Bank of Japan Intervention and its Impact on Price Efficiency of Underlying Stocks in ETFs

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Bank of Japan Intervention and its Impact on Price Efficiency of Underlying Stocks in ETFs

น.ส.กัลยรัตน์ งามบริรักษ์

สารนิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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Price efficiency of stock market is one of classic stories in financial and economics world. This paper aims at quantitatively identify the impact of government intervention in stock market on price efficiency of the stocks rather than testing whether stock market is efficient or not. The government intervention in this paper is the intervention from the Bank of Japan to stimulate Japan's economy through the purchase of ETFs. First, we test whether price efficiency of the underlying stocks in ETFs are improved or deteriorated as a result of the intervention. The results suggest that in aggregate stocks with high exposure to the BOJ purchase do not significantly relates to higher or lower level of price efficiency. Then, we further categorize stocks into groups according to their weight exposures to the purchase ranking from lowest/low/moderate/high/highest exposure and test the impact of the BOJ purchase of each groups on the price efficiency and find that the BOJ intervention causes price efficiency of stocks that are not affected from the purchase to be worsen. In contrast, price efficiency of stocks that are the BOJ targets have been improved significantly. Moreover, stocks in groups with higher exposure to the purchase are faced with more improvement in price efficiency especially from stocks with no exposure to stock with low and lower exposure. However, as the exposure increases further, we found no significant difference in the increase of price efficiency.

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Kunyarat Ngamboriruk

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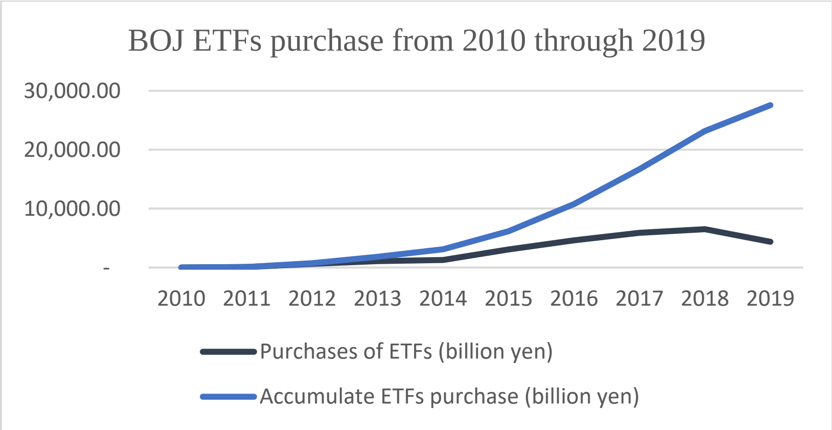
1. Introduction

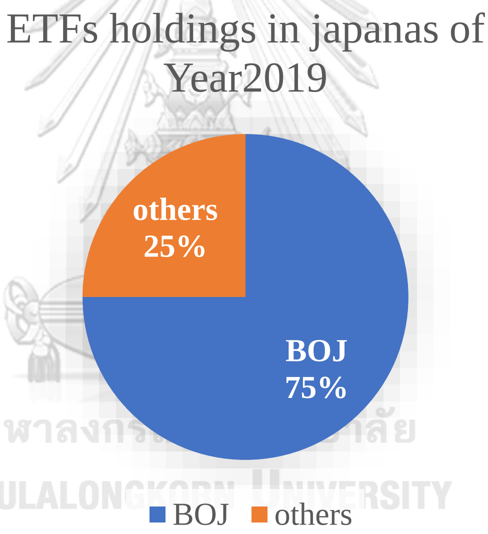
There has long been study on price efficiency of stocks in the markets. Previous literatures test market efficiency differently, however most of them rely on the same notion of Efficient Market Hypothesis (EMH) that asset prices fully and instantaneously reflect all available and relevant information (Fama, 1970) . In other words, current price already incorporates all information relative to the stocks, only news can cause the price change. News, by definition, is information not previously known by someone, therefore change in price is unpredictable. The test of market efficiency aims at testing how stock prices react to certain sets of information rather than testing whether the market is efficient or not. The EMH is categorized into three sub types; (1) Weak form Hypothesis tests the reaction of stock prices whether the prices already reflect all information in market trading data which includes past prices and trading volume. (2) Semi-Strong form Hypothesis tests whether stock prices incorporate all publicly available information, for example corporate announcement, financial statement, macro-economic events. (3) Strong form Hypothesis tests whether stock prices already reflect all information relevant to the stock including inside information. Empirical studies usually test weak form and semi-strong form of EMH.

