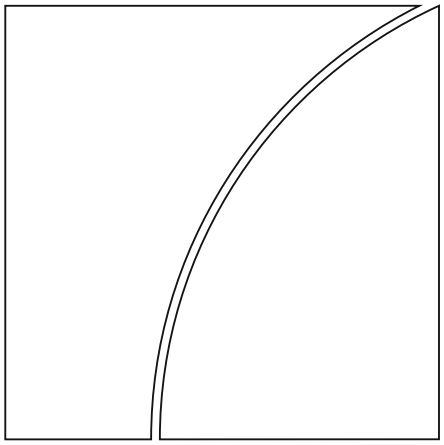

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by Mitsuru Katagiri, Junnosuke Shino and Koji Takahashi

Monetary and Economic Department

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To Lend or Not to Lend: The Bank of Japan's ETF Purchase Program and Securities Lending

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Abstract

This study investigates the effects of the Bank of Japan's (BOJ) exchange-traded fund (ETF) purchase program on stock returns, particularly focusing on the role of the stock lending market. Using firm-level panel data, we find that the BOJ's purchases raised stock returns more for those stocks with limited availability in the stock lending market. Nonetheless, over the longer term, the BOJ's accumulated purchases lowered lending fees and weakened the effects of their purchases on stock returns. This result suggests that ETF managers supply stocks that constitute ETFs held by the BOJ to the stock lending market, which weakens the policy effects of the program.

Keywords: Large-scale asset purchase (LSAP), ETF purchase program, stock lending market, Bank of Japan
JEL Classification codes: E58, G12, G14

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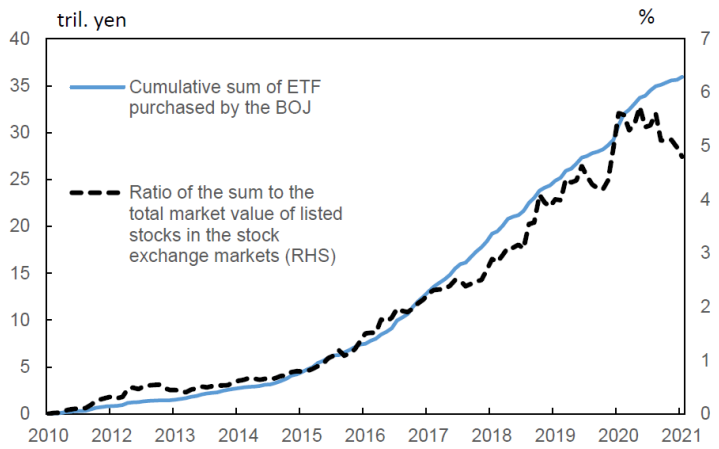
1 Introduction

On October 28, 2010, the Bank of Japan (BOJ) decided to establish a program to conduct outright purchases of various financial assets to stimulate the economy. This policy is quite unique as a monetary policy tool used by a central bank because exchange-traded funds (ETFs), that is, equities of private firms, were included in those assets. Starting with 0.45 trillion yen (about 6 billion USD), the BOJ has continuously increased the purchase amount, leading to a net increase of 34.8 trillion yen (about 0.3 trillion USD) at the end of 2018, which accounts for 6% of the total market value of all listed firms in Japan (Figure 1). The pronounced increase in the presence of the BOJ in the stock market has provoked discussions among economists and researchers on the BOJ's impact on the market structure. In particular, one of the most frequently asked questions is, to what extent does it affect stock prices by changing the demand–supply balance in the stock market? While some previous studies show significant effects of the program on Japanese stock prices, those results rely solely on the demand–supply situation in the spot market and almost completely ignore the role of the stock lending market.

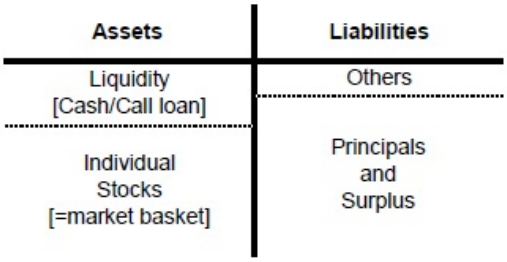
Figure 1: Cumulative amount of ETFs purchased by the BOJ



Source: Bank of Japan.

To fill this gap, this study investigates the effects of the ETF purchase program by shedding light on the demand–supply balance in both the spot and stock lending markets. In so doing, we focus on the two distinct features of the purchase program. First, the BOJ's ETF purchases under the program increase the creation of ETFs. As the market-tracking ETFs that the BOJ has been purchasing are nonsynthetic, ETFs need to hold a market basket to follow its mandate of minimizing tracking errors from the market returns. Therefore, the BOJ's ETF purchases inevitably result in increases in demand for individual stocks that constitute the ETFs, thus tightening supply–demand conditions in the stock market and possibly leading to overvaluation

Figure 2: Balance sheet of an ETF



or liquidity shortages of individual stocks.[1]

Second, ETF managers freely lend out their holding stocks that constitute ETFs purchased by the BOJ. To understand this, it should be noted that each ETF has its own balance sheet managed by an asset management company or ETF fund managers (Figure 2). The liability side of the balance sheet includes principals obtained by issuing beneficiary certificates. Under the BOJ's massive ETF purchase program, most of the certificates are held by the BOJ. On the asset side, the ETF holds the corresponding amounts of individual stocks to fulfill the mandate of minimizing tracking errors. This implies that the BOJ does not invest in individual stocks but holds ETFs backed by them. Under this framework, ETF fund managers have strong incentives to earn lending fees by supplying stocks in ETFs to the stock lending market. It is particularly true for ETFs held by the BOJ, given that the BOJ does not have plans to sell its ETF holdings and is considered a long-term ETF holder.[2] In fact, Figures A1 and A2 in Appendix 1 show that the upper limits of the stock lending ratios, defined as the number of lending shares to the total number of shares in ETFs, have increased over time as the purchase program continues.[3] Hence, our objective is to examine the possibility that stocks purchased by the BOJ under the program contribute to an increase in short selling by increasing the supply of lendable stocks, which eventually diminishes the policy effects of their purchases on stock returns.

In the empirical analysis, we investigate the effects of the BOJ's ETF purchase program on stock returns by considering the interconnectedness of the stock market and its associated stock lending market based on the following identification strategy. First, to identify the causal effects of the ETF purchase program by the BOJ on the stock and the lending markets, we exploit both time and cross-sectional variation in the amount of indirect purchases of each stock using

[1]Kalak et al. [20] show that as the BOJ purchases more ETFs and the BOJ's ownership of a firm increases, its stock illiquidity increases significantly.

[2]Empirically, Evans et al. [13] show that a fund manager who lends stocks constituting the fund earns higher returns. Blocher and Whaley [6] and Dunham et al. [12], focusing on stock lending patterns in ETFs, find that ETF managers have incentives to lend stocks to earn fees and offset the various costs of managing the fund.

[3]The figures in the Appendix strongly suggest such an upward shift in the ratio. For a more detailed discussion, see Maeda, Shino and Takahashi [24].

firm-level panel data for the stock spot market and the associated stock lending market. The BOJ has changed the amount of indirect purchases and targeted types of ETFs in our sample period, which allows us to identify the causal effects as described in Section 3.1. In our panel regression at the individual stock level, we control time- and firm-fixed effects and provide robust evidence of the policy effects. Second, to identify the effect through the stock lending market, we define a "special" stock as one with high stock lending fees following Blocher et al. [5]. Then, by comparing the impacts on special and non-special stocks, we examine the effect through the stock lending markets.

Our empirical analysis shows evidence of the two channels through which the ETF purchase program affects stock markets: the direct channel and the lending channel. First, we find that the ETF program has a positive effect on stock returns by shifting upward the demand curve in the stock market, which we call the "direct channel." In particular, we find that the BOJ's purchases have more significant effects on stock returns for those stocks with limited availability in the stock lending market. This result implies that investors borrowed overvalued stocks in the stock lending market and sold them in the stock market in response to the BOJ's ETF purchases. Next and more intriguingly, we empirically show that, over longer periods, the BOJ's accumulated purchases lowered lending fees in the stock lending market and weakened the effects of the BOJ's purchases on stock returns, particularly for those stocks with limited availability in the stock lending market. This result suggests that the accumulated purchases by the BOJ increased the supply of lendable shares in the stock lending market, thus diminishing the policy effect of the ETF purchase program. We call the rightward shift of the supply curve in the lending market the "lending channel." These results on the lending channel indicate that the intended effects of the BOJ's ETF purchase program on stock returns were somewhat offset by the increased supply of lendable shares in the stock lending market through the response of ETF managers.

Our study relates to two different research fields: the effects of large-scale asset purchases (LSAPs) and the roles and functions of stock lending markets. Regarding the effects of LSAP programs on asset markets, most previous studies focus on fixed-income security markets such as government bonds and asset-backed securities (e.g., Krishnamurthy and Vissing-Jorgensen [23], Hancock and Passomore [15], and D'Amico and King [8]). Regarding the effects of the BOJ's Quantitative and Qualitative Easing (QQE) policy introduced in April 2013, Ueda [31] and Matsuki et al. [25] argue that QQE, including the ETF purchases, had a large impact on asset prices or real economic activity, but they do not consider the effects of the ETF purchase program separately. Furthermore, while several studies show that the ETF purchase program had

positive effects on individual stocks (e.g., Barbon and Gianinazzi [2], Katagiri et al. [22], Harada and Okimoto [16], Charoenwong et al. [7], Katagiri et al. [21], Hattori and Yoshida [17], Maeda et al. [24], and Shirota [30]), these studies, however, ignore the role of the stock lending market in assessing the policy effects. Regarding the functions of stock lending and its interactions with the spot stock market, the most related study in the literature is by Blocher et al. [5], which provides a theoretical basis for our empirical analysis. They study the interconnectedness of the stock market and its associated equity lending market and clarify the mechanism through which equity returns, especially those for hard-to-borrow stocks, are affected by changes in supply in the stock lending market. Relatedly, several previous studies focus on the effects of short-selling restrictions on stock prices or volatilities and find that such restrictions lead to overvaluation and higher volatility (e.g., Jones [19], Miller [26], Hong and Stein [18], and Abreu and Brunnermeier [1]), while they do not prevent stock prices from falling further in a crisis period (Beber and Pagano [3]).[4] Furthermore, some empirical studies focus on how the trading volume in the stock lending market influences stock prices and find that stock lending does significantly affect price formation and volatility in spot markets (e.g., Seneca [29], Figlewski [14], Reed [27], Duffie [10], and Duffie et al. [11]).

The rest of this paper is organized as follows. Section 2 presents a conceptual framework to examine the impacts of ETF purchases on the stock and lending market and establishes some testable hypotheses. Section 3 empirically tests the hypotheses using firm-level panel data for Japanese firms, and Section 4 concludes.

2 Conceptual framework and testable hypotheses

In this section, first, we briefly review the structure of the stock lending market. Then, we establish several testable hypotheses regarding the effects of the BOJ's ETF purchase program on stock returns as well as stock lending fees. To do so, we use the reduced-form framework of Blocher et al. [5] to analyze the functions of the stock lending market and their impact on stock returns.

2.1 Structure of stock lending market

We briefly review the basic structure of a stock lending market.[5] The primal function of the stock lending market is to match a short seller, an investor who wants to sell a stock short, with

[4]Some empirical studies argue that such restrictions do not have strong effects (e.g., Boehmer et al. [4] and Diamond and Verrecchia [9]).

