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The BOJ's ETF Purchases and Its Effects on Nikkei 225 Stocks*

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Abstract

This paper examines the impacts of the Bank of Japan's (BOJ) exchange-traded funds (ETFs) purchasing program that has been conducted since December 2010. The program is a part of the BOJ's unconventional monetary policy and has accelerated since the introduction of the Quantitative and Qualitative Easing in April 2013. In this study, the influence of underlying stocks is assessed by comparing the performance of the stocks (those included in the Nikkei 225 and others) using a difference-in-difference analysis. We also separate morning and afternoon returns to control for the fact that the BOJ tends to purchase ETFs when performance of the stock market is weak, in the morning session. We find that the Nikkei 225 component stocks' afternoon returns are significantly higher than those of non-Nikkei 225 stocks when the BOJ purchases ETFs. However, the subsample analysis demonstrates that the impact on Nikkei 225 stock returns becomes smaller over time despite the growing purchase amounts. Overall, our results indicate that the cumulative treatment effects on the Nikkei 225 are around 20% as of October 2017.

Keywords; Exchange Traded Funds, Unconventional Monetary Policy, Stock Market Intervention, Difference in Difference

JEL classification: E52, E58, G10

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1. Introduction

The current paper examines the impacts of the Bank of Japan's (BOJ) exchange-traded funds (ETFs) purchasing program that has conducted since December 2010; this program is part of the BOJ's unconventional monetary policy, which has accelerated after the introduction of the Quantitative and Qualitative Easing (QQE) in April 2013. As of April 10th, 2018, the BOJ holds a total of 530.5 trillion yen in assets, and its balance sheet already totals more than 100% of Japan's nominal gross domestic product. The BOJ's holdings of Japanese government bonds totals 449.9 trillion yen and holdings of ETFs equates to about 24 trillion yen with 19.1 trillion yen purchases.¹

Although the amount of ETFs that the BOJ holds is relatively small compared with government bonds, maturity—or redemption—does not occur with ETFs, suggesting that credit and price fluctuation risks are relatively higher for ETFs than for government bonds. Therefore, the BOJ will face more risks by holding ETFs in its “monetary normalization” to exit from its ongoing unconventional monetary policy. It is not only the BOJ that purchases various non-government debt securities; in fact, the European Central Bank makes these purchases as well. However, the BOJ is the only central bank that holds the stock of a number of companies indirectly via its large holdings in ETFs.²

Physical ETFs are securities backed by a pool of stocks. For example, an ETF tracking the Nikkei 225 holds the stocks underlying the benchmark Nikkei 225 index. According to the Investment Trusts Association Japan, at the end of March 2018, the total net asset value of the ETF market was 32.5 trillion yen, with a total of 178 ETFs. This means that the BOJ holds approximately 60% of the ETF market, making the BOJ the top shareholder of more than 55

¹ Bank of Japan Accounts (April 10, 2018)

<https://www.boj.or.jp/en/statistics/boj/other/acmai/release/2018/ac180410.htm/>

² The BOJ is the first and only central bank to purchase domestic stocks as part of its unconventional monetary policy; however, there have been several central banks that have purchased private firms' stocks. The Swiss National Bank purchases foreign stocks such as Facebook as part of its foreign exchange rate policy. The Hong Kong Monetary Authority bought about \$15 billion of Hong Kong-listed stocks at the height of the Asian Financial Crisis in 1998. The Hong Kong Authority later pooled the holdings into an ETF-like security and sold them in the market.

companies in the Nikkei's 225 companies. As explained in Section 2.1, until the BOJ changed its policy in September 2016, it dominated the trade of individual stocks on the Nikkei 225 so heavily that the presence of the BOJ raised concerns. As we will review in Section 3, the effects of the ETF purchasing policy on the market itself, its influence on price formation, and its effects on the underlying stocks and indices have begun to be examined, but the number of studies is still limited. Hence, the main contribution of the current paper is coming to a better understanding of the impact of the BOJ's ETF purchasing policy on individual stock prices.

It is said that the BOJ is more likely to place a purchasing order in the afternoon when the market is likely to be swinging downward in the morning (Fueda-Samikawa and Takano (2017), Ohta (2016), and Shirota (2017)). For example, by looking at the BOJ's purchase frequency, Fueda-Samikawa and Takano (2017) point out that the BOJ continues to buy ETFs for several days when stock prices are declining and tends to stop buying when stock prices rise sharply. Consequently, it is impossible to assess the policy effects of the BOJ's ETF purchase program by simply comparing the performance of individual stocks between intervention and non-intervention days because returns on intervention days tend to be lower by the nature of the program. Ideally, stock returns with and without an intervention on the exact same day should be compared to evaluate the effect of the BOJ's ETF purchasing program. However, stock returns without an intervention on an intervention day cannot be observed. To resolve this issue, we focus on the effects of the BOJ's purchase of ETFs tracking the Nikkei 225 and consider the stocks in the Nikkei 225 as a treatment group and those stocks not in the Nikkei 225 as a control group. This allows us to apply a difference-in-difference (DID) methodology to examine the effects of the BOJ's purchasing of Nikkei 225 ETFs on individual Nikkei 225 stock prices.³ We also separate the morning and afternoon returns to control for the fact that the BOJ tends to purchase ETFs when the performance of the stock market is not great in the morning session. By doing so, we can reasonably alleviate the simultaneity problem between the performance of morning returns and the BOJ's intervention.

³ The DID model is used by Boermans and Keshkov (2018) to analyze the impact of the ECB asset purchasing program on the European bond market. Gunji et al. (2018) also use a DID model to investigate the impact of the BOJ's ETF purchasing policy on corporate performance.

Our results are summarized as follows: First, our results indicate that the Nikkei 225 component stocks' afternoon returns are significantly higher than those of non-Nikkei 225 stocks when the BOJ purchases ETFs. Second, when we consider the four subsamples depending on the policy framework, our results imply that the positive impact on stock returns is significant for all subsamples but has become smaller over time. Third, based on the empirical results, we conduct counterfactual simulations and confirm that the cumulative treatment effects on the Nikkei 225 are around 20% as of October 2017. Finally, our results also show that the additional effects on stocks with a high weight in the Nikkei 225 or with a high BOJ shareholding rate are not observed. Overall, our results are similar and stable, demonstrating that the BOJ's interventions have had considerable impacts, particularly during the early stages of the QQE periods.

The rest of the article is organized as follows: We provide an overview of the ETF purchasing program in Section 2, and we review the related research in Section 3. Section 4 presents the data and empirical results. Finally, we offer conclusions in Section 5.