Financial derivatives have grown substantially and became an important financial instrument in the investment world. It is said that derivatives increase market efficiency since derivatives are priced associated with the underlying asset, therefore the price of both underlying asset and derivatives tend to be in equilibrium to avoid arbitrage opportunities. Among derivative innovations, Exchange Traded Funds

(ETFs) has increased in popularities in the recent decades especially after the financial crisis in 2008 mainly due to its low transaction cost and intraday liquidity. Researchers have explored many aspects of ETFs, not only the positive side but also negative consequences. One of the aspects is the impact of ETFs existence on price efficiency of the underlying securities. One stream of literatures supports the role of ETFs in improving price efficiency of the underlying assets whereas other stream of literatures argue that increase in ETFs ownership could deteriorate price efficiency of the underlying securities. However, most studies on the impact of ETFs on price efficiency focus primarily on the US market which considered being the largest ETFs market with total asset under management around 70% of ETFs worldwide. Market in the US is competitive and is driven by substantial number of traders, both retail and institutional investors. The lack of study in other markets with different market characteristics gives rise to the study of this paper, whether ETFs traded or held by government affect price efficiency of underlying securities in a different manner.

Japanese ETFs is observed to have special properties in terms of ownership, 75% of ETFs in Japan are owned by the Bank of Japan (BOJ) following Unconventional Monetary Policy launched by the BOJ. Purchasing of corporate equities is part of the program, which is named as “Comprehensive Monetary Easing (CME)”. CME was launched in October 2010 aiming to stimulate the economy by holding near-zero interest rate and by purchasing long-duration financial assets in order to lower long-term interest rate and risk premium. Purchasing ETFs was one of the CME’s various stimulants. Originally, purchase of ETFs was capped at ¥0.45 trillion in 2010. However, the ETF purchasing cap has been increased over time since it originated, as of December 2019, BOJ has accumulated equity index ETFs holdings worth almost ¥28 trillion.





The BOJ purpose on buying ETFs is to indirectly increase stock valuation and decrease firm’s cost of capital and hence increase firms’ investment to stimulate the economy as a whole. Fueda-Samikawa and Takano (2017) find that BOJ tends to make a purchase on the day that market drops in the first sessions and continues to buy ETFs for several days when stock prices are declining and tends to stop buying when stock prices rise sharply. The decision to purchase ETFs is made by the Ministry of Finance and the Commissioner of the Financial Services Agency, the purchase is then made through an investment trusts which is annually reselected. Operationally, the BOJ creates reserves, and passes them to an investment trusts that buys underlying equities in the proportions that makes up the value of the indexes. The BOJ targeted ETFs are those that track the Tokyo Stock Price Index (TOPIX), the Nikkei 225 Stock Average, or the JPX-Nikkei Index 400 (JPX-Nikkei 400), the amount purchased is proportionate to the market value of ETF issued. The BOJ ETFs purchase is publicly announced one day after the purchase. Since the ETFs are not purchased through usual mechanism like other competitive markets, the BOJ intervention could have to different results on price efficiency of the underlying assets unlike the studies conducted in the US.

Due to the fact that the market can be affected by various factors, natural, economic, political and/or social events which can disrupt its dynamic. As a consequence, stock market could exhibit deviations in efficiency. Thus, this paper seeks to answer two questions as follows

1. Does the BOJ intervention enhance or deteriorate price efficiency of the stocks in Tokyo Stock Exchange (TSE)?
2. Is there any difference in impact on price efficiency across stocks with different exposure to the BOJ intervention?