[5]The following description is based on market survey papers such as Reed [28].

a stock owner who is willing to lend her shares for a fee. When a short seller finds a stock owner, usually with a market maker's assistance, this short seller borrows stocks from the stock owner and sells the stocks to a stock buyer in the spot stock market. The proceeds from this short selling are deposited with the stock owner as collateral. The collateral is evaluated and marked to market on a daily basis and returns to the short seller when the term ends, i.e., when the stocks return to the owner.

In general, stock lenders receive lending fees from stock borrowers. When the supply of lendable shares is limited compared with borrowing demands, lending fees become high. We call a stock with high lending fees "on special" or a "special stock," and call a stock with low lending fees "not on special" or a "non-special stock." In market practice, the lending fee is sometimes called an indicative fee. Hereafter, we will use the terms of lending fee, borrowing cost, and indicative fee interchangeably. To identify the effects of the BOJ's ETF purchase program, especially those produced via the stock lending market and its interconnectedness with the stock market, we focus on the differences between special and non-special stocks in the subsequent analysis.

2.2 Model: Stock market and stock lending market

Blocher et al. [5] consider two markets and their interconnectedness: the (spot) stock market and the stock lending market. In their baseline model, which does not contain the BOJ's program, the equilibrium conditions for the respective markets are simply expressed as follows:

$$(\textit{Stock market}) \qquad D_L(\overset{(-)}{p}, \overset{(\cdot)}{p_s}) + D_S(\overset{(-)}{p}, \overset{(+)}{p_s}) = N \tag{1}$$

$$(\textit{Lending market}) \qquad \begin{cases} r(\overset{(+)}{p_s}) D_L(\overset{(-)}{p}, \overset{(\cdot)}{p_s}) = -D_S(\overset{(-)}{p}, \overset{(+)}{p_s}) & if \quad p_s > 0. \\ r(\overset{(+)}{p_s}) D_L(\overset{(-)}{p}, \overset{(\cdot)}{p_s}) > -D_S(\overset{(-)}{p}, \overset{(+)}{p_s}) & if \quad p_s = 0. \end{cases} \tag{2}$$

$p \geq 0$ is the stock price and $p_s \geq 0$ is the lending fee. $D_L(p, p_s)$ denotes the number of shares demanded by long investors at p and p_s, while $D_S(p, p_s)$ is the negative of the number of shares sold by short investors (i.e., aggregate short demand). N is the number of outstanding shares. The ratio $r(p_s) \in [0, 1]$ is the ratio of shares available for stock borrowing to the total shares owned by long investors. Following Blocher et al. [5], the following assumptions are made: (i) $D_L(p, p_s)$ is decreasing in p (long investors demand less when prices are higher) and independent from p_s, (ii) $D_S(p, p_s)$ is decreasing in p and increasing in p_s (the size of short demands $-D_S$ increase as the share price increases or lending fee decreases), and (iii) $r(p_s)$ is increasing in p_s (the ratio of shares available for stock borrowing increases as the lending fee increases).

Figure 3: Stock market and stock lending market (special stock)

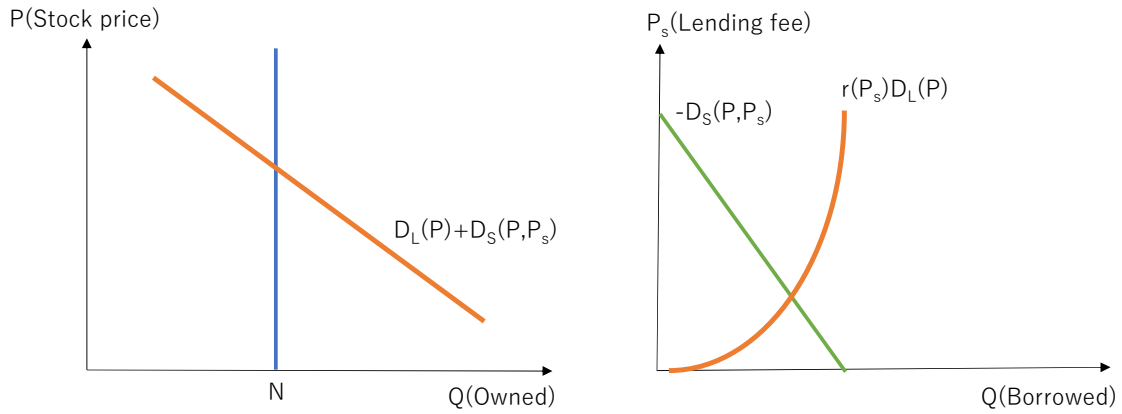
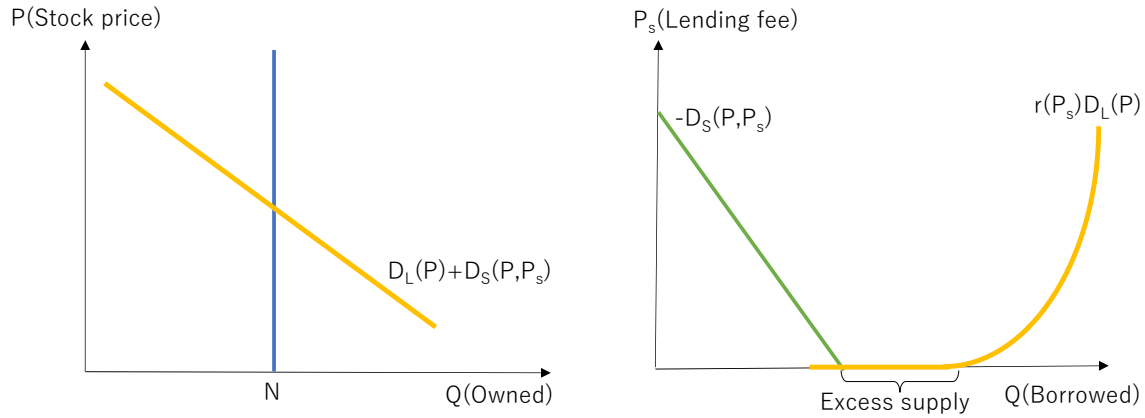
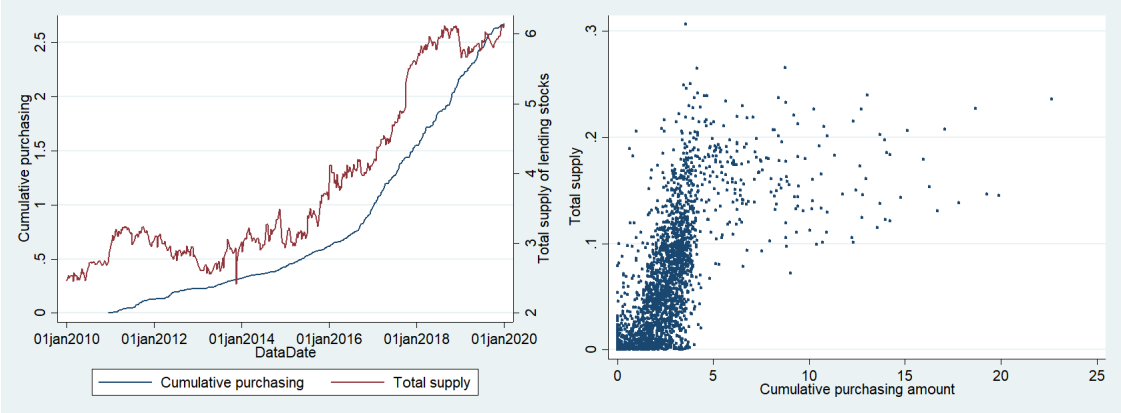


Figure 4: Stock market and stock lending market (non-special stock)



Note: The left panel of Figure 3 (and that of this Figure 4) shows a graphical image of the equilibrium for the stock market, in which the (net) demand curve $D_L(\cdot) + D_S(\cdot)$ is expressed as a downward-sloping curve, while the supply curve is a vertical line fixed at N. The right panels in Figure 3 (and that of this Figure 4) shows a graphical image of the equilibrium for the stock lending market for special and non-special stocks, respectively.

Figure 5: Cumulative purchase amount and lending stock supply



Note: In the left-hand panel, the blue line shows the median cumulative purchases of stocks, and the red line indicates the total supply of stocks available in the lending market. Both are shown as a ratio to the market capitalization of each stock. The right panel shows the scatter plot of the cumulative purchase amount and the stocks available for lending on December 30, 2019.

The equilibrium for the stock market and the equity lending market is characterized as follows. First, the equilibrium condition for the stock market (i.e., equation (1)) simply states that the number of shares demanded must equal the number of shares outstanding. The left panel of Figure 3 (and that of Figure 4) shows a graphical image of the condition, in which the (net) demand curve $D_L(\cdot) + D_S(\cdot)$ is expressed as a downward-sloping curve, while the supply curve is a vertical line fixed at N. Second, the equilibrium condition for the equity lending market (i.e., equation 2) is expressed as two different cases depending on levels of the lending fee p_s. The first case is $p_s > 0$, i.e., the stock is on special, and the second case is $p_s = 0$, i.e., the stock is not on special. In the lending market, the supply of borrowable shares is the ratio of shares that long investors choose to lend out multiplied by the number of shares held by them, i.e., the left-hand side of equation (2). If many stock owners make shares available even when $p_s = 0$, then an excess supply exists in the lending market. In this case, the second case of equation (2) holds: the equity lending constraint is slack. If, on the other hand, the equity lending constraint binds for some $p_s > 0$, the first case holds. For graphical images of those cases, see the right panels in Figures 3 and 4.

2.3 Hypotheses: The effects of the BOJ's purchases on stock prices and lending fees

Using the abovementioned framework, we establish several testable hypotheses on the short-run and long-run effects of the BOJ's ETF purchases on stock returns and lending fees. In the short run, the BOJ's ETF purchases increase the demand in the stock market, i.e., shift the demand curve rightward, and raise stock prices. We call this channel the "direct channel." Furthermore, in the long run, in addition to the short-run direct effects, the BOJ's ETF purchases

may increase the available stocks for borrowing in the lending market, as ETF managers supply stocks that constitute the ETFs purchased by the BOJ to the lending market. As we argue in Section 1, under the BOJ's ETF purchase program, ETF managers have a strong incentive to do this. Indeed, a clear relationship between the amount of BOJ's ETF purchases and the lendable shares is observed in the data. The left panel in Figure 5 shows the median value of the BOJ's cumulative purchases and stock lending supply. It shows that as the cumulative purchases increase, the supply of stocks available for borrowing increases. In addition, regarding the cross-sectional variation, the right panel in Figure 5 shows that they are positively correlated as well, suggesting that the BOJ's ETF purchases increase the amount of available stocks for borrowing in the lending market. We call this rightward shift of the stock lending supply curve, which occurs in the medium- to longer-term, the "lending channel."

More specifically, let $x > 0$ be the amount of ETFs purchased by the BOJ. Then, in the short run, the equilibrium conditions for the respective markets are expressed as follows:

$$(\textit{Stock market}) \qquad D_L(\overset{(-)}{p}, \overset{(\cdot)}{p_s}) + x + D_S(\overset{(-)}{p}, \overset{(+)}{p_s}) = N \tag{3}$$

$$(\textit{Lending market}) \qquad \begin{cases} r(\overset{(+)}{p_s}) D_L(\overset{(-)}{p}, \overset{(\cdot)}{p_s}) = -D_S(\overset{(-)}{p}, \overset{(+)}{p_s}) & if \quad p_s > 0. \\ r(\overset{(+)}{p_s}) D_L(\overset{(-)}{p}, \overset{(\cdot)}{p_s}) > -D_S(\overset{(-)}{p}, \overset{(+)}{p_s}) & if \quad p_s = 0. \end{cases} \tag{4}$$

For the stock market, equation (3) means that the number of shares outstanding must equal the sum of investors' short- and long-positions, plus the number of shares indirectly purchased by the BOJ under the program. The first and second lines of equation (4) are the equilibrium conditions in the lending market when associated stocks are special and non-special, respectively, and in the short run, they are identical to equation (2).