2. The BOJ's ETF Purchasing Program

The BOJ buys stocks via ETFs to promote more risk-taking activity in the overall economy by lowering the risk premium of asset prices and reducing the cost of the equity capital of Japanese companies. When the program started in December 2010,⁴ it was supposed to be a temporal policy that would end in 2011, and the maximum outstanding amount was set to 450 billion yen for purchasing either ETFs that track the TOPIX or the Nikkei 225.⁵ The BOJ raised the maximum amount and extended the program several times as show in Table 1.

⁴ For the detail of the introduction of the program, see Bank of Japan, Statement on Monetary Policy's Operational Guidelines for Asset Purchase Program, October 28, 2010.

⁵ The Nikkei 225 Index is the average of 225 high liquidity companies' stocks listed in the first section of the Tokyo Stock Exchange (TSE), while the TOPIX covers all firms in the first section of TSE and a capitalization-weighted index.

[Table 1]

When the BOJ adopted the QQE in April 5, 2013, it announced the purchase of ETFs with an annual pace of 1 trillion yen. The target annual amount tripled to three trillion yen per year on October 31, 2014 and doubled again on July 29, 2016 to six trillion yen. On September 21, 2016, the BOJ made an adjustment as part of its monetary policy review, announcing that it would allocate 2.7 trillion yen a year to TOPIX ETFs from its allocated six trillion yen, while the remaining three trillion yen would be between the TOPIX, the Nikkei 225, and the JPX-Nikkei Index 400.^{6, 7} Since then, the BOJ has bought more ETFs tracking the TOPIX (Table 2). Before the new rule was implemented, nearly half of the budget was spent on Nikkei 225 ETFs' components.

[Table 2]

The purchased amount of ETFs is publicly available on a daily basis on the BOJ website; however, information such as the time of executing an order and whether the BOJ's large order was divided into smaller limit orders is not provided. Figure 1 plots the accumulated amount of the BOJ's ETF purchases. As can be seen, the BOJ's holdings increased rapidly, and the BOJ owned more than 19 trillion yen worth of ETFs by the middle of April 2018. Figure 2 shows the estimated amount allocated for ETFs tracking the Nikkei 225 and other ETFs tracking the TOPIX and the JPX-Nikkei Index 400. The estimated amount of purchased Nikkei 225 ETFs is computed by multiplying the daily purchased amount of ETFs released from the BOJ by 55% until November 18, 2014, 53% until September 20, 2016, and 28% after September 21, 2016. Figure 2 indicates that the amount of ETF purchases has accelerated with its policy changes. In addition, the amount allocated to the Nikkei 225 ETFs was adjusted drastically in September 21, 2016. Specifically, the amount of the BOJ's Nikkei ETF purchases per intervention nearly doubled to more than 35 billion yen on August 4, 2016, following the

⁶ The BOJ started buying ETFs tracking the JPX-Nikkei 400 Index on November 19, 2014. These ETFs make up approximately 4% of the BOJ's holdings.

⁷ The BOJ also keeps its 300 billion yen of purchases in ETFs that support firms proactively investing in physical and human capital, leaving overall ETFs purchased at six trillion yen.

expansion of the program. When the new rule was implemented in September 21, 2016, the amount declined to almost its original level, or about 20 billion yen.

[Figures 1 and 2]

Since the BOJ's ETF purchasing program has been evolved as explained above, for our empirical analysis, we focus on data after the introduction of the QQE and divide the sample into four subsamples based on policy decisions; QQE1: April 5, 2013 to October 30, 2014; QQE2: October 31, 2014 to August 3, 2016; QQE3: August 4, 2016 to September 20, 2016; QQE4: September 21, 2016 to October 31, 2017.⁸ Table 3 summarizes the characteristics of the BOJ's ETF purchase program for each subsample, including the average ETF purchase amount, estimated purchase amount allocated to Nikkei 225 ETFs, the number of intervention days that the BOJ purchased ETFs, and the number of business days in a subsample. The average daily total amount increased from 15.59 billion yen in QQE1 to 72.26 billion yen in QQE3 before slightly declining to 72.21 billion yen in QQE4. The average amount allocated to Nikkei 225 ETFs also rose from 8.57 billion yen in QQE1 to 38.30 billion yen in QQE3 before drastically dropping to 20.22 billion yen in QQE4. When the amount was expanded to six trillion yen in QQE3, allocation to Nikkei 225 ETFs still followed the previous rule, as shown in Table 2. After 32 business days in QQE3, a new rule was implemented in QQE4 to mitigate the possible misallocation problem, that was buying more Nikkei 225 stocks, particularly those with higher weights in the index.

[Table 3]

3. Related Research

⁸ Our timing of the sample division between QQE2 and QQE3 is August 4, 2016, which is slightly different from the day that the BOJ's policy change was announced (July 29, 2016) because the amount of ETF purchases was modified on August 4, 2016.

Although the Japanese ETF market has been expanding at a rapid rate after the introduction of the BOJ's ETF purchasing program in 2010, there is limited research on how the ETF purchasing program affects the stock market. Ueda (2013) examines the impacts of an overall QQE program in which ETF purchasing is included and finds that the BOJ's unconventional monetary policies has had positive effects on the TOPIX and the yen-dollar exchange rates. The response of asset prices to the BOJ's various policy measures is investigated as well; however, the ETF purchasing policy is not specifically taken into consideration by Ueda (2013).

It has become obvious that the growth of the Japanese ETF market is strongly related to the BOJ's monetary policy. Because the BOJ indirectly owns firms' stocks over years, there have been some concerns regarding the Nikkei 225, such as possible distortions in equilibrium prices and the liquidity of the market, negative impacts on corporate governance, and influences on individual stocks.

The certification effects for a stock that has been added to and deleted from the Nikkei 225 are examined because there are many changes in its component stocks. Using data between 1991 and 2002, Okada et al. (2006) find that the stock prices of added firms go up on the announcement date and then decrease after the change date. Similar reactions are observed by Harada (2017) when the ETF purchasing program started. Harada (2017) finds that the stock prices of the added firm significantly went up on the announcement date, continued to increase until the day before the change date, and then decreased after the date; in addition, the negative impacts on the removed firms were significant. The structure of ETFs differs from that of stocks: ETFs are traded as beneficiary certificates with the value of portfolios consisting of component stocks, so certification effects would not occur for the component stocks of ETFs because they are part of a predetermined set. Nonetheless, the pricing of individual stocks in ETFs might be affected as a result of trading ETFs, suggesting that the BOJ's purchasing actions might have a substantial impact on individual stock prices.