Objectives and Contributions

The objective of this paper is to quantitatively identify the impact of the BOJ intervention through ETFs purchase on price efficiency of the underlying stocks in the

ETFs and to differentiate the impact of price efficiency on stock affected by BOJ ETFs purchase and stocks that do not affect from the purchase.

This paper contributes to the existing literature in the following ways. First, even though the study on the impact of Comprehensive Monetary Easing program has been studied by many researchers, the impact of BOJ ETFs purchase on price efficiency of stocks has not yet been explored. Second, the result from this paper could raise the awareness of the policy makers and/or investors on the impact of monetary policy in aggregate.

2. Literature Review

Studies that supports the role of ETFs in enhancing price efficiency of the underlying stocks have been widely documented. Glosten, Nallareddy and Zou (2020) test weak form of efficiency by studying whether the prices incorporate earnings news in a timely manner. They find that ETF activity increases stort-run informational efficiency[1] since it incorporates earnings information more quickly once stocks are in ETFs (Glosten, Nallareddy, & Zou, 2020). Madhavan (2012) argue that information will be reflected in ETFs before the underlying assets since ETFs is a cost-effective tool for investors to exploit the systematic information (Madhavan, 2012). Therefore, ETFs should have important role in enhancing the well-functioning capital market. Stratmann and Welborn (2012) and Broman and Shum (2018) argue that APs who take arbitrage action in the ETFs have to ensure that price of the underlying stocks is in line with the ETFs price. ETFs trading activity should help transmit systematic

1 Informational efficiency, price efficiency and market efficiency are used interchangeably in most of the literatures since in the context of market efficiency, security prices are capable of incorporating new information into the prices.

information from ETFs to underlying securities. Therefore, ETFs is a potential instrument in improving price discovery of the stocks (Stratmann & Welborn, 2012), (Broman & Shum, 2018).

While other stream of literatures poses negative impacts of ETFs that the increase in ETF ownership result in high trading costs and lower benefits from information acquisition, in other word, decrease pricing efficiency for the underlying component securities (Israeli, Lee, & Sridharan, 2017). Da and Shive (2018) provide evidence that ETFs degrade informational efficiency because it increases return co-movement in the stocks that are part of an index (Da & Shive, 2018). As news related to the index arises, investors trade ETFs more actively causes higher return co-movement with the index and therefore, the stocks become less timely in response to the news. Broman (2016) and Brown, Davies and Ringgenberg (2016) document that ETFs attract short-horizon investors who typically are noise trader whose demands are correlated across investment, hence slow down price discovery.

The relationship between trading volume and price efficiency is still an open question. Classical finance supports the view that as volume increases, efficiency should improve as it provides more information which accelerate price discovery and increase liquidity of stocks. While behavioral finance suggests that greater volume is resulted in higher speculation by investors which will lead to mispricing and hence indicate price inefficiency. Gunduz and Mark (2016) find that efficiency increases as volume increases but only for low to moderate volume, as volume increases further, price efficiency decreases.

Ding and Suardi (2019) study the association between state ownership of firms' equity and liquidity in China. They find that state ownership provides higher liquidity at stock level which lower investor's risk perception of the firms' stock. Government ownership is viewed as an implicit guarantee on the stocks and being perceived as value-enhancing, thus, investors are willing to trade the stocks more (Ding & Suardi, 2019).