With this simple and tractable framework, we establish the following hypotheses about the effects of the BOJ's ETF purchases in the short run. First, we focus on the effects of the ETF purchases on stock returns (Figure 6). In the stock market, the BOJ's purchases of ETFs directly raise stock returns, irrespective of specialness or non-specialness, as presented by (i) in Figure 6. This rightward shift of the demand curve stemming from BOJ purchases in the stock market, i.e., the direct channel, establishes the following hypothesis related to this channel.

- **Hypothesis R.0.: The BOJ's ETF purchases increase stock returns for both special and non-special stocks.**

It should be noted that the existing literature aiming to capture the policy effects of the BOJ program on stock returns focuses mainly on this hypothesis (Barbon and Gianinazzi [2], Charoenwong et al. [7], Harada and Okimoto [16], and Hattori Yoshida [17]).

Figure 6: Effects of ETF purchases (special stocks)

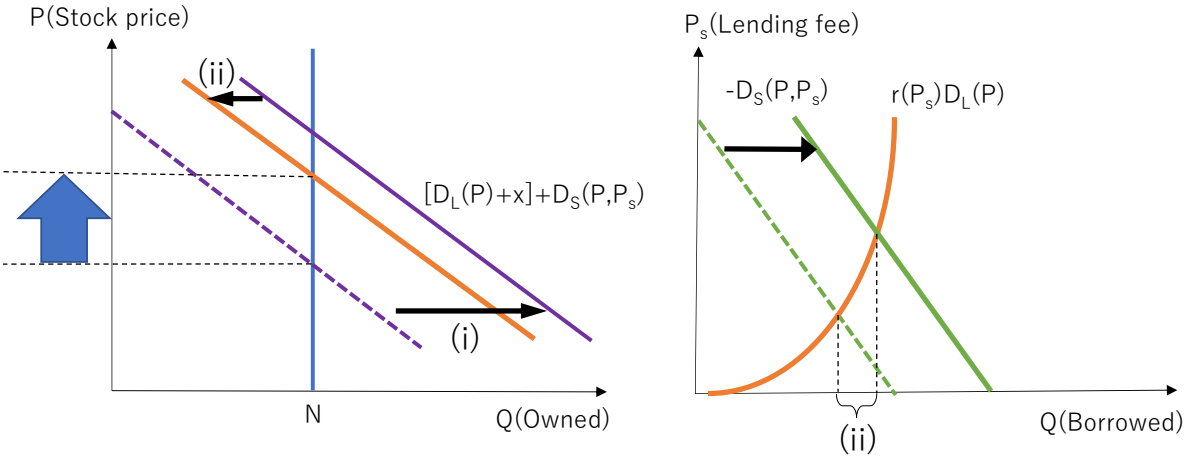
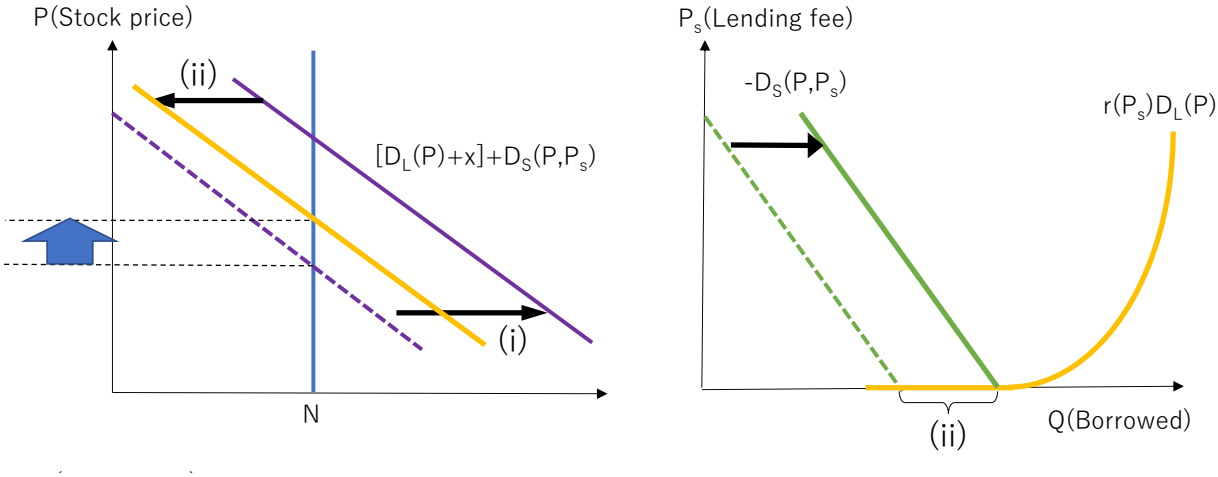


Figure 7: Effects of ETF purchases (non-special stocks)



Note: The left panel shows the demand and supply curves in the stock market, and the right panel shows the demand and supply curves in the lending market. The rightward shift of the demand curve in the stock market, i.e., arrow (i), describes the "direct channel" of the BOJ's ETF purchases. The rightward shift of the demand curve in the lending market, i.e., arrow (ii), describes the increase in stock borrowing demand in response to overvaluation stemming from the BOJ's ETF purchases, which somewhat push back the stock price through the increase in short selling.

We then consider the role of the stock lending market in examining the effects of the BOJ's ETF purchases. In general, when the stock price is considered overvalued because of the BOJ's ETF purchases, investors have the incentive to borrow stocks in the lending market and sell them in the stock market, which somewhat pushes back the effects of the BOJ's ETF purchases on stock prices, as described by (ii) in Figures 6 and 7. For the special stocks in Figure 6, however, given that the supply of lendable stocks is relatively limited, the effects of pushing back the stock price through short selling, i.e., arrow (ii), are not large. Hence, their stock price increases in response to the BOJ's ETF purchases are expected to be relatively large. For the non-special stocks in Figure 7, on the other hand, given the excess supply in the lending market, the effect of pushing back the stock prices is larger than that for the special stocks. That is, the size of the shift (ii) in Figure 7 is larger than that in Figure 6, even though the size of the shift of the demand curve in the lending market, i.e., the shift of $-D_s(p, p_s)$, is the same for these two types of stocks. Thus, the increases in stock prices in response to the BOJ's ETF purchases are expected to be smaller for the non-special stocks in Figure 7 than those for the special stocks in Figure 6, shown by the blue arrows in the figures. In sum, regarding the short-term effects of the BOJ's ETF purchases on stock returns, including those via the stock lending market, the following hypothesis is established:

- **Hypothesis R.1. The BOJ's ETF purchases increase the returns of the special stocks more than those of the non-special stocks.**

In other words, hypothesis R.1. argues that the BOJ's ETF purchases do not have large effects on the non-special stocks' returns because investors borrow stocks in the lending market and sell them in the stock market in response to the overvaluation of those stocks caused by the BOJ's purchases.

Next, we examine the longer-term effects of ETF purchases on stock returns. Given x amounts of the BOJ's ETF purchases, which can be interpreted as a long position held by the BOJ, the number of shares offered in the lending market increases from $D_L(p, p_s)$ to $D_L(p, p_s) + x$ in the long run. Thus, the equilibrium conditions after the BOJ's ETF purchases are

$$(\textit{Stock market}) \qquad D_L(\overset{(-)}{p}, \overset{(\cdot)}{p_s}) + x + D_S(\overset{(-)}{p}, \overset{(+)}{p_s}) = N \tag{5}$$

$$(\textit{Lending market}) \qquad \begin{cases} r(\overset{(+)}{p_s}) D_L(\overset{(-)}{p}, \overset{(\cdot)}{p_s}) + r_x(\overset{(+)}{p_s}) x = -D_S(\overset{(-)}{p}, \overset{(+)}{p_s}) & if \quad p_s > 0. \\ r(\overset{(+)}{p_s}) D_L(\overset{(-)}{p}, \overset{(\cdot)}{p_s}) + r_x(\overset{(+)}{p_s}) x > -D_S(\overset{(-)}{p}, \overset{(+)}{p_s}) & if \quad p_s = 0. \end{cases} \tag{6}$$

Here, we expect that the fraction of lendable stocks for a given p_s is higher for the stocks purchased by the BOJ, i.e., $r_x(p_s) \geq r(p_s)$ for a given p_s. As we argue in Section 1, under the BOJ's

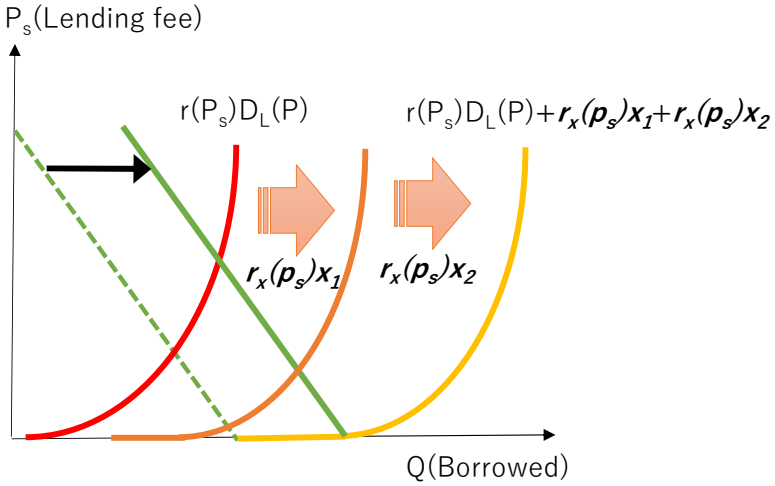
ETF purchase program, ETF managers have more incentive to lend stocks than other investors for a given p_s, which increases the stock lending supply further. Hence, the equilibrium condition (6) implies that the BOJ's ETF purchases increase the supply of lendable stocks and shift the supply curve in the lending market rightward in the long run, as presented in Figure 8). We call the longer-term effects of the BOJ's ETF purchases the "lending channel." Importantly, as shown in Figure 8, the lending channel possibly has different effects on the special stocks and the non-special stocks. For the special stocks, the additional supply of lendable stocks through the lending channel would stimulate short selling, as the supply of lendable stocks is limited in the first place, thus exerting more downward pressure on stock returns in response to overvaluation. Hence, as the BOJ's ETF purchases proceed, the size of the pushing back effects through short selling for special stocks, i.e., arrow (ii) in Figure 6, increases in the long run and becomes close to that for non-special stocks, as shown in Figure 8. For non-special stocks, on the other hand, the effects of the lending channel are negligible, as the excess supply of lendable stocks exists from the beginning. In sum, as for the longer-term effects of the BOJ's ETF purchases on stock returns, we establish the following hypothesis:

- **Hypothesis R.2.: As the BOJ's ETF purchases proceed, the effect of ETF purchases, which increases the returns of special stocks, is reduced.**

In Subsection 3.3, we empirically investigate the validity of Hypothesis R.2.—whether the lending channel works under the program—by considering whether triple interactions of a (one-shot) ETF purchase, the cumulative amount of ETF purchases, and the dummy variable representing specialness have an impact on weekly cumulative stock returns.