Because the BOJ's ETF purchasing program favors constituent stocks in the Nikkei 225, it might produce misallocation relative to market capitalization.⁹ Since October 2016, the BOJ has bought more ETFs that measure overall trends in the stock market to mitigate this misallocation. The extent of this misallocation and distortion is examined in, for example, Ide and Takehara (2017) and Barbon and Gianinazzi (2018). Specifically, Ide and Takehara (2017) examine the differences between days with and without interventions by using measures such as an illiquidity measure, which is calculated using the high-frequency price data from January 2011 to December 2016, and two-sample t-test, which investigates the difference in mean; they show that the ETF purchasing program has provided a higher liquidity and has reduced asymmetric information in the stock market, but they question how this purchasing may have created distortions in stock pricing. Barbon and Gianinazzi (2018) examine the asset pricing implications of the ETF purchasing program on individual stock's daily returns for the period of 2013 to 2016; they show that the BOJ's program has a positive and persistent effect on individual stocks and find that the heterogeneity observed in stock prices arises from the fact that the Nikkei 225 is a price-weighted index. Their analysis is supported by a dynamic asset pricing model with the portfolio rebalancing channel. Their model also suggests that the BOJ's ETF purchase shifts the fundamental risk from the market to the balance sheet of the central bank.

Ohta (2016) examines both ETFs and their component stocks by using high-frequency data and finds that there are no significant differences in liquidity between the days the BOJ intervened and the days it did not. However, it is implied that the prices of ETFs became inefficient toward the closing time of the market, most likely because the liquidity of component stocks became less liquid near the closing time. It is also suggested that the BOJ's transactions are not iceberg orders.¹⁰ Liquidity effects are also examined by Shirota (2017),

⁹ For example, Fast Retailing Co., Ltd.'s (9983) weight in the Nikkei 225 was 6.03% in August 2017 and 7.53% in April 2018. Its weight in TOPIX was less than 0.5% throughout this time because the firm's market capitalization was relatively small—at 835 billion yen when floating stock is taken into consideration—although its total market capitalization was 3,338 billion yen at the end of August 2017. The NLI Research Institute estimates that the BOJ holds 63.2% of Fast Retailing Co., Ltd.'s floating stock.

¹⁰ Iceberg orders are large single orders that have been divided into smaller limit orders. The term "iceberg" comes from the fact that the visible lots are just the tip of the iceberg given the greater number of limit orders ready to be placed. Institutional investors tend to use iceberg orders to buy and sell large amounts of stocks.

who finds aggregate liquidity effects caused by price pressure effects when there are large purchase orders of ETFs. Shirota (2017) confirms that the BOJ's interventions have a considerable impact on permanent liquidity effects.

Hanaeda and Serita (2017) examine the effects of the BOJ's intervention on the stock market, focusing only on Nikkei 225 ETFs; they find that deviations between the market price and net asset value for each ETF increase on days the BOJ purchases ETFs. It is also implied that the presence of the central bank creates higher volatilities in the ETFs' component stocks. Influences on the corporate performance of Nikkei 225 companies are examined by Gunji et al. (2018); they use the DID approach and find that performance indicators such as ROA and ROE for companies in the Nikkei 225 tend to be lower compared with those not included in the index because of the BOJ's ETF purchasing policy.

Charoenwong et al. (2019) take a stock's free float weight in an index into consideration to examine the impact of the BOJ's purchases on a firm's daily stock returns; by aggregating the BOJ purchases up to the quarterly level, they find that the BOJ's ETF purchasing program has an immediate impact, increasing stock prices, but this effect is short-lived and has no permanent impact.

4. Empirical Analysis

4.1 Data

Given that the BOJ purchases ETFs and accumulates its outstanding, a question arises about the link between the demand for ETFs and prices. When a large order has been made, new ETFs are usually created because the demand exceeds the supply in the secondary market. In the current study, to see the effects of the BOJ's ETF purchase program on individual stock prices, we collect individual stock data from the Japan Exchange Group (JPX) for stocks listed in the first section of the TSE for the period after the introduction of the QQE, namely April 5,

2013 to October 31, 2017.¹¹ We focus on data after the QQE because the ETF purchase program has been operated more aggressively since then, with the frequency of ETF purchases nearly tripling after the introduction of QQE. In addition, soon after the introduction of the QQE on July 16, 2013, the TSE and the Osaka Securities Exchange (OSE) merged their cash-equity trading platforms. Firms traded on the OSE moved their listings to the TSE, and the number of stocks increased by more than 1000, going up to 3423 companies. The TSE's first section stocks increased by 37 to 1760 because of this merge. Using the data after the QQE mitigates the effect of this merger.¹²

The BOJ is more likely to place an ETF purchasing order in the afternoon when the market is likely to be in a downturn in the morning. We decompose day returns, which are calculated using the opening and closing prices, into the morning and afternoon returns to control the timing of the BOJ's purchasing of ETFs. Specifically, the morning returns are percentage changes between the opening price and closing price in the morning session, while the afternoon returns are percentage changes between the closing price in the morning session and closing price of the day. When the opening or closing price is not provided, its closest indicative price is used, if available. The morning session of the TSE starts at 9:00 a.m. and closes at 11:30 a.m. The afternoon session is between 12:30 p.m. and 15:00 p.m.

For the BOJ's intervention days and non-intervention days, the average performance of individual stock returns is shown in Table 4. As can be seen, the average day and morning returns are negative on the intervention days. On the other hand, the average returns are all positive for the day, morning, and afternoon returns on the non-intervention days. However, this does not mean that the BOJ's purchases decrease stock market prices, just that the BOJ

¹¹ The number of listed firms differs each year. That is, there were 1774 firms in 2013 and 2062 in 2017. Our sample is not the number we collect from the JPX because we exclude 150 firms that did not have a quote price for at least one day and exclude 14 firms whose stock prices declined lower than 10 yen during the sample period. Thirteen electric utility companies, such as Tokyo Electric Power Co., Inc., are also excluded because the stock prices of those firms were heavily affected by the Great East Japan Earthquake of March 2011 (see Jaussaud et al. (2015)).

¹² We also conduct the same analysis after the merger between the TSE and OSE and obtain the qualitatively same results.

tends to buy ETFs when stock prices are declining. We examine the effects of the policy more precisely by employing a DID analysis in the following subsections.

