase relative to the baseline probability for the sixth decile group. Return decile groups are calculated for each of the overnight period (from 15:00 on the previous trading day to 09:00), the morning market (from 09:00 to 11:30), the lunchtime (from 11:30 to 12:30), and the afternoon market (from 12:30 to 15:00). The sample period is from April 2013 to December 2019.

Appendix

We estimate Equation (2) by using REIT spreads over TOPIX returns instead of controlling for TOPIX returns directly as in Equations (3) and (4). The result is consistent with that for Equations (4) shown in Table 3.

Linear Probability Model Based on REIT spreads over TOPIX returns

	Coefficient	Coefficient
overnight (spread)	-2.319	-1.983
	(-1.081)	(-0.938)
morning (spread)	-12.290 ***	-12.257 ***
	(-6.654)	(-6.339)
lunch (spread)	13.363 *	14.195 **
	(1.95)	(2.046)
afternoon (spread)	3.96 **	4.089 **
	(2.19)	(2.255)
L.overnight (spread)		1.784
		(1.033)
L.morning (spread)		-1.282
		(-0.817)
L.lunch (spread)		-0.799
		(-0.133)
L.afternoon (spread)		3.924 **
		(2.373)
N	1654	1654
Adjusted R-squared	0.046	0.048

Note: This table shows the estimation results of Equations (1) and (2) by replacing REIT returns with REIT spread over TOPIX returns. The dependent variable is the dummy variable for the BOJ's REIT purchases. Returns are measured during the overnight period (from 15:00 on the previous trading day to 09:00), the morning market (from 09:00 to 11:30), lunchtime (from 11:30 to 12:30), and the afternoon market (from 12:30 to 15:00). Lagged returns are for the previous trading day. The sample period is from April 2013 to December 2019. The t-statistics are in parentheses based on Newey-West (1987) standard errors. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.