Finally, we discuss the shorter- and longer-term effects of the BOJ's ETF purchases on lending fees. For the special stocks, on the one hand, the increase in lendable shares because of the BOJ's ETF purchases, i.e., the lending channel, is expected to lower lending fees in the lending market. Lending fees for the special stocks are, by construction, at a higher level, as the supply of lendable stocks is limited, and as a result, their demand–supply condition is tight. Therefore, as shown in Figure 8, as BOJ's ETF purchases proceed, downward pressures exert on lending fees for the special stocks. Furthermore, the negative impact on lending fees through the lending channel is expected to be more apparent in longer terms for the following reasons. First, as discussed in the effects on returns, ETF managers probably need some time to supply stocks that constitute ETFs purchased by the BOJ to the lending market. Second, over a shorter time horizon, the downward pressure on lending fees from an increase in the supply of lendable stocks, i.e., the effects through the lending channel, may be offset by the upward pressure from an increase in demand for short selling in response to overvaluation (see Figure 6). On the other

Figure 8: Lending channel: Shift of lendable stock supply curve



Note: The figure presents the shift of the lendable stock supply curve induced by the increase in the supply of lendable stocks through the BOJ's ETF purchases, i.e., the "lending channel."

hand, for the non-special stocks, downward pressure on lending fees does not exist both in the short and long terms, as there is no room for their lending fees to be lowered by definition. In sum, regarding the effect of the BOJ's ETF purchases on lending fees, we establish the following hypothesis.

- **Hypothesis F: The BOJ's ETF purchases lower lending fees of the special stocks in the medium to longer term.**

In the next section, we examine Hypothesis F using the data on lending fees for the special and non-special stocks for several different time horizons.

3 Empirical analysis

In this section, we empirically test our hypothesis by examining the effect of the ETF purchase program on the stock market and the stock lending market. After describing the BOJ's ETF purchase program and some properties of the program in relation to our identification strategy in Subsection 3.1, we construct the dataset in Subsection 3.2. Subsection 3.3 investigates the impacts of the program on the returns of special and non-special stocks, and Subsection 3.4 examines the effects of the program on stock lending fees. Subsection 3.5 provides policy insights based on our findings.

3.1 Bank of Japan's ETF purchase program

In October 2010, the BOJ decided to establish a program to conduct outright purchases of various financial assets, including equity market-tracking ETFs. Although the initial target amount was relatively small, 0.45 trillion yen (about 6 billion USD), the target has increased several times since its introduction.[6] With the introduction of QQE in April 2013 and its expansion in October 2014, it was decided to increase the target to 1 and 3 trillion yen, respectively. After some more expansions, the target is set to 12 trillion yen in March 2023.

In relation to our identification strategy, it should be noted that under this program, the BOJ has purchased different types of market-tracking ETFs: Nikkei 225-tracking and TOPIX-tracking ETFs. Regarding the ratios of the individual stocks' weights in Nikkei 225 relative to those in TOPIX, there exist substantial differences among individual stocks for the following two reasons. First, Nikkei 225 covers only 225 stocks listed in the first section of TSE. Therefore, large gaps exist between stocks included in Nikkei 225 and those included only in TOPIX. Second, Nikkei 225 is a price-weighted equity index rather than a market value-weighted index, which makes the ratio vary even among stocks included in Nikkei 225. Therefore, by purchasing both Nikkei 225-tracking ETFs and TOPIX-tracking ETFs, the BOJ's purchases relative to total market values differ substantially across individual stocks, especially until September 2016, when the share of purchases of Nikkei 225-tracking ETFs was reduced. In other words, if the BOJ purchased stocks so that the purchase amount perfectly followed the share of each stock in the market portfolio, it would be difficult to identify the policy effects utilizing the heterogeneous effects across individual stocks.[7]

Our empirical study utilizes this cross-sectional variation in the ratios to identify the effect of the BOJ's ETF purchase program, focusing on differences between special stocks and non-special stocks. In particular, including time-fixed effects enables us to control for the average effects of the ETF purchases across all stocks, as well as the effects of any macroeconomic news and shocks. Therefore, our specification is relatively robust to the omitted variable problem compared with empirical studies using only time series variations.

3.2 Dataset

To identify the effects of the BOJ's ETF purchases and the associated hypotheses discussed in the previous section, we construct a panel data consisting of (i) the equity lending market data,

[6] For a more detailed description of the transition of the ETF purchase program, see Appendix 3.

[7] Some previous empirical studies utilized the fact that the BOJ has purchased different types of market-tracking ETFs and pointed out that the equity prices of stocks included in Nikkei 225 are boosted by the program (e.g., Harada and Okimoto [16]).

(ii) the amount of individual stock that the BOJ indirectly purchased through the ETF purchase program, and (iii) other financial market and firm characteristics data. The frequency of the dataset is weekly, and the sample period covers from 2011 to 2019.

Regarding the equity lending market data, we examine the effects of the ETF purchase program on lending fee (***Lending_Fee***), i.e., the price in the lending market. In this study, we employ an indicative fee released by IHS Markit, the borrowing cost calculated using borrowing costs between lenders and prime brokers, as well as the rates from hedge funds to produce an indication of the current market rate.

Next, we construct BOJ's ETF purchase data. More particularly, the ratio of the amount indirectly purchased by the BOJ through the program to the total market value of stock i in period t, denoted by ETF_{it}, is calculated as follows:

$$ETF_{it} = ETFV_{it}/MCAP_{it}, \tag{7}$$

where $ETFV_{it}$ is the amount of stock i indirectly purchased by the BOJ at t. $ETFV_{it}$ is calculated from the daily purchase amount of TOPIX- and NKY225-tracking ETFs by the BOJ as follows:

$$ETFV_{it} = BOJTopix_t \times WTOPIX_{it} + BOJNKY_t \times WNKY_{it}, \tag{8}$$

where $BOJTopix_t$ and $BOJNKY_t$ indicate the values of TOPIX-tracking ETFs and Nikkei225-tracking ETFs purchased by the BOJ, respectively. We originally computed those values by utilizing publicly available information on the ETF purchase program and market values of each type of ETF. $WTOPIX_{it}$ and $WNKY_{it}$ are stock i's weight of TOPIX and NKY225 at time t, respectively, obtained from Bloomberg. For a more detailed description of the construction of the unique panel data $ETFV_{it}$, see Katagiri et al. [22]. In the regression with stock returns as a dependent variable, we use the weekly purchase amount of each stock. More precisely, by aggregating the daily values of ETF_{it} from a week (five business days) before day t to t, we calculate the weekly purchase amount. To save notation, we denote ETF_{it} as the weekly purchase amount hereafter.

We also use data for financial market and firm characteristics, which are available from Bloomberg. The set of control variables used for our panel regression analysis includes the free-floating rate (***frate_stock***, measured by %), the logarithm of turnover (***log_turnover***) in the stock market, the logarithm of market capital (***log_marketcap***), dividend yield (***DIVY***, measured by %), and the logarithm of PER (***log_per***).

Finally, to examine the effects of the program on stock prices through the lending channel, in

Subsection 3.3 we regress weekly cumulative stock return (**CR**) of individual stock i on double and triple interactions of variables related to the BOJ's ETF purchase of stock i and dummy variable representing specialness, together with numerous firm characteristics as control variables. Weekly cumulative stock return of stock i at t is defined as the cumulative daily total returns of stock i from one week (five business days) before date t up to t.

Table 1 reports summary statistics of the data by year. For the dependent variables, the mean, median, and standard deviation by special and non-special stocks are also presented. Regarding the amount of ETF purchases, ETF_{it} defined in equation (7) is denoted by ETF_1w in the table. The table indicates that the distribution of lending fees is skewed rightward and that lending fees for special stocks are higher than those for non-special stocks by more than two standard deviations. Consistent with our definition of special stocks following Blocher et al. [5], this distribution of lending fees suggests that lending fees for most stocks are very small, i.e., there is slack in the lending market, and those for only a small fraction of stocks are significantly higher than others. On the other hand, the table also shows that the returns of special and non-special stocks are not significantly different.

3.3 Effects on stock returns

This subsection empirically examines our hypotheses regarding the effects of ETF purchases on stock returns established in the previous sections, i.e., **Hypotheses R.0., R.1.,** and **R.2**. Specifically, we consider the following panel regression model, in which a weekly cumulative stock return of individual stock i is the dependent variable, and double and triple interactions of the BOJ's ETF purchases and a dummy variable for specialness are included:

$$\begin{aligned} CR_{it} &= \beta_0 ETF_{it} + \beta_1 SP_{it-1} \times ETF_{it} + \beta_2 CumETF_{it-1} \times ETF_{it} + \beta_3 SP_{it-1} \times CumETF_{it-1} \times ETF_{it} \\ &\quad + \alpha_i + TimeFE_t + \gamma Control_{it} + \epsilon_{it}. \end{aligned} \tag{9}$$

CR_{it} is the weekly cumulative stock return defined in the previous subsection. ETF_{it} is the ratio of the amount purchased by the BOJ to total market value, as defined in equation (7) and aggregated as a weekly sum. $CumETF_{it-1}$ is the cumulative sum of $ETF_{i\tau}$ from the start of the sample period (beginning of 2011) to $t-1$. SP_{it-1} is a dummy variable that takes the value of one if stock i is special at $t-1$ and zero otherwise. Following Blocher et al. [5], stock i is defined as a special one at time t if the associated lending fee is higher than the 90th percentile. α_i is firm (stock)-fixed effects and $TimeFE_t$ is time-fixed effects. By including $TimeFE_t$, we can disentangle the effect of the BOJ's ETF purchases from changes in macroeconomic and financial

Table 1: Time series summary statistics from 2011 to 2019

Variable Name	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Dependent Variables										
Lending_Fee (%)										
Mean	1.665	1.867	2.005	2.091	2.174	2.300	2.320	2.190	1.979	2.079
Median	0.625	0.625	0.750	0.750	0.750	0.625	0.625	0.538	0.483	0.625
Sd. Dev.	2.297	2.392	2.325	2.433	2.415	2.729	2.942	3.058	2.964	2.663
Lending_Fee (%, = Special)										
Mean	6.327	6.725	7.347	7.371	7.943	8.881	9.569	9.639	9.076	8.280
Median	6.000	6.000	7.000	7.000	8.000	8.000	9.000	8.617	7.778	8.000
Sd. Dev.	1.796	1.952	2.686	2.523	1.550	2.557	2.764	3.434	3.886	3.015
Lending_Fee (%, = non-special)										
Mean	1.185	1.477	1.614	1.632	1.729	1.664	1.599	1.389	1.190	1.500
Median	0.500	0.625	0.625	0.625	0.625	0.625	0.625	0.529	0.456	0.625
Sd. Dev.	1.738	1.957	1.741	1.802	1.825	1.716	1.733	1.574	1.363	1.727
CR (%)										
Mean	-0.006	0.509	0.920	0.352	0.269	0.277	0.649	-0.311	0.349	0.328
Median	0.000	0.292	0.495	0.254	0.128	0.211	0.364	-0.135	0.096	0.178
Sd. Dev.	5.578	5.091	6.359	4.874	4.906	5.389	4.241	5.279	4.465	5.150
CR (%, = Special)										
Mean	0.222	0.476	1.395	0.297	0.190	0.487	0.947	-0.248	0.550	0.451
Median	0.000	0.001	0.397	-0.001	-0.105	0.000	0.215	-0.345	0.000	0.000
Sd. Dev.	8.135	7.458	9.764	7.408	7.218	8.200	6.738	7.881	6.759	7.706
CR (%, = non-special)										
Mean	-0.030	0.512	0.886	0.357	0.275	0.257	0.619	-0.318	0.327	0.317
Median	0.000	0.306	0.500	0.281	0.153	0.227	0.374	-0.122	0.105	0.194
Sd. Dev.	5.244	4.851	6.033	4.588	4.680	5.034	3.904	4.918	4.132	4.843
Independent Variables										
ETF_1w (%)										
Mean	0.003	0.002	0.002	0.003	0.005	0.009	0.012	0.013	0.010	0.007
Median	0.000	0.000	0.001	0.001	0.003	0.005	0.009	0.010	0.008	0.003
Sd. Dev.	0.007	0.007	0.005	0.005	0.008	0.014	0.013	0.014	0.011	0.011
frate_stock (%)										
Mean	67.13	65.43	64.08	63.98	63.55	63.19	63.21	63.63	63.46	64.10
Median	68.47	66.64	65.05	64.98	64.55	64.33	64.43	64.73	64.22	65.20
Sd. Dev.	18.97	19.43	19.58	19.59	19.68	19.64	19.72	19.47	19.20	19.52
log_turnover										
Mean	17.66	17.57	18.48	18.50	18.68	18.50	18.85	18.91	18.57	18.45
Median	17.46	17.35	18.35	18.35	18.49	18.35	18.79	18.85	18.47	18.36
Sd. Dev.	2.47	2.43	2.25	2.20	2.17	2.24	2.03	2.01	2.07	2.24