Japan's Comprehensive Monetary policy has been studied by many researchers, namely Barbon and Gianinazzi (2019) provide empirical evidence that Quantitative Easing Program by the BOJ has a positive and persistent effect on individual stocks by employing the asset pricing implication (Barbon & Gianinazzi, 2019), Harada and Okimoto (2019) analyze the effect of the BOJ's ETFs purchase on stock prices and find that BOJ's purchase of Nikkei 225 ETFs have a significant positive impact on afternoon return on Nikkei 225 stocks compare to those of non-Nikkei 225 stocks (Harada & Okimoto, 2019). However, the impact is getting smaller over time even though, the BOJ's purchase is growing. The BOJ policy in buying ETFs aims at boosting equity values to reduce firms' cost of fund and stimulate their investment, Charoenwong, Morck, and Wiwattanakantang (2019) evident the success of BOJ's ETF purchase in boosting equity values, however the result does not suggest the increase in firms' investment (Charoenwong, Morck, & Wiwattanakantang, 2019). While Nagayasu (2003) researches on the efficiency of the Japanese equity market find that the Price Keeping Operation (PKO) conducted by the government is likely to erode market pricing and thus work against the Efficient Market Hypothesis (EMH) (Nagayasu, 2003).

3. Hypotheses development

On the one hand, there is a possibility that the BOJ intervention could enhance price efficiency of the underlying stocks if its purchase is random and unpredictable. But on the other hand, since Charoenwong, Morck and Wiwattanakantang (2019) provide evident on the success of BOJ in bringing up stocks value, the continuation of the purchase could possibly signal to the market on the price to increase further, and hence become predictable by the market. Moreover, the BOJ has announced its purpose on buying ETFs to indirectly boost firm valuations, thus ones can predict that the BOJ will continue the scheme to meet its cap. Therefore, I rather predict that the BOJ intervention leads to price inefficiency of the underlying securities.

H1: BOJ intervention could lead to price inefficiency of stocks in ETFs.

Trading volume of ETFs tends to have more or less impact on price efficiency of the underlying stocks either positively or negatively since trading volume have implicit information about the underlying stocks. With a substantial number of ETFs purchased by BOJ, such trading volume could potentially affect price efficiency of the underlying securities.

H2: Stocks affected by greater BOJ-ETF purchase are expected to worsen the impact on price efficiency.

4. Data and Methodologies

The study focuses on all stocks traded in Tokyo Stock Exchange (TSE). Data is being collected from January 2007 to December 2019. The period of January 2007 to September 2010 is considered as “Pre-intervention period” while from October 2010 onward is considered as “Post-intervention period”. The stocks that claimed to have effect from BOJ ETF purchase consist of all stocks in the three indexes, namely Nikkei 225, JPX-Nikkei 400 and TOPIX. According to Bank of Japan’s special rule for purchase of ETFs, ETF purchase during 2010 to October 2014 are those that track TOPIX and Nikkei 225 index. After November 2014, JPX-Nikkei 400 has been supplemented into BOJ ETF basket. Stocks assumed to have no impact from BOJ purchase are stocks located in the TSE but not in any of the above-mentioned indexes.

Daily stocks return of each stock obtained from Thomson Reuter DataStream are for the purpose of measuring price efficiency. The data required to test impact of BOJ ETFs purchase on price efficiency of stocks are in panel data, each observation is for individual stock, i, in quarter frequency, q. First, market capitalization of stocks (MK) from Thomson Reuter DataStream, for Momentum factor (MOM), share price momentum from Bloomberg has been used. Daily turnover in Yen is collected from Thomson Reuter DataStream together with daily stock returns are for illiquidity ratio calculation. Weight of stock in the indexes (Nikkei 225, JPX-Nikkei 400 and/or TOPIX) should in fact be obtained from Bloomberg on a monthly basis for stocks in TOPIX and on a quarterly basis for stocks in Nikkei 225 index and/or JPX-Nikkei 400. However, due to time constraint and limited access, weights of stocks in an index is held constant using the weight at the end of the observing period that is on

December 30th, 2019. Aggregate BOJ ETF purchase is publicly available on a daily basis in the Bank of Japan's website.

To identify the impact of BOJ ETF purchase on price efficiency of the underlying stocks, we first measure price efficiency of all stocks traded in Tokyo Stock Exchange by employing the measurement of price inefficiency by Xu and Yin (2017). The proxies are then used to estimate the impact of BOJ ETF purchase on price efficiency of the underlying stocks.