[Table 4]

4.2 DID estimation

Stock returns with and without an intervention on the intervention days should be compared to assess the effect of the BOJ's ETF purchasing program; however, it is not possible to observe stock returns that are not affected by an intervention on the intervention day. To overcome this problem, the DID methodology is used in the analysis by focusing on the BOJ's purchasing of Nikkei 225 ETFs. Specifically, our treatment group is Nikkei 225 component stocks, while non-Nikkei 225 stocks are the control group. Imbens and Wooldridge (2009) explain that a DID approach is associated with natural experiments where policy changes can be used to effectively define the control and treatment groups. Because the average gain in the control group is subtracted from the gain in the treatment group, this difference removes biases between the intervention and non-intervention days.

The DID model is defined as follows:

$$r_{it} = \alpha + \beta DI_t + \gamma DN_{it} + \delta TE_{it} + \varepsilon_{it}, \quad (1)$$

where DI_t is a dummy variable for the intervention days. DN_{it} is a dummy variable that takes 1 for Nikkei 225 stocks and 0 for non-Nikkei stocks. $TE_{it} = DI_t \times DN_{it}$, which works as a DID term. The coefficient δ measures the treatment effect (TE), given that the difference between the two groups is the same regardless of a BOJ intervention. Errors are assumed to be serially uncorrelated but contemporaneously correlated.

The results based on equation (1) are summarized in the second and third columns of Table 5, reporting the estimate of TE, its t-statistic, and adjusted coefficient of determination, R^2 for each return. As can be seen, we find that δ , the estimate of the TE, is insignificant for

day returns and significantly negative for morning returns. These most likely reflect a simultaneous bias because of the negative correlation between DI_t and the error term, given that the market consensus is that the BOJ intervenes in the afternoon session when the performance of morning returns is poor. On the other hand, we can mitigate this problem by using the afternoon returns if we assume that the BOJ determines whether to intervene based on the information up to the end of the morning session, as also discussed by Shirota (2017). Indeed, δ is significantly positive for afternoon returns with an estimate of 0.0616. This means that if the BOJ purchases ETFs that track the Nikkei 225, its component stock prices increase by 0.0616% on average in the afternoon of the same day. Although our estimate of the effect is relatively small, it is expected that its cumulative effect could be large, as we confirm below, because the BOJ had intervened 364 times during our sample period.

[Table 5]

Next, our standard DID model is extended to accommodate the quantitative impact of the program, which is relevant because the amount of ETFs that the BOJ purchases fluctuates, mostly reflecting the BOJ's policy changes. In this model, the treatment reflects the estimated amount of Nikkei 225 ETFs that the BOJ purchased, as follows:

$$r_{it} = \alpha + \beta PA_t + \gamma DN_{it} + \delta TE_{it} + \varepsilon_{it}. \quad (2)$$

Here, PA_t is the BOJ's purchased amount of Nikkei 225 ETFs in 10 billion yen, and $TE_{it}(= PA_t \times DN_{it})$ is the extended DID (EDID) term. δ now shows the TE per 10 billion yen of BOJ purchases of Nikkei 225 ETFs.

The results of the EDID model (2) are shown in the last two columns of Table 5. δ is again significantly positive for afternoon returns with an estimate of 0.0302, meaning that Nikkei 225 stock prices increased by 0.0302% per 10 billion yen of ETFs purchased by the BOJ. Because the BOJ's average purchase amount of Nikkei 225 ETFs per intervention is 16.37 billion yen over the entire sample, as can be seen in Table 3, this suggests that the BOJ's purchasing of Nikkei 225 ETFs raises the component stocks by $0.0302\% \times 16.37 = 0.049\%$ per intervention on average.

A counterfactual simulation is also conducted to see how the Nikkei 225 would act if there were no Nikkei 225 ETF purchases by the BOJ. We assume that there would be no TEs on the days the BOJ intervened. CF1 is based on the results of the DID for the afternoon returns, which is shown in the second and third columns of Table 5, and CF2 reflects the results given by the EDID for the afternoon returns, which is shown in the last two columns of Table 5. Figure 3 shows that the discrepancy between the lines is small until mid-2014, then two lines—CF1 and CF2—started to separate from the index along with the expansion of the program. Our results show that cumulative treatment effects on the Nikkei 225 are around 20% as of October 2017.

[Figure 3]

4.3 Subsample analysis

At the beginning of the QQE in April 2013, the annual maximum amount for ETF purchases was set at one trillion yen, but the amount tripled to three trillion yen in October 2014 and then doubled to six trillion yen in July 2016. These policy changes might have created different impacts on stock returns. In this subsection, the sample is divided into four subsamples, and the influences of the program on each subsample is investigated to determine whether the TEs depend on the policy framework. The four subsamples based on the policy decisions are QQE1 (April 5, 2013 to October 30, 2014), QQE2 (October 31, 2014 to August 3, 2016), QQE3 (August 4, 2016 to September 20, 2016), and QQE4 (September 21, 2016 to October 31, 2017), respectively.

Table 6 documents the estimate of TE, its t-statistic, and adjusted R^2 **results** based on equation (1) for each subsample and for the afternoon returns. As can be seen in the second column, the TE for the DID analysis is highly significant for all the subsamples, but the magnitude varies. The TE grew until QQE3, but it dropped significantly in QQE4, partly reflecting a reduction in the amount allocated to Nikkei 225 ETFs.

[Table 6]

To accommodate for changes in the amount of ETFs purchased, we also use the EDID model (2) for each subsample. The results are summarized in the last two columns of Table 6. As can be seen, the TE was the largest in the first subsample, QQE 1, and has been declining since then despite increased purchase amounts. Specifically, Nikkei 225 stock prices increased by 0.0554% per 10 billion yen of ETFs purchased by the BOJ in QQE1, but the impact was only 0.0195% in QQE4.

We conduct a similar counterfactual simulation, and Figure 3 shows the results. CF3 and CF4 are based on the results of the DID and EDID shown in Tables 6, respectively. As can be seen, the overall difference is quite small across the models, and most of the results indicate that the cumulative treatment effects on the Nikkei 225 are around 20% as of October 2017.

4.4 Additional effects on the highest weight and BOJ's shareholding rate companies

An additional analysis using the EDID estimation is also run to consider the characteristics of the Nikkei 225 and share of the BOJ's shareholdings in a company's outstanding stocks, which are all the stocks of a firm that have been authorized and issued.¹³

The Nikkei 225 is the leading and most widely used index of the Japanese stock market. It is a price-weighted, yen-denominated stock index comprised of 225 firms traded on the TSE. The Nikkei 225 is equivalent to the Dow Jones Industrial Average Index in the United States. The Nikkei 225 has been calculated since September 1950 and is the oldest stock index in Asia. Because it is a price-weighted index, each stock influences the index in proportion to its price per share. The value of the index is generated by adding the prices of each of the stocks in the index and dividing them by the total number of stocks. By definition, the stocks with a higher price are given more weight and have a greater influence over the performance of the entire

¹³ The results based on DID models are qualitatively very similar and omitted to save space but are available upon request.

index. For the Nikkei 225, there are several high-weight firms, as can be seen below.¹⁴ Not only do these stocks influence the Nikkei 225, but also they might be affected more by the BOJ's ETF purchasing program. Therefore, we examine this possibility in this subsection.