Table 1 – *Continued*

Variable Name	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Independent Variables (Continued)										
log_marketcap										
Mean	10.47	10.40	10.67	10.78	10.92	10.81	11.02	11.09	10.94	10.81
Median	10.25	10.16	10.42	10.54	10.65	10.55	10.78	10.86	10.70	10.57
Sd. Dev.	1.59	1.58	1.61	1.60	1.64	1.64	1.60	1.58	1.61	1.62
DIVY (%)										
Mean	2.51	2.58	2.07	1.97	1.84	2.21	1.88	1.94	2.43	2.15
Median	2.31	2.41	1.90	1.83	1.72	2.09	1.78	1.82	2.28	1.98
Sd. Dev.	1.75	1.68	1.54	1.38	1.31	1.44	1.30	1.36	1.58	1.50
log_per										
Mean	2.82	2.81	2.88	2.85	2.93	2.86	2.95	2.95	2.89	2.88
Median	2.67	2.64	2.75	2.73	2.80	2.71	2.82	2.81	2.71	2.74
Sd. Dev.	0.93	0.93	0.82	0.82	0.83	0.88	0.81	0.82	0.92	0.86

Note: This table reports summary statistics from 2001 to 2011 by year.

conditions. $Control_{it}$ is a vector of control variables. Following Blocher et al. [5], we include the logarithm of the turnover (*log_turnover*) in the stock market, the logarithm of the market capital (*log_marketcap*), dividend yield (*DIVY*), and the logarithm of PER (*log_per*), in addition to the free-floating rate (*frate_stock*).

We examine Hypotheses R.0., R.1., and R.2. using the panel regression (9) as follows. First, we test the validity of Hypothesis R.0. by examining the coefficient β_0 on ETF_{it} without including any double- and triple-interaction terms. If the BOJ's ETF purchases have positive effects on stock prices through the direct channel, β_0 will be positive. Second, we test the validity of Hypothesis R.1. by examining the coefficient β_1 on $SP_i \times ETF_{it}$ without including double- and triple-interaction terms with $CumETF_{it-1}$. As special stocks are those with limited supply in the stock lending market, β_1 is expected to be positive too. Finally and most importantly, we test Hypothesis R.2., i.e., the lending channel, by examining β_3 on the triple-interaction term, $SP_{it-1} \times CumETF_{it-1} \times ETF_{it}$. As shown in Figure 8, the BOJ's cumulative ETF purchases might contribute to increasing the supply of lendable stocks over the longer term, which weakens the intended positive effects of the purchases for special stocks only. Therefore, if the lending channel works, then the estimated parameter β_3 on the triple-interaction term is expected to be significantly negative.

Table 2 presents the estimation results. Column (1) presents the results of a simple model to examine whether ETF purchases affect cumulative stock returns without distinguishing direct and lending channels or special and non-special stocks. The estimated coefficient on ETF_{it} is positive and statistically significant, which is consistent with Hypothesis R.0. Quantitatively, the result implies that a one basis point increase in the ratio of ETF purchases of stock i to the

Table 2: Effect of the ETF purchase program on cumulative stock returns

	(1)	(2)	(3)	(4)	(5)
ETF	13.67***	13.86***	178.4***	19.92***	177.7***
	(1.793)	(1.806)	(12.380)	(2.547)	(12.420)
SP × ETF		21.59***	14.26***	28.79***	20.02***
		(5.101)	(5.037)	(5.903)	(6.058)
CumETF×ETF				-1.025***	-0.0598
				(0.211)	(0.194)
SP×CumETF				-4.819***	-3.299**
×ETF				(1.336)	(1.485)
Control vars.					
frate_stock	-0.00419***	-0.00452***	0.00147	-0.00488***	0.00141
	(0.00163)	(0.00160)	(0.00181)	(0.00162)	(0.00183)
log_turnover	-0.0444***	-0.0442***	-0.00283	-0.0468***	-0.00304
	(0.00886)	(0.00886)	(0.01120)	(0.00888)	(0.01120)
log_mcap	-0.569***	-0.569***	-0.540***	-0.560***	-0.539***
	(0.0311)	(0.0312)	(0.0351)	(0.0313)	(0.0351)
DIVY	0.0668***	0.0679***	0.0868***	0.0700***	0.0865***
	(0.0119)	(0.0119)	(0.0147)	(0.0120)	(0.0146)
SP	-0.0819*	-0.236***	-0.156***	-0.243***	-0.172***
	(0.0428)	(0.0513)	(0.0516)	(0.0517)	(0.0525)
log_per	-0.139***	-0.140***	-0.186***	-0.143***	-0.186***
	(0.00941)	(0.00937)	(0.01410)	(0.00944)	(0.01410)
ETF × frate_stock			-0.820***		-0.816***
			(0.122)		(0.122)
ETF ×log_turnover			-5.685***		-5.662***
			(0.747)		(0.748)
ETF×log_mcap			1.566		1.601
			(1.001)		(0.978)
ETF ×log_per			3.690***		3.643***
			(1.004)		(1.009)
ETF ×DIVY			0.48		0.497
			(0.661)		(0.650)
N	518992	518992	518992	518992	518992
Individual FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes

Notes: * $p < 0.10$, ** $p < 0.05$, ** $p < 0.01$. Clustered standard errors at the individual stock level are in parentheses. The table shows the estimation results for the panel regressions with weekly cumulative stock returns as a dependent variable as shown in equation (9). *SP* and *ETF* are the special stock dummy and weekly purchase amount of each stock, respectively. *CumETF* is the cumulative purchase amount of each stock up to the previous week.

total market value increases weekly cumulative stock return by around 0.14%. The finding of a positive effect of ETF purchases on stock returns is consistent with other existing empirical studies such as Barbon and Gianinazzi [2], Harada and Okimoto [16], and Katagiri et al. [22].

Column (2) presents the results of the model that adds the interaction term with the special dummy to the model for column (1). The results suggest that the effect of ETF purchases on weekly cumulative stock returns is larger by around 20% than that on non-special stocks, which is consistent with Hypothesis R.1. To take account of the possibility that the dummy variable for special stocks SP_{it} might be correlated with other individual firm characteristics, in column (3), we also consider a specification in which the corresponding interaction terms with control variables, $Control_{it} \times ETF_{it}$, are added to the previous model. Column (3) shows that the effects of purchases on the weekly cumulative return for special stocks are smaller, but still significantly larger than those for non-special stocks.

Column (4) of Table 2 shows the results of our benchmark model, i.e., the one with the triple-interaction term discussed above. Intriguingly and consistent with Hypothesis R.2. that the BOJ's cumulative ETF purchases weakened the effects of their purchases via the lending channel, the estimated coefficient on the triple interaction variable is significantly negative. Again, this finding is unchanged in column (5), in which the interactions of ETF purchases and the control variables are included. Furthermore, it should be noted that while β_2 in equation (9), i.e., the coefficient on the double interaction $CumETF_{it-1} \times ETF_{it}$, is estimated to be significantly negative, its absolute size is much smaller than that on the triple interaction in column (4), and it is even not statistically significant when we add the interaction terms in column (5). This finding, together with the negative and statistically significant β_3 on the triple interaction, implies that, although ETF purchases contribute to shifting the supply curves rightward in the lending market for both special and non-special stocks, the effects of the shift on stock returns are significant only for special stocks, as shown in Figure 8.

As a robustness check, we conducted the estimation with an alternative definition of special stocks. Namely, we define a special stock as one whose lending fee is in the top 25th percentile in our sample. The estimation results in Table A1 of Appendix 2 are the same by and large, indicating that the coefficient on the triple-interaction variable is significantly negative. The results of the robustness checks suggest the effectiveness of the lending channel in alleviating the effects of the program on returns for special stocks.

Overall, the estimation results in Table 2 for the effects of the purchases on stock returns are consistent with Hypotheses R.0., R.1., and R.2. and suggest that the direct channel increases stock returns, while the lending channel significantly alleviates the policy effects for special

stocks by shifting the supply curve in the lending market rightward. Thus, at least for special stocks, incorporating the lending market mechanism is key to understanding the effects of the ETF purchase programs.

3.4 Effects on stock lending fees

Next, we examine Hypothesis F regarding the effects of the BOJ's ETF purchases on lending fees in the stock lending market. More specifically, we estimate the following panel regression models with firm- and time-fixed effects:

$$\Delta Fee\_XXw_{it} = \beta_0 ETF\_XXw_{it} + \beta_1 SP_{it} \times ETF\_XXw_{it} + \alpha_i + TimeFE_t + \gamma Control_{it} + \epsilon_{it}. \quad (10)$$

The dependent variable ΔFee_XXw_{it} in equation (10) is defined as the change in lending fees of stock i from time t to XX weeks afterward. Namely, noting that the dataset is constructed at a weekly frequency, we define

$$\Delta Fee\_XXw_{it} = Lending\_Fee_{it+XX} - Lending\_Fee_{it}.$$

To examine whether ETF purchases lower lending fees over the longer term, we consider different time horizons with $XX \in \{1, 2, 5, 15, 25, 50, 75\}$. For example, ΔFee_1w_{it} and ΔFee_50w_{it} are the changes in lending fee from t to one week and 50 weeks after t, respectively.