4.1 Measure Price Efficiency of BOJ-backed and non-BOJ-backed stocks.

Price efficiency measures rely on two explanations; price is unpredictable by past information and log of stock price follows a random walk.

Price is unpredictable by past information

The equation aims to test the randomness of return by regressing daily stock returns at day t and day t-1 for individual stocks in a quarterly interval. Absolute $\beta_{i,q}$ from the estimation is defined as absolute serial correlation of returns for each stock i in quarter q, $|\beta_{i,q}| = SC_{i,q}$. $SC_{i,q}$ is required to be zero in order to reflect the randomness of the stock returns, hence predict price efficiency.

$$R^{i}_{q,t} = \alpha^{i}_{q} + \beta^{i}_{q} R^{i}_{q,t-1} + e^{i}_{q,t}$$

$$|\beta_{i,q}| = SC_{i,q}$$

As reported in Table 1, though the minimum of estimated SC is zero, mean and standard deviation suggest that SC does deviate from zero.

Log of stock price follows a random walk

Variances of return is found to have property to justify the deviation of prices with reference to a random walk process. Lo and Mackinlay (1988) test random walk based on the fact that the variance of the increments is linear in the sampling interval. If stock prices are generated by random walk, the variance of monthly return must be four times as large as the variance of weekly return. Xu and Yin (2017) also adopt this variance ratio in their study by using the frequency of 1-minute and 15-second return instead. This paper follows this variance ratio in price efficiency estimation using weekly (subscript w) and daily (subscript t) return variance in a quarterly interval as below. Estimated VR for individuals must be zero to justify the random walk, like SC, the deviation from zero of the estimated values imply price inefficiency.

$$VR_q^i = \left|\frac{(\sigma_{q,w}^i)^2}{5(\sigma_{q,t}^i)^2} - 1\right|$$

Summary statistics of estimated VR is shown in Table 1. Though the minimum of VR is zero, its mean is higher and with larger standard deviation comparing to SC which is consistent with results by Xu and Yin (2017) in such a way that the estimated SC is lower and near zero and less vary than the estimated VR. Figure 1 and 2 show histograms of SC and VR for the whole observing period. Figure 3 and 4 illustrate histograms of SC and VR during the pre-intervention period. And Figure 5 and 6 are histograms of SC and VR during the post-intervention period. The distribution of SC and VR in the period of pre- and post-intervention are highly consistent with SC and VR of the whole observing period.

Table 1

Summary Statistics of quarterly SC and VR of individual stocks in Tokyo Stock Exchanges indicates Mean, Standard Deviation, Minimum and Maximum and number of observations from the estimation.

Variable	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**	**Obs.**
SC	0.1266	0.0972	0.0000	1.1437	132161
VR	0.2915	0.1702	0.0000	4.3012	132108

Figure 1 Histogram of SC

Value of SC estimates from the equation stay mostly near zero and become less intense when the value goes down to 0.5.