Additionally, we take the share of the BOJ's shareholding in a company's outstanding stocks into account in our additional analysis. As discussed, the BOJ became the top shareholder of more than 55 companies in the Nikkei 225, so it might be possible that BOJ's ETF purchasing program will have larger effects on those firms with a higher BOJ shareholding rate.

The top 10 highest weighted companies in the Nikkei 225 and their corresponding weights are shown on the left side of Table 7. As can be seen, Fast Retailing Co. Ltd. (9983), Softbank Group Corp. (9984), and Fanuc Corp. (6954) are the top three stocks, with 6.03%, 5.13%, and 4.09%, respectively, as of August 2017. The 10 companies with the highest BOJ shareholding rates and their rates are on the right side of the same table,¹⁵ showing that Advantest Corp. (6857), Fast Retailing Co. Ltd, and Taiyo Co. Ltd. (6976) are the top three at 17.57%, 15.80%, and 14.95% respectively. The companies on the left and right are not the same, except one company, Fast Retailing Co. Ltd. Floating stock adjustments are not taken into consideration in Table 7, so the percentages shown in the table on the right are the ratios of the BOJ's indirect holdings to total outstanding stocks.¹⁶ The ratio would be 31.95% for Advantest Corp., 63.20% for Fast Retailing Co. Ltd., and 23.00% for Taiyo Yuden Co. Ltd. if stocks that are not traded in the market were to be excluded.

[Table 7]

¹⁴ The weights are regularly disclosed by the Nikkei Inc. Nikkei Stock Average - Weight (Closing date Apr/2,2018) and can be found here:

https://indexes.nikkei.co.jp/nkave/archives/file/nikkei_stock_average_weight_en.pdf

¹⁵ Note that all of these companies are included in the Nikkei 225.

¹⁶ We also examined the highest BOJ shareholding rate in floating stocks and obtained qualitatively similar results.

Additional effects on some Nikkei 225 component companies with either a higher weight or higher BOJ shareholding rate are examined. Specifically, the additional treatment effects (TE2) are estimated as follows:

$$r_{it} = \alpha + \beta PA_t + \gamma DN_{it} + \delta TE_{it} + \eta TE2_{it} + \varepsilon_{it}.$$

$TE_{it}(= PA_t \times DN_{it})$ is the EDID term, $TE2_{it}(= PA_t \times AD_{it})$ captures additional effects, and AD_{it} is a dummy variable that takes 1 for either top three or top seven (10) highest weight (BOJ shareholding rate) stocks in the Nikkei 225 and 0 for the rest of the stocks.¹⁷

The estimates of TE and TE2 on companies with the top three and seven highest weights in the Nikkei 225 are reported in Table 8. Because the results are based on an EDID analysis, the coefficients of the TE are essentially the same as the results of the EDID in Table 6. The coefficient of the TE is the largest in the first subsample (QQE 1) and has been declining over time. TE2 on highly weighted stocks are not significant at the 5% significance level, indicating that the BOJ's ETF purchases did not have supplemental effects on stocks with higher weights in the Nikkei 225.

[Table 8]

Similarly, estimates of TE2 on companies with the top three and 10 highest BOJ shareholding rate are shown in Table 9. The coefficients of the TE are highly significant and resemble those in Tables 6 and 8, suggesting that our estimation results are robust. Additional effects on high BOJ shareholding rate stocks are mixed, and strong effects on them are not observed. More specifically, none of the additional effects are significant at the 5% significance level.

[Table 9]

¹⁷ We chose the top seven for the highest weighted companies with 2% as the threshold, and we used the top 10 for the highest BOJ shareholding rate with 12% as the threshold. The results are qualitatively similar if we adopt different thresholds.

In sum, our results are clear-cut. The Nikkei 225 stocks with the highest weights in the Nikkei 225 and highest BOJ shareholding rates received no additional impacts from the BOJ's ETF purchase.

4.5 Robustness test results

To further see the robustness of our results, we include either a firm-specific fixed effect or a market factor for both the DID and EDID models, namely equations (1) and (2). The impact of the individual specific characteristics is captured using a fixed effect, and the entire market on the TSE first section is captured using a market factor. Specifically, we estimate with models (1) and (2) using α_i instead of α for the fixed effect, while a market factor is added to control the entire market performance as follows:

$$r_{it} = \alpha + \beta PA_t + \gamma DN_{it} + \eta r_{Mt} + \delta TE_{it} + \varepsilon_{it}.$$

Here $TE_{it}(= PA_t \times DN_{it})$ is the EDID term and r_{Mt} is the market factor measured by the counterfactual Nikkei 225 returns calculated in Section 4.3.¹⁸

The estimation results are summarized in Table 10. As can be seen, the results with the fixed effect are essentially the same as those in the previous subsections. Although the TEs with the market factor are slightly different, our main finding of significant and decreasing TEs over the QQE periods is still the same. In sum, our estimation results are quite robust.

[Table 10]

5. Conclusion

¹⁸ To estimate the treatment effect precisely, we need to use market returns without treatment effects. We use the counterfactual Nikkei 225 returns calculated in Section 4.3 as the market returns for this.

This paper examines the impacts of the BOJ's ETF purchasing program that the BOJ has conducted since December 2010 as a part of its unconventional monetary policy and accelerated after the introduction of the QQE in April 2013. The BOJ is the only central bank that holds the stocks of a number companies indirectly via large positions in ETFs. The BOJ allocates its budget to major stock market indices, including the TOPIX, the Nikkei 225, and the JPX-Nikkei Index 400. Earlier, the BOJ purchased more ETFs that track the price-weighted Nikkei 225 than the TOPIX, and this possible misallocation had raised concerns.

In the current study, the influence on underlying stock returns is assessed by comparing the performance of stocks among those included in the Nikkei 225 and others not included using a DID analysis. We also separate morning and afternoon returns to control the fact that the BOJ tends to purchase ETFs when performance of the stock market is poor in the morning session. Our empirical analysis focuses on various QQE periods because the BOJ's purchasing frequency increases abruptly under different QQE periods.