ETF_XXw_{it} is the cumulative amount of BOJ's ETF purchases of stock i from time t to XX weeks afterward, measured by the ratio of BOJ's ETF purchases to the total market value of stock i at t. Namely, we define $ETF\_XXw_{it} = \sum_t^{t+XX-1} ETF_{it}$, where ETF_{it} is defined in equation (7). For example, ETF_50w_{it} represents the BOJ's cumulative indirect ETF purchases of stock i from time t to 50 weeks afterward. SP_{it} is a dummy variable taking a value of one if stock i is special and zero otherwise. In the robustness check in Appendix 2, we also show the estimation results where the threshold equals 75% rather than 90%. Similar to equation (9), α_i is firm (stock)-fixed effects, and $TimeFE_t$ is time-fixed effects. As we discussed, the effect of ETF purchases by the BOJ can be disentangled from the change in macroeconomic conditions by including them. $Control_{it}$ is a vector of control variable including *frate_stock, log_turnover, log_marketcap, DIVY, and log_per.*

The variable of interest in equation (10) is $SP_{it} \times ETF\_XXw_{it}$. As Hypothesis F suggests, if the lending channel works, ETF purchases exert downward pressure on the lending fees for special stocks only. Furthermore, the downward pressure is expected to be evident only for longer time horizons because ETF managers probably need some time to supply stocks that constitute

ETFs purchased by the BOJ to the lending market. We test this hypothesis, i.e., the downward pressure on lending fees for special stocks through the lending channel, by examining whether the estimated coefficients β_1 on $SP_{it} \times ETF\_XXw_{it}$ are significantly negative for different time horizons.

Table 3 reports the estimation results of the regression model (10). The results of our benchmark models are presented in columns (1)–(7), in which time horizons from 1 to 75 weeks are included, together with the control variables defined above. Note that the number of samples increases as the time horizon extends because the regression model (10) is estimated based on samples with $ETF\_XXw > 0$ and the model is estimated with overlapping data when XX is more than one week. The estimation results indicate that the coefficients on the interaction terms of specialness and ETF purchases are significantly negative for longer time horizons, especially 25, 50, and 75 weeks, while they are negative but not significant for shorter terms. Taking account of the possibility that the dummy variable for special stocks SP_{it} might be correlated with other firm characteristics, in Table 4, we consider specifications in which the corresponding interaction terms with control variables, $Control_{it} \times ETF\_XXw_{it}$, are added to the benchmark models. The estimated coefficients on the interaction terms show the same pattern as those in the benchmark models, indicating that our benchmark estimation is robust to adding the interaction terms.[8]

Based on the estimation results in Table 3, Figure 9 compares the effects of ETF purchases on lending fees of special stocks with those of non-special stocks for different time horizons. More specifically, the figure shows (i) β_0 of equation (10) in the benchmark model represents the average effects of the purchases on lending fees for non-special stocks (the red line), and (ii) $\beta_0 + \beta_1$ represents the average effects of purchases on lending fees for special stocks (the blue line), for different time horizons. The dashed lines around the bold lines are 95% confidence intervals. The figure clearly shows that the ETF purchase exerts statistically significant downward pressure on lending fees of special stocks for a longer time horizon, while no such effect is identified for non-special stocks. Furthermore, the coefficient for non-special stocks is associated with a relatively tight confidence interval around zero, which suggests that lending fees for non-special stocks are not responsive to changes in the supply of lendable stocks. Given that non-special stocks are those with slack in the stock lending market, this result is consistent with our model in Section 3.

In sum, the estimation results in Tables 3 and 4 and Figure 9 suggest clearly that cumulative

[8] As a robustness check, we conducted the estimation with an alternative indicator of special stocks. Namely, we define a special stock as one whose lending fee is in the top 25th percentile in our sample. The estimation results in Table A2 of Appendix 2 indicate that the lending fee of special stocks is affected significantly by the ETF purchase program, especially for longer time horizons.

Table 3: Effect of the ETF purchase program on lending fee

	(1) ΔFee_1w	(2) ΔFee_2w	(3) ΔFee_5w	(4) ΔFee_15w	(5) ΔFee_25w	(6) ΔFee_50w	(7) ΔFee_75w
SP × ETF_1w	-0.729						
	(0.656)						
SP × ETF_2w		-0.546					
		(0.429)					
SP × ETF_5w			-0.34				
			(0.374)				
SP × ETF_15w				-0.302			
				(0.338)			
SP × ETF_25w					-0.658**		
					(0.278)		
SP × ETF_50w						-0.948***	
						(0.207)	
SP × ETF_75w							-1.134***
							(0.163)
Ctrl. Vars.							
ETF_XXw	0.0646	-0.0196	-0.0189	-0.0325	-0.0395	-0.028	-0.0189
	(0.0587)	(0.0378)	(0.0333)	(0.0301)	(0.0279)	(0.0246)	(0.0224)
frate_stock	-0.000221**	-0.000172	-0.000732**	-0.00252***	-0.00312***	-0.00512***	-0.00547***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)
log_turnover	0.00822***	0.00943***	0.0193***	0.0218***	0.0181***	0.00272	-0.0173**
	(0.00075)	(0.00082)	(0.00160)	(0.00310)	(0.00397)	(0.00555)	(0.00702)
log_marketcap	-0.00963***	-0.0101***	-0.0190***	-0.0132	0.004	0.0416	0.0693**
	(0.0021)	(0.0024)	(0.0051)	(0.0111)	(0.0159)	(0.0260)	(0.0341)
DIVY	0.000754	0.0011	0.00317*	0.00806*	0.0116*	0.0117	0.0144
	(0.0007)	(0.0008)	(0.0018)	(0.0044)	(0.0063)	(0.0103)	(0.0131)
SP	-0.154***	-0.176***	-0.465***	-0.966***	-1.239***	-1.641***	-1.887***
	(0.0074)	(0.0081)	(0.0168)	(0.0372)	(0.0486)	(0.0674)	(0.0783)
log_per	0.00172**	0.00140*	0.00613***	0.0112***	0.0140**	0.014	0.0115
	(0.0008)	(0.0008)	(0.0018)	(0.0042)	(0.0062)	(0.0100)	(0.0130)
N	517101	648947	748176	777152	781018	790807	798960
Ctrl.×ETF_XXw	No	No	No	No	No	No	No
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

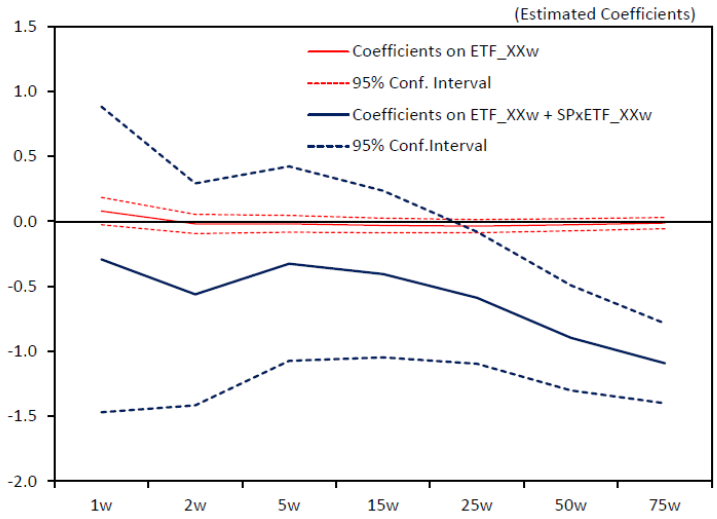
Notes: * $p < 0.10$, ** $p < 0.05$, ** $p < 0.01$. Clustered standard errors at the individual stock level are in parentheses. The table shows the estimation results for the weekly panel regression with the dependent variable ΔFee_XXw, which is defined as the change in lending fees of each stock from time t to XX weeks afterward. ETF_XXw is the cumulative amount of BOJ's ETF purchases (as a ratio of the market value) of each stock from time t to XX weeks afterward. The regression model is estimated based on only samples with $ETF\_XXw > 0$. When XX is more than one week, the regression model is estimated with overlapping data. *SP* indicates the special stock dummy that takes a value of one if the lending fee is larger than the 90th percentile.

Table 4: Robustness check for the effect on lending fees

	(1) ΔFee_1w	(2) ΔFee_2w	(3) ΔFee_5w	(4) ΔFee_15w	(5) ΔFee_25w	(6) ΔFee_50w	(7) ΔFee_75w
SP × ETF_1w	-0.613						
	(0.640)						
SP × ETF_2w		-0.433					
		(0.419)					
SP × ETF_5w			-0.209				
			(0.376)				
SP × ETF_15w				-0.16			
				(0.332)			
SP × ETF_25w					-0.519*		
					(0.273)		
SP × ETF_50w						-0.782***	
						(0.205)	
SP × ETF_75w							-0.985***
							(0.161)
Ctrl. Vars.							
ETF_XXw	-1.865***	-1.333***	-1.851***	-2.185***	-2.108***	-1.817***	-1.653***
	(0.5130)	(0.3790)	(0.3360)	(0.2820)	(0.2570)	(0.2210)	(0.199)
frate_stock	-0.000242**	-0.00021	-0.000880***	-0.00304***	-0.00384***	-0.00624***	-0.00671***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)	(0.00198)
log_turnover	0.00831***	0.00962***	0.0191***	0.0198***	0.0143***	0.00044	-0.0189**
	(0.00087)	(0.00095)	(0.00183)	(0.00368)	(0.00488)	(0.00741)	(0.00963)
log_marketcap	-0.0109***	-0.0117***	-0.0230***	-0.0232*	-0.0103	0.014	0.0327
	(0.0022)	(0.0025)	(0.0053)	(0.0119)	(0.0172)	(0.0280)	(0.0363)
DIVY	-0.000541	-0.000249	0.00128	0.00454	0.00662	0.00545	0.00879
	(0.0009)	(0.0012)	(0.0022)	(0.0050)	(0.0070)	(0.0112)	(0.0140)
flag_high	-0.155***	-0.178***	-0.469***	-0.981***	-1.263***	-1.692***	-1.954***
	(0.0074)	(0.0082)	(0.0170)	(0.0372)	(0.0484)	(0.0671)	(0.0776)
log_per	0.00155	0.00171	0.00726***	0.0127**	0.0160*	0.0207	0.0154
	(0.0010)	(0.0011)	(0.0024)	(0.0056)	(0.0083)	(0.0130)	(0.0166)
N	517101	648947	748176	777152	781018	790807	798960
Ctrl.×ETF_XXw	YES	YES	YES	YES	YES	YES	YES
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * $p < 0.10$, ** $p < 0.05$, ** $p < 0.01$. Clustered standard errors at the individual stock level are in parentheses. The table shows the estimation results for the weekly panel regression with the dependent variable of ΔFee_XXw, which is defined as the change in lending fees of each stock from time t to XX weeks afterward. ETF_XXw is the cumulative amount of BOJ's ETF purchases (as a ratio of the total market value) of each stock from time t to XX weeks afterward. The regression model is estimated based on only samples with $ETF\_XXw > 0$. When XX is more than one week, the regression model is estimated with overlapping data. SP is the special stock dummy that takes a value of one if the lending fee is larger than the 90th percentile. In the regressions in this table, the interaction effects between the control variables and ETF_XXw are included as independent variables.

Figure 9: Effects of the ETF purchase program on lending fee



Note: Based on the estimation results in Table 3, the figure shows (i) β_0 of equation (10) in the benchmark model represents the average effects of purchases on lending fees for non-special stocks (the red line), and (ii) $\beta_0 + \beta_1$ represents the average effects of purchases on lending fees for special stocks (the blue line), for different time horizons. The dashed lines around the bold lines are 95% confidence intervals.