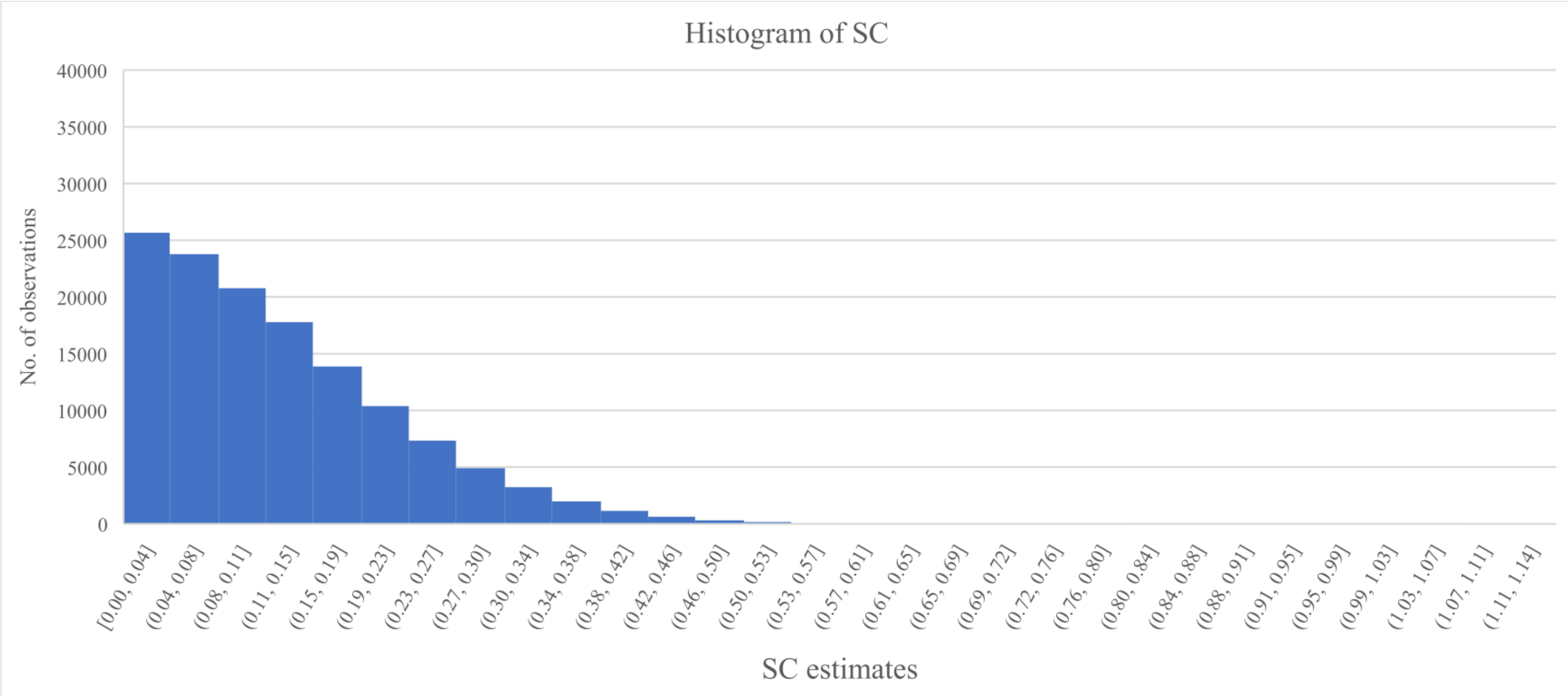


Figure 2 Histogram of VR

The histogram of VR suggests the difference distribution from SC estimates. Most of the VR population deviate from zero at around 0.3-0.4 where the maximum of the majority rest at around 0.8.