Based on the DID (EDID) model, we find that the Nikkei 225 component stocks' afternoon returns are significantly higher at 0.0616% (0.049%) than those of non-Nikkei 225 stocks on average when the BOJ purchased ETFs. With the subsample analysis, our results show that the positive impact on stock returns is significant for all subsamples but has become smaller over time, with an estimated TE of 0.0554% and 0.0195% per 10 billion yen of ETFs purchased by the BOJ in QQE1 and QQE4, respectively. In addition, our counterfactual simulations indicate that the cumulative treatment effects on the Nikkei 225 are around 20% as of October 2017. Our results also show that the additional effects on the highest weighted stocks in the Nikkei 225 and the stocks with the highest BOJ shareholding rate are not observed. Our results are overall similar and stable, meaning that the BOJ's interventions have had considerable impacts on the market, particularly in the early stages of QQE periods.

References

Bank of Japan (2010), Principal Terms and Conditions for Purchases of ETFs and J-REITs Conducted through the Asset Purchase Program, https://www.boj.or.jp/en/mopo/measures/term_cond/yoryo59.htm/ (Last accessed December 27, 2018).

Bank of Japan (2017), Principal Terms and Conditions for Purchases of ETFs and J-REITs, https://www.boj.or.jp/en/mopo/measures/term_cond/yoryo85.htm/ (Last accessed December 27, 2018).

Boermans, Martijn and Viacheslav Keshkov (2018), The impact of the ECB asset purchases on the European bond market structure: Granular evidence on ownership concentration, DNB Working Paper No. 590

Charoenwong, Ben, Randall Morck, and Yupana Wiwattanakantang (2019), Asset Prices and Corporate Responses to Bank of Japan ETF Purchases, NBER Working Paper 25525.

Fueda-Samikawa, Ikuko and Tetshushi Takano (2017), BOJ's ETF purchases expanding steadily --How long will the BOJ hold risky assets with no maturity?, Japan Center for Economic Research July 6 2017.

Gunji, Hiroshi, Kazuki Miura, and Yuan Yuan (2018), The impact of the BOJ's ETF purchases on the Nikkei 225 companies' performance (in Japanese), mimeograph.

Hanaeda, Hideki and Toshio Serita (2017), Effects of Nikkei 225 ETFs on stock markets: impacts of purchases by the Bank of Japan, mimeograph.

Harada, Kimie (2017), Event study analysis of additions and subtractions from the Nikkei 225 under the ETF purchasing policy [Nihon ginko no ETF kaiire seisaku to Nikkei heikin kabuka meigara irekae no event study] (in Japanese), *Shoken Keizai Kenkyu* 100, 75-90.

Ide, Shingo and Hitoshi Takehara (2017), The BOJ's ETF purchasing and its effects on price [Nihon ginko niyoru ETF kaiire ga kabuka hakken ni ataeta eikyo: kobetsu meigara tick data wo mochiita bunseki] (in Japanese), mimeograph.

Imbens, Guido and Jeffrey Wooldridge (2009), Recent Developments in the Econometrics of Program Evaluation, *Journal of Economic Literature* 47(1), 5-86.

Jaussaud, Jacques, Sophie Nivoix and Serge Rey (2015), The Great East Japan Earthquake and Stock Prices, *Economics Bulletin* 35(2), 1237-1261.

Okada, Katsuhiko, Nobuyuki Isagawa and Kenya Fujiwara (2006), Addition to the Nikkei 225 index and Japanese market response: temporary demand effect of index arbitrageurs, *Pacific-Basin Finance Journal* 14, 395-409.

Ohta, Wataru (2016), Large investors and liquidity in the stock markets [Shoken shijyo ni okeru oguchi tousei to ryudousei] (in Japanese), mimeograph.

Shirota, Toyochiro (2017), Evaluating the "Unconventional" monetary policy in stock markets: The propensity score approach, mimeograph.

Ueda, Kazuo (2013), Response of Asset Prices to Monetary Policy under Abenomics, *Asian Economic Policy Review*, 8(2).

Table 1: The BOJ's ETF purchasing program and its changes

October 28, 2010	Principal Terms and Conditions for Purchases of ETFs and J-REITs Conducted through the Asset Purchase Program has been established. The maximum outstanding amount of ETFs was set to 450 billion yen. Purchases of ETFs were a temporal policy ending in 2011.
March 14, 2011	The maximum outstanding amount of ETF was set to 900 billion yen and the policy was extended until June 2012.
August 4, 2011	The maximum outstanding amount of ETF was set to 1.4 trillion yen and it was extended until the end of 2012.
April 27, 2012	The maximum outstanding amount ETF was set to 1.6 trillion yen.
October 30, 2012	The maximum outstanding amount of ETF was set to 2.1 trillion yen and it was extended until the end of 2013.
April 4, 2013	Principal Terms and Conditions for Purchases of ETFs and J-REITs Conducted through the Asset Purchase Program became invalid. New Principal Terms and Conditions for Purchases of ETFs and J-REITs has been enacted. Annual maximum purchase amount of ETF was set to 1 trillion yen.
October 31, 2014	Annual maximum purchase amount of ETF was set to 3 trillion yen.
November 19, 2014	JPX-Nikkei Index 400 is added as ETFs shall be purchased.
March 15, 2016	Annual maximum purchase amount of ETF was set to 3.3 trillion yen. 300 billion yen was set for ETFs that support firms proactively investing in physical and human capital.
July 29, 2016	Annual maximum purchase amount of ETF was set to 6 trillion yen.
September 21, 2016	The maximum amount of each ETF to be purchased has changed. 2.7 trillion yen a year is for ETFs that track TOPIX. 3 trillion yen is for ETFs that track any of the three indices as before, proportionate to the total market value of that ETF issued.

Source: Various documents of Bank of Japan's Principal Terms and Conditions for the Asset Purchase Program.

Notes: Authors' creation.

Table 2: Purchasing rule of ETFs

From October 28, 2010 to July 29, 2016

Nikkei 225 approximately 53%	TOPIX Approximately 42%	JPX Nikkei 400 4%	0.3
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Proportionate to the total market value of each ETFs issued.
0.3 trillion yen is for ETFs to Support Firms Proactively
Investing in Physical and Human Capital from March 15, 2016.

Since September 21, 2016

3 trillion yen	TOPIX 2.7 trillion yen		0.3
3 trillion yen	TOPIX	Nikkei 225	JPX Nikkei 400

3 trillion yen is allocated for ETFs that track any of three indices same as before.
The purchase amount of each ETF is set to be proportionate to the total market value of each ETF.

2.7 trillion yen is for ETFs that track TOPIX.