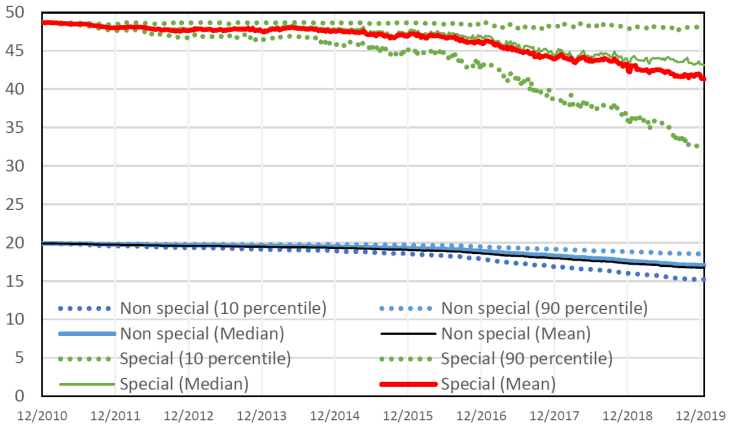
ETF purchases exert downward pressure only on stock lending fees of special stocks over the longer term. In other words, the ETF purchase program increases the supply of special stocks in the lending market, thus leading to a decrease in lending fees for special stocks. Hence, these results imply strongly the existence of the lending channel, consistent with our model discussed in Section 2.[9] Furthermore, the significant effects on lending fees support our interpretation of the triple-interaction variable in the return estimation of equation (9). That is, while the significant coefficient on the triple-interaction variable of the return regression stems possibly not from the lending channel but from other factors such as changes in short demands, i.e., D_S, the significant effects on lending fees strongly support that it captures the effects through the lending channel.

3.5 Discussion on policy insights

Our analysis so far has shown clearly that the lending channel should be considered in evaluating the effect of an asset purchase program on asset prices, especially when the assets purchased by a central bank can be lent out subsequently in the associated lending market. More specifically, these results provide policy implications for future changes to the ETF program. For

[9]It should be noted that special stocks account for only 10% of all stocks by their definition. To examine the "average" effect of ETF purchases on the lending fees of all stocks, including non-special ones, the model without the interaction term $SP \times ETF\_XXw$ needs to be estimated. While we do not show the estimation results, no significant effects that reduce lending fees are identified on average, even for longer time horizons such as 50 and 75 weeks. This implies that, while the diminishing policy effect through the lending channel is evident, for special stocks at the aggregate level, i.e., when non-special stocks are also considered, the effect is quantitatively limited.

Figure 10: Marginal effects on returns for special and non-special stocks



Note: The blue and black solid lines indicate the median and mean of the marginal effects for non-special stocks, respectively, while the dotted blue lines indicate their 10th and 90th percentiles. Similarly, the green and red solid lines indicate the median and mean of the marginal effects for special stocks, respectively, while the dotted green lines indicate their 10th and 90th percentiles.

example, suppose that, as the BOJ is retaining the large-scale ETF purchase program, the supply of lendable stocks is expected to increase, i.e., the supply curve in the lending market shifts rightward. Based on our estimation results, especially the significantly negative coefficient on the triple-interaction variable in the model (9), the rightward shift exerts downward pressure on lending fees for special stocks, which offsets the intended policy effects generated by the direct channel.

Figure 10 shows the average marginal effects of the BOJ's ETF purchases for special stocks (the red line) and non-special stocks (the blue line) based on the estimation result of column (4) in Table 2.[10] First, the chart shows that the marginal effects for non-special stocks are lower than those for special ones. Furthermore, they have remained almost unchanged over time, reflecting that the coefficient on $CumETF \times ETF$ is relatively small for non-special stocks. On the other hand, the average marginal effects for special stocks have declined over time, especially after 2015, when the BOJ substantially increased the purchase amount. Given that the coefficient on the triple-interaction variable is negative and statistically significant, the figure shows that the increase in the BOJ's cumulative ETF purchases has decreased the average marginal effect by 15%. In addition, the marginal effects for special stocks show substantial variation across individual stocks, as implied by the 10th and 90th percentiles (the dotted green lines around the red line). Specifically, the figure indicates that the marginal effects for some stocks that have been purchased intensively have decreased by more than 30%.

Finally, from a different perspective, this purchase program can be evaluated positively

[10]The average marginal effect is calculated by taking the average of the cumulative ETF purchase amount for each week for special and non-special stocks.

in terms of helping the stock lending market operate more effectively. Specifically, when the BOJ's ETF purchases help increase the supply of lendable stocks in the lending market, it helps investors borrow overvalued stocks and sell them in the spot market, which exerts downward pressure on overvalued stock prices and thus corrects price distortions among individual stocks.[11] In other words, if such effects exist, the BOJ should consider the possibility that an exit from their ETF purchase program may cause a sudden deterioration in the availability of lendable stocks and induce unintended consequences.

4 Conclusions

This paper investigates the effects of the BOJ's ETF purchase program by considering the functions of the stock lending market and its impact on stock returns. In particular, we examine the mechanism by which ETF purchases impact the stock market and the lending market through two different channels: the direct channel and the lending channel. Using individual stock-level panel data for the stock lending market, we first show that ETF purchases increase stock returns, especially those with limited supply in the stock lending market (the direct channel). Then, we show that the BOJ's accumulated purchases lower lending fees over longer terms and weaken the effects of their purchases on stock returns. This result suggests that ETF managers supply stocks that constitute ETFs held by the BOJ to the stock lending market, which weakens the policy effects of the program (the lending channel).

To conclude, we point out a future research topic. In this paper, we assume that stock prices change in accordance with the BOJ's actual ETF purchases. However, the BOJ usually announces changes in the ETF purchase program in the policy statements, which helps market participants to form expectations about the buying schedule. In addition, in the course of BOJ purchasing, market participants can learn its purchasing strategy. Therefore, if market participants expect a future increase in stock prices due to the ETF program, it is rational to buy stocks before the actual purchase by the BOJ. In this way, the stock price can change when their expectations regarding the purchasing strategy changes. Examining the effect of expectation formation by considering how it is interconnected with the stock lending market is a natural extension of our research.

[11] This view is supported by the fact that stock lending is highly selective and intensively utilized for less liquid or overvalued stocks. For more detailed discussions, see Maeda et al. [24].

Appendix 1: Stock lending ratio of individual stocks in targeted ETFs

Figures A1 and A2 show stock lending microdata from the financial statements of two representative TOPIX-tracking ETFs. Each panel shows the stock lending ratio (vertical axis) of an individual stock with its security code, arranged in ascending order (horizontal axis) in a specific year. The stock lending ratio for security code i is defined as the amount of stock i in the ETF used for lending divided by the total amount of stock i in the ETF, both measured by market value.

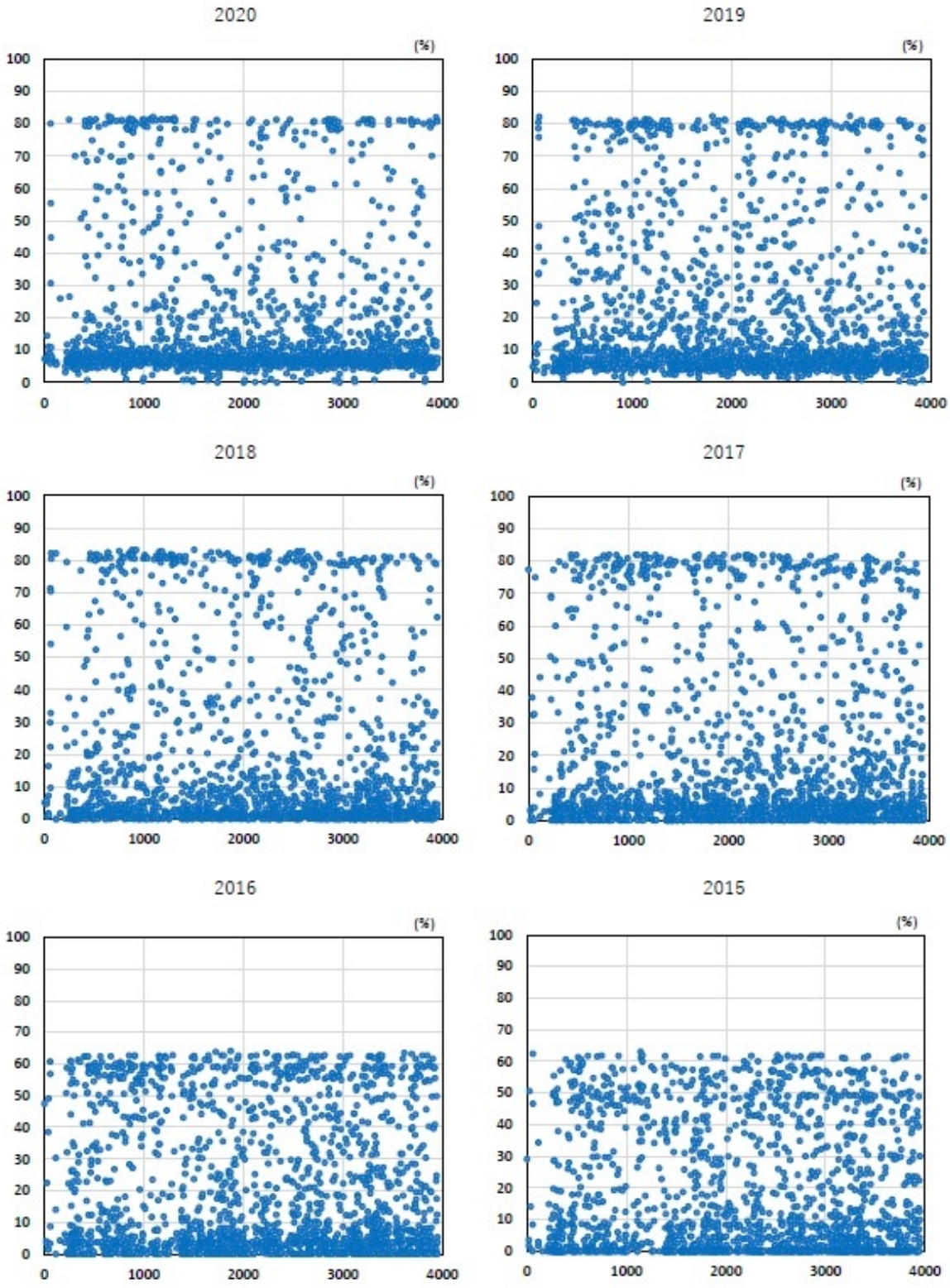
Some intriguing observations can be made from the figures. First, each fund seems to have an "upper limit" on stock lending ratios. Second, the level of the upper limit varies among funds and years. To our knowledge, there is no public regulation in the Japanese ETF market imposing a uniform upper limit on lending ratios. Therefore, each limit is considered to be established as an "internal rule" within the ETFs or associated asset management companies. The existence of upper limits is consistent with the fact that ETF managers need to prepare for sudden or large redemptions in the future. Third, some funds seem to have raised their upper limits during the period from 2015 to 2020. Overall, these observations are consistent with our hypothesis that under the expansions of the BOJ's purchase program, the incentives for fund managers to lend out stock have increased and stock lending has become active on the backdrop of the resulting increases in stock lending provision.

Appendix 2: Estimation results using an alternative definition of special stocks

In Section 3, we present the estimation results for the effect of the ETF purchases using the special stock dummy based on the 90th percentile value of lending fees. In this appendix, we show the robustness of our findings using an alternative definition of special stock. More specifically, we define a special stock when its lending fee is greater than the 75th percentile of stocks in the previous week. In what follows, we first report the estimation results for stock returns and then show the results for the lending fee.

Columns (1)–(4) of Table A1 show the estimation results with the alternative special dummy, which confirms three main findings in the baseline specification. First, the coefficients on the weekly purchase amount, *ETF*, are significantly positive and almost the same as the baseline result in Table 2 for all specifications, which supports Hypothesis R.0. regarding the positive effect on stock returns. Second, the effect of the ETF purchases is more pronounced for special stocks, which supports Hypothesis R.1. Third, the more the BOJ purchases stocks, the weaker

Figure A1. Lending ratios of stocks held by an individual ETF (1)



Sources: ETF balance sheets, EDINET.