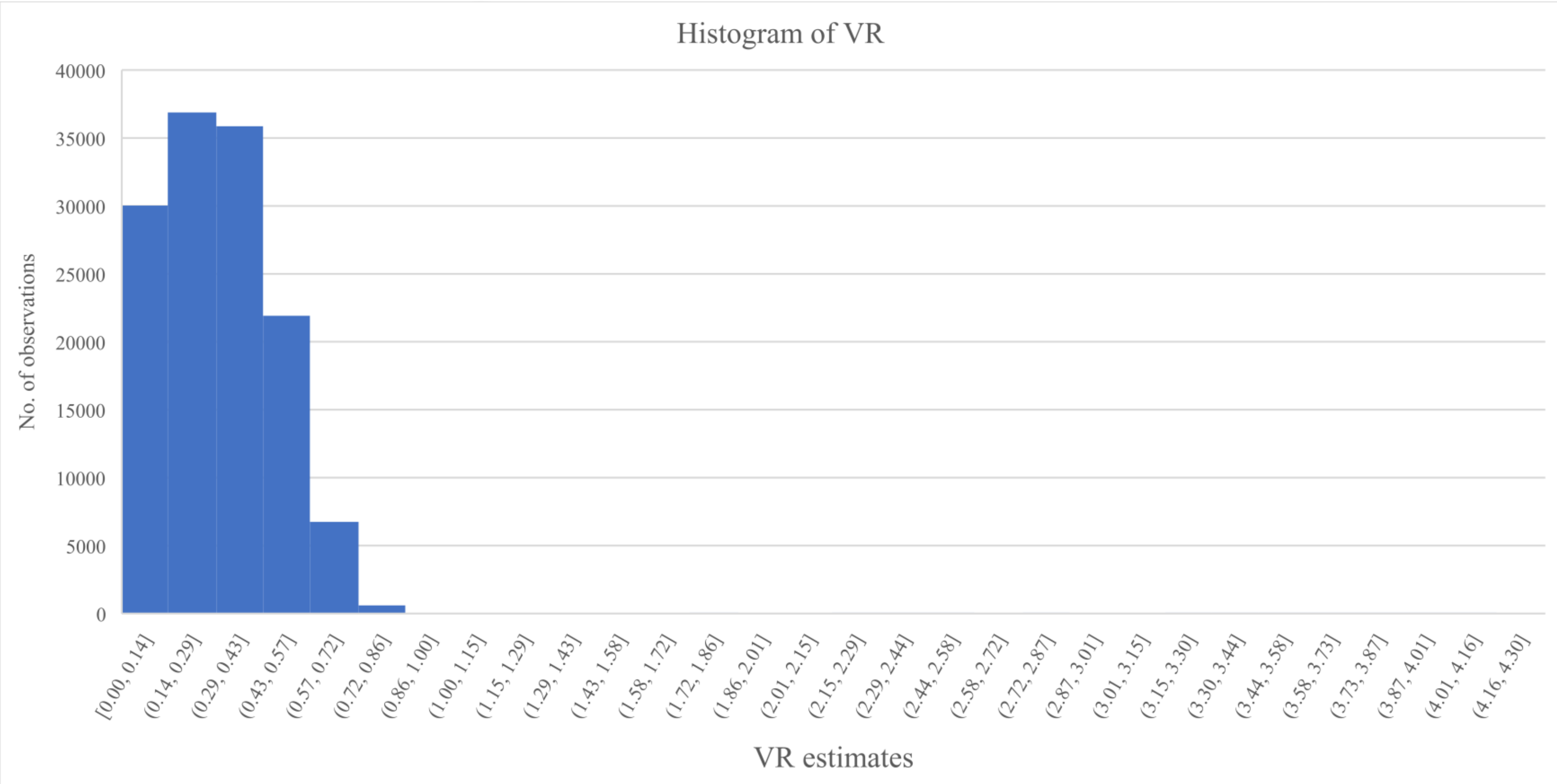


Figure 3 Histogram of SC during pre-intervention period

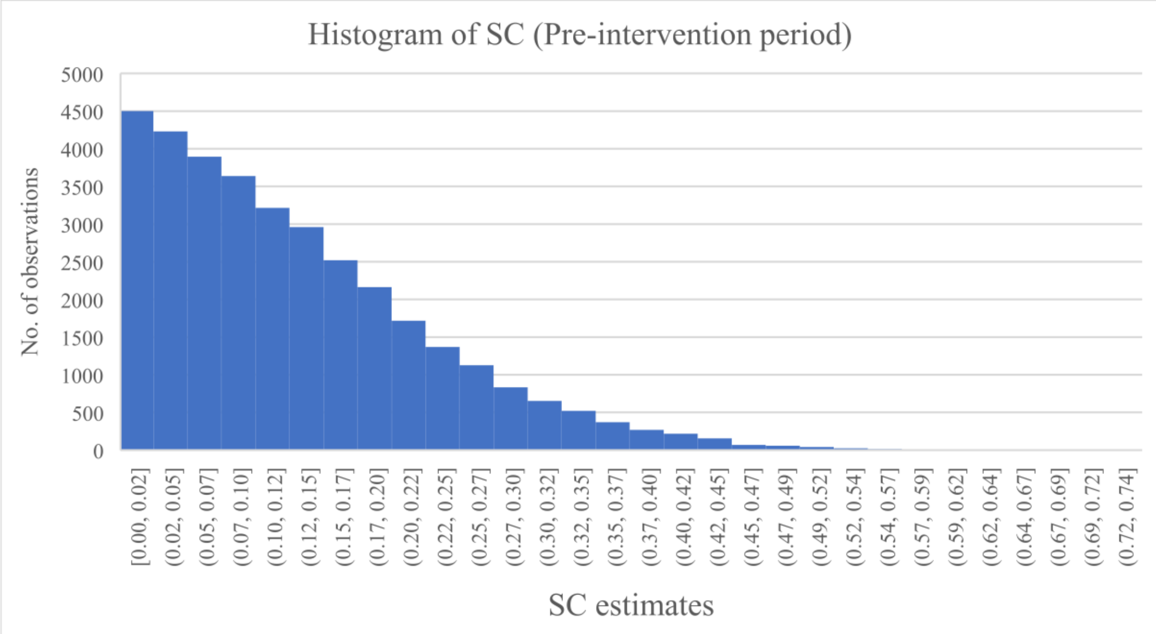