Source: Various documents of Bank of Japan's Principal Terms and Conditions for the Asset Purchase Program.

Notes: Authors' creation.

Table 3: Summary statistics of BOJ's ETF purchases

		ETF purchase amount (10 bil. Yen)	Nikkei ETFs purchase amount (10 bil. yen)	Business days	Intervention days
Full	Average	3.873	1.637	1122	364
	Std. Dev.	2.180	0.626		
QQE1	Average	1.559	0.857	387	113
	Std. Dev.	0.342	0.188		
QQE2	Average	3.486	1.849	429	155
	Std. Dev.	0.173	0.096		
QQE3	Average	7.226	3.830	32	10
	Std. Dev.	0.134	0.071		
QQE4	Average	7.221	2.022	274	86
	Std. Dev.	0.141	0.039		

Notes: This table provides summary statistics of the BOJ's average ETF purchased amount, estimated purchase amount allocated to the Nikkei 225 ETFs, business days and intervention days that the BOJ purchased ETFs within each subsample.

Table 4: Summary statistics of stock returns

		Non-intervention days			Intervention days			Total observations	Number of firms
		Day	Morning	Afternoon	Day	Morning	Afternoon		
Full	Average	0.162	0.138	0.027	-0.342	-0.311	-0.030	1746954	1557
	Std. Dev.	1.668	1.390	1.237	1.840	1.431	1.258		
QQE1	Average	0.169	0.105	0.067	-0.491	-0.340	-0.150	631197	1631
	Std. Dev.	1.794	1.451	1.320	1.978	1.542	1.409		
QQE2	Average	0.195	0.205	-0.005	-0.431	-0.368	-0.062	762762	1778
	Std. Dev.	1.748	1.494	1.375	1.903	1.501	1.298		
QQE3	Average	0.087	0.072	0.019	-0.016	-0.135	0.119	62560	1955
	Std. Dev.	1.693	1.415	1.240	1.572	1.270	0.963		
QQE4	Average	0.098	0.076	0.025	-0.026	-0.184	0.159	528546	1929
	Std. Dev.	1.433	1.247	1.083	1.594	1.249	1.091		

Notes: Summary statistics of stock returns are provided separately for non-intervention days and intervention days. Day refers to day returns, calculated using opening and closing prices. Morning returns, Morning, are percentage changes between the opening price and closing price in the morning session. Afternoon returns, Afternoon, are percentage changes between the closing price in the morning session and closing price of the day.

Table 5: Estimates of TE based on the DID and EDID analyses for Nikkei 225 Stock returns

	DID		EDID	
	TE	Adj R ²	TE	Adj R ²
Day	0.0047	0.0184	-0.0001	0.0110
	0.9859		-0.0400	
Morning	-0.0562	0.0220	-0.0299	0.0166
	-11.7959		-11.3267	
After noon	0.0616	0.0005	0.0302	0.0001
	12.9157		11.4523	

Notes: The table reports the estimates of TE based on the DID and EDID analyses for day, morning and afternoon returns. Numbers recorded under estimates are t-statistics.

Table 6: Estimates of TE based on the Subsample DID and EDID analyses for Nikkei 225 afternoon returns

	DID		EDID	
	TE	Adj R ²	TE	Adj R ²
QQE1	0.0575	0.0054	0.0554	0.0044
	6.8944		5.8777	
QQE2	0.0795	0.0005	0.0431	0.0004
	10.6919		10.7365	
QQE3	0.1232	0.0019	0.0316	0.0019
	4.4197		4.3425	
QQE4	0.0388	0.0034	0.0195	0.0035
	4.0858		4.1431	

Notes: The table reports the estimate of the TE based on the DID and EDID analyses for the afternoon returns in each subsample. Numbers recorded under estimates are t-statistics.

Table 7: The top 10 highest weighted and the highest BOJ shareholding rate stocks in Nikkei 225 (as of August 2017)

	The top 10 highest weighted companies			The 10 companies with the highest BOJ shareholding rates		
	Code	Name	Weight	Code	Name	Rate
Top1	9983	Fast Retailing Co Ltd	6.03%	6857	Advantest Corp	17.57%
Top2	9984	SoftBank Group Corp	5.13%	9983	Fast Retailing Co Ltd	15.80%
Top3	6954	FANUC Corp	4.09%	6976	Taiyo Yuden Co Ltd	14.95%
Top4	9433	KDDI Corp	3.41%	6762	TDK Corp	14.29%
Top5	8035	Tokyo Electron Ltd	2.96%	8028	FamilyMart UNY Holdings Co Ltd	14.16%
Top6	6971	Kyocera Corp	2.53%	5707	Toho Zinc Co Ltd	13.70%
Top7	6367	Daikin Industries Ltd	2.11%	4704	Trend Micro Inc/Japan	12.94%
Top8	4063	Shin-Etsu Chemical Co Ltd	1.86%	1721	COMSYS Holdings Corp	12.75%
Top9	6988	Nitto Denko Corp	1.86%	9766	Konami Holdings Corp	12.54%
Top10	4543	Terumo Corp	1.63%	4021	Nissan Chemical Corp	12.28%

Notes: This table provides companies with the highest weights in the Nikkei 225 and with highest BOJ shareholding rates. Floating stock adjustments are not taken into considered in the table so that the percentage shown in the table on the right end are the ratio of the BOJ's indirect shareholdings to total stock outstanding.

Table 8: Estimates of TE and TE2 on stocks with the highest weight in the Nikkei 225 based on the EDID analysis

	Top 3		Top 7	
	TE	TE2	TE	TE2
QQE1	0.0554	-0.0021	0.0559	-0.0183
	5.8694	-0.0345	5.8880	-0.4471
QQE2	0.0428	0.0243	0.0423	0.0279
	10.6648	0.9653	10.4675	1.6798
QQE3	0.0323	-0.0599	0.0327	-0.0341
	4.4291	-1.2491	4.4480	-1.0750
QQE4	0.0194	0.0017	0.0203	-0.0259
	4.1198	0.0547	4.2812	-1.2619

Notes: The table reports the estimates of the TE and TE2 on the highest weighted stocks in Nikkei 225, based on the EDID analysis for the afternoon returns in each subsample. Numbers recorded under estimates are t-statistics.