Figure A2. Lending ratios of stocks held by an individual ETF (2)

Sources: ETF balance sheets, EDINET.

the effect of the weekly purchases on stock returns. This result supports Hypothesis R.2. as shown in the baseline specification of the special dummy. These results show that our findings with the 90th percentile special dummy are robust to other specifications of a special stock indicator.

Table A2 presents the estimation results for the lending fee regression with the 75th percentile special dummy. Columns (1)–(7) present the results without the interaction effects between control variables and the ETF purchase amounts, while columns (8)–(14) report those with the interaction terms. As shown in the baseline specifications in Tables 3 and 4, the coefficient on a variable of interest, i.e., the interaction term between the special dummy and cumulative purchase amount by the BOJ (SP $\times$ ETF_XXw), is estimated to be significantly negative for longer-term cumulative changes in lending fees. This result provides evidence for Hypothesis F—the BOJ's ETF purchases lower lending fees of special stocks over medium to longer terms.

Appendix 3: Bank of Japan's ETF purchase program

Table 3 details the changes in the BOJ's ETF purchase program.

Table A1: Robustness check for the effect of the ETF purchase program on stock returns

	(1)	(2)	(3)	(4)
ETF	14.39***	173.5***	19.99***	172.5***
	(1.843)	(12.380)	(2.586)	(12.44)
SP × ETF	23.69***	13.81***	32.66***	21.53***
	(2.548)	(2.558)	(4.286)	(4.453)
CumETF×ETF			-0.909***	-0.0486
			(0.198)	(0.193)
SP×CumETF			-5.296***	-3.952*
×ETF			(1.923)	(2.058)
Control vars.				
frate_stock	-0.00504***	0.001	-0.00551***	0.000776
	(0.00159)	(0.00180)	(0.00161)	(0.00183)
log_turnover	-0.0429***	0.00229	-0.0450***	0.00247
	(0.00882)	(0.01110)	(0.00883)	(0.0111)
log_mcap	-0.568***	-0.553***	-0.561***	-0.553***
	(0.0310)	(0.0349)	(0.0311)	(0.0349)
DIVY	0.0702***	0.0865***	0.0713***	0.0854***
	(0.0119)	(0.0149)	(0.0120)	(0.0147)
SP	-0.281***	-0.188***	-0.293***	-0.209***
	(0.028)	(0.029)	(0.030)	(0.0305)
log_per	-0.140***	-0.184***	-0.143***	-0.184***
	(0.009)	(0.014)	(0.009)	(0.014)
ETF × frate_stock		-0.796***		-0.787***
		(0.122)		(0.122)
ETF ×log_turnover		-6.050***		-6.052***
		(0.739)		(0.749)
ETF×log_mcap		2.452**		2.518**
		(1.010)		(0.991)
ETF ×log_per		3.508***		3.433***
		(0.995)		(1.000)
ETF ×DIVY		0.498		0.540
		(0.694)		(0.667)
N	518992	518992	518992	518992
Individual FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes

Notes: * $p < 0.10$, ** $p < 0.05$, ** $p < 0.01$. Clustered standard errors at the individual stock level are in parentheses. The table shows the estimation results for the panel regression with weekly cumulative stock returns as a dependent variable as shown in equation (9). *SP* indicates the special stock dummy that takes a value of one if the lending fee is larger than the 75th percentile, and *ETF* is the weekly purchase amount of each stock. *CumETF* is the cumulative purchase amount of each stock up to the previous week.

Table A2: Robustness check for the effect of the ETF purchase program on lending fee

	(1) ΔFee_1w SP:75pt	(2) ΔFee_2w SP:75pt	(3) ΔFee_5w SP:75pt	(4) ΔFee_15w SP:75pt	(5) ΔFee_25w SP:75pt	(6) ΔFee_50w SP:75pt	(7) ΔFee_75w SP:75pt	(8) ΔFee_1w SP:75pt	(9) ΔFee_2w SP:75pt	(10) ΔFee_5w SP:75pt	(11) ΔFee_15w SP:75pt	(12) ΔFee_25w SP:75pt	(13) ΔFee_50w SP:75pt	(14) ΔFee_75w SP:75pt
SP × ETF_1w	-0.863***							-0.677**						
	(0.272)							(0.280)						
SP × ETF_2w		-0.663***							-0.480**					
		(0.188)							(0.192)					
SP × ETF_5w			-0.116							0.206				
			(0.168)							(0.173)				
SP × ETF_15w				-0.228							0.0901			
				(0.143)							(0.146)			
SP × ETF_25w					-0.435***							-0.160		
					(0.119)							(0.120)		
SP × ETF_50w						-0.926***							-0.731***	
						(0.0967)							(0.0953)	
SP × ETF_75w							-1.083***							-0.939***
							(0.0854)							(0.0834)
Ctrl. Vars.														
ETF_XXw	0.0524	-0.0122	0.0194	0.0216	0.00708	-0.00528	-0.0125	-2.393***	-1.902***	-2.836***	-3.074***	-2.745***	-2.048***	-1.635***
	(0.0600)	(0.0394)	(0.0354)	(0.0329)	(0.0305)	(0.0268)	(0.0239)	(0.527)	(0.391)	(0.341)	(0.296)	(0.257)	(0.211)	(0.182)
frate_stock	-0.000382***	-0.000416***	-0.00124***	-0.00353***	-0.00429***	-0.00604***	-0.00615***	-0.000400***	-0.000455***	-0.00141***	-0.00406***	-0.00496***	-0.00691***	-0.00691***
	(0.000126)	(0.000152)	(0.000327)	(0.000697)	(0.000948)	(0.00141)	(0.00179)	(0.000128)	(0.000155)	(0.000337)	(0.000724)	(0.000979)	(0.00146)	(0.00185)
log_turnover	0.00928***	0.0114***	0.0234***	0.0310***	0.0297***	0.0208***	0.00434	0.00915***	0.0114***	0.0240***	0.0307***	0.0278***	0.0160**	-0.00286
	(0.000796)	(0.000865)	(0.00169)	(0.00328)	(0.00409)	(0.00535)	(0.00658)	(0.000917)	(0.00101)	(0.00196)	(0.00403)	(0.00509)	(0.00708)	(0.00912)
log_marketcap	-0.0179***	-0.0214***	-0.0437***	-0.0667***	-0.0675***	-0.0670**	-0.0519	-0.0193***	-0.0235***	-0.0528***	-0.0903***	-0.0981***	-0.102***	-0.0871**
	(0.00223)	(0.00267)	(0.00551)	(0.0118)	(0.0162)	(0.0252)	(0.0329)	(0.00232)	(0.00277)	(0.00575)	(0.0125)	(0.0173)	(0.0267)	(0.0345)
DIVY	-0.000336	-0.000413	-0.0000419	0.00112	0.00204	-0.00164	-0.000346	-0.00143	-0.00166	-0.00188	-0.00230	-0.00238	-0.00577	-0.00235
	(0.000811)	(0.000861)	(0.00191)	(0.00458)	(0.00615)	(0.00931)	(0.0114)	(0.000920)	(0.00121)	(0.00212)	(0.00496)	(0.00661)	(0.00992)	(0.0121)
SP	-0.122***	-0.166***	-0.407***	-0.865***	-1.108***	-1.445***	-1.606***	-0.124***	-0.169***	-0.418***	-0.895***	-1.152***	-1.505***	-1.672***
	(0.00380)	(0.00448)	(0.00932)	(0.0205)	(0.0273)	(0.0372)	(0.0449)	(0.00388)	(0.00454)	(0.00949)	(0.0209)	(0.0277)	(0.0374)	(0.0447)
log_per	0.00177**	0.00149*	0.00601***	0.0115***	0.0150**	0.0169*	0.0149	0.00124	0.00139	0.00667***	0.0114**	0.0141*	0.0152	0.00706
	(0.000753)	(0.000896)	(0.00196)	(0.00435)	(0.00613)	(0.00929)	(0.0117)	(0.000972)	(0.00113)	(0.00248)	(0.00573)	(0.00804)	(0.0120)	(0.0148)
Ctrl.× ETF_XXw	No	No	No	No	No	No	No	YES	YES	YES	YES	YES	YES	YES
N	517101	648947	748176	777152	781018	790807	798960	517101	648947	748176	777152	781018	790807	798960
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: * $p < 0.10$, ** $p < 0.05$, ** $p < 0.01$. Clustered standard errors at the individual stock level are in parentheses. The table shows the estimation results for the weekly panel regression with the dependent variable ΔFee_XXw, which is defined as the change in lending fees of each stock from time t to XX weeks afterward. ETF_XXw is the cumulative amount of BOJ's ETF purchases (as a ratio of the total market value) of each stock from time t to XX weeks afterward. The regression model is estimated based on only samples with $ETF\_XXw > 0$. When XX is greater than one week, the regression model is estimated with overlapping data. *SP* is the special stock dummy that takes a value of one if the lending fee is larger than the 75th percentile.

Table A3: Bank of Japan's ETF purchase program

Announcement Date	Total size	Purchased ETFs and their share.
(1) 10/28/2010	The maximum outstanding amount to be purchased is about **0.45 tril. yen**	ETFs tracking the **Tokyo Stock Price Index (TOPIX)** and **Nikkei 225 Stock Average** are purchased so that the bank's purchases would be approximately proportionate to the total market value of that ETF issued. (2010/11/5)
(2) 3/14/2011	The "maximum" amount is increased to about **0.9 tril. yen**	Unchanged
(3) 8/4/2011	Up to about **1.4 tril. yen**	Unchanged
(4) 4/27/2012	Up to about **1.6 tril. yen**	Unchanged
(5) 10/30/2012	Up to **2.1 tril. yen**	Unchanged
(6) 4/4/2013	**At an annual pace of 1 tril. yen**.	Introduction of the "Quantitative and Qualitative Monetary Easing"
(7) 10/31/2014	**3.0 tril. yen/year**	Unchanged
(8) 11/19/2014	Unchanged	**JPX400** ETFs are included. (The decision was made on 10/31/2014)
(9) 3/15/2016 (4/1/2016)	**3.3 tril. yen/year**	Of which 0.3 tril. yen/year for purchasing ETFs composed of stocks issued by firms that are proactively investing in physical and human capital.
(10) 7/29/2016	**6.0 tril. yen/year**	Unchanged
(11) 9/21/2016	Unchanged	**3.0 tril. yen/year** for TOPIX, Nikkei 225, and JPX400 (proportional to the market value of that ETF); **2.7 tril. yen/year** for TOPIX; **0.3 tril. yen/year** for ETFs to support corporate investment
(12) 7/31/2018 (8/6/2018)	Unchanged	**1.5 tril. yen/year** for TOPIX, Nikkei 225, and JPX400 ETFs; **4.2 tril. yen/year** for TOPIX ETFs; **0.3 tril. yen/year** for ETFs to support corporate investment
(13) 3/16/2020	**12 tril. yen/year** as a temporary measure for COVID-19	Unchanged
(14) 3/19/2021	**12 tril. yen/year** even after COVID-19 subsidies	The Bank only purchases ETFs tracking TOPIX.

Note: Based on a decision on 10/28/2010, the BOJ started purchasing ETFs on 12/5/2010. The date in parenthesis indicates the starting date of the policy change.

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