Table 9: Estimates of TE and TE2 on stocks with the highest BOJ shareholding rates based on EDID analysis

	Top 3		Top 10	
	TE	TE2	TE	TE2
QQE1	0.0553	0.0024	0.0559	-0.0123
	5.8467	0.0388	5.8610	-0.3554
QQE2	0.0437	-0.0425	0.0428	0.0067
	10.8451	-1.6855	10.5474	0.4808
QQE3	0.0316	0.0002	0.0327	-0.0241
	4.3229	0.0046	4.4321	-0.9036
QQE4	0.0201	-0.0435	0.0210	-0.0319
	4.2562	-1.4039	4.3987	-1.8459

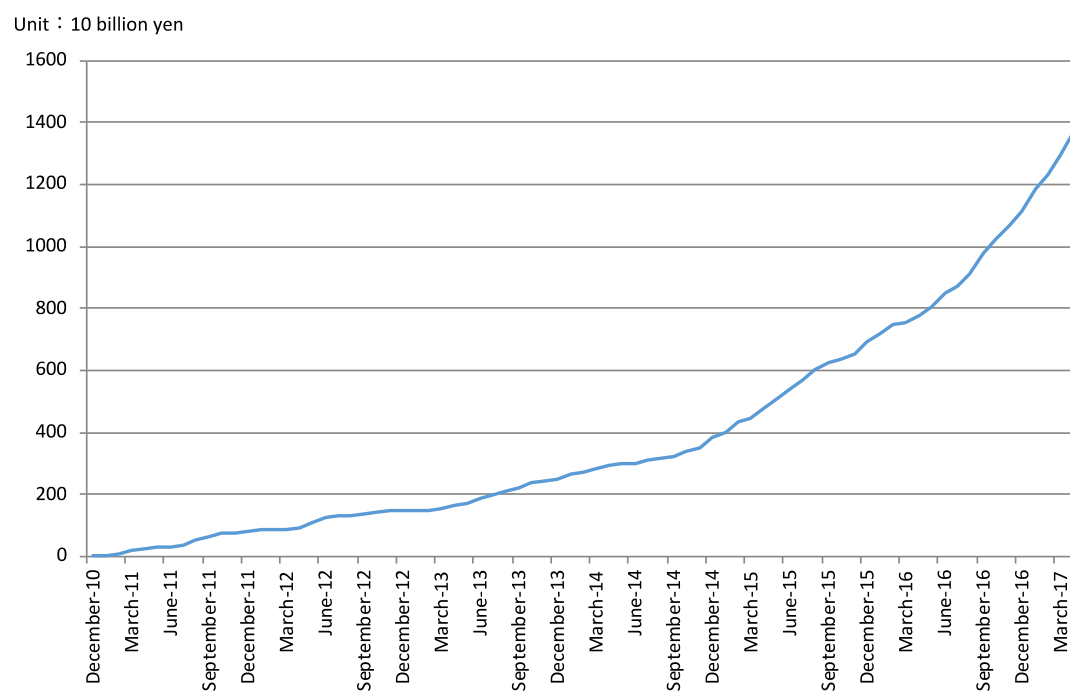
Notes: The table reports the estimates of the TE and TE2 on the highest BOJ shareholding rate stocks, based on EDID analysis for the afternoon returns in each subsample. Numbers recorded under estimates are t-statistics.

Table 10: Robustness test results

	Fixed effect		Market factor	
	DID	EDID	DID	EDID
QQE1	0.0574	0.0554	0.1174	0.1169
	6.8817	5.8770	13.9354	12.3092
QQE2	0.0795	0.0431	0.0900	0.0482
	10.6935	10.7384	12.1070	12.0206
QQE3	0.1234	0.0317	0.1007	0.0258
	4.4259	4.3490	3.6056	3.5405
QQE4	0.0388	0.0195	0.0213	0.0107
	4.0844	4.1415	2.2351	2.2728

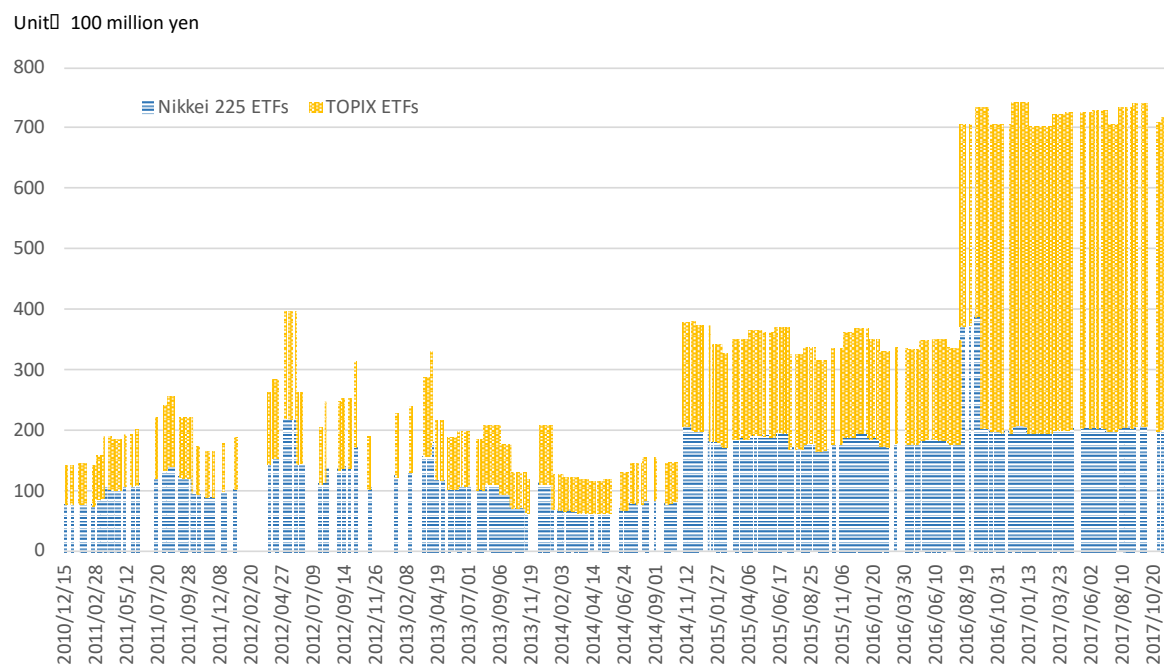
Notes: The table reports the estimates of TE based on the DID and EDID analyses with firm-specific fixed effect (left) or a market factor (right) for the afternoon returns in each subsample. Numbers recorded under the estimates are t-statistics.

Figure 1: ETF outstanding held by the BOJ



Source : Bloomberg's JMBTETF.

Figure 2: Estimated purchased amount of Nikkei 225 ETFs and TOPIX ETFs



Source: Bank of Japan's Website.

Notes: Authors' creation.

Figure 3: Actual and counterfactual Nikkei 225 based on DID and EDID for the full sample and subsample analyses