Figure 4 Histogram of VR during pre-intervention period

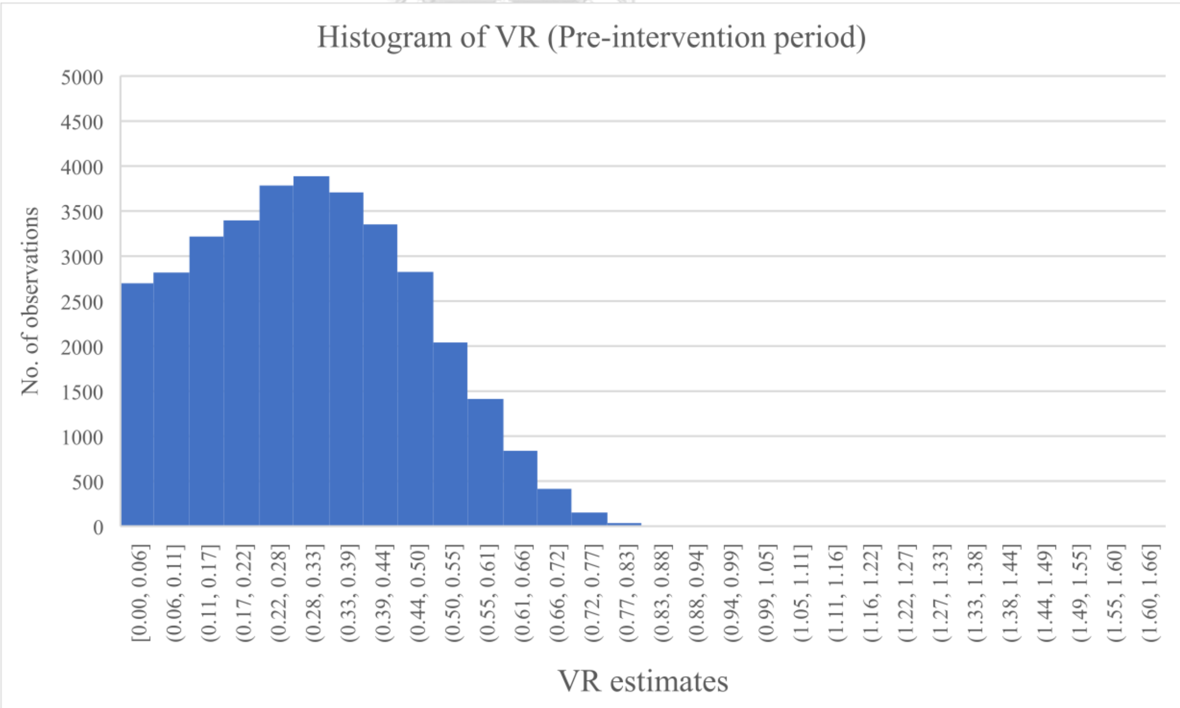


Figure 5 Histogram of SC during post-intervention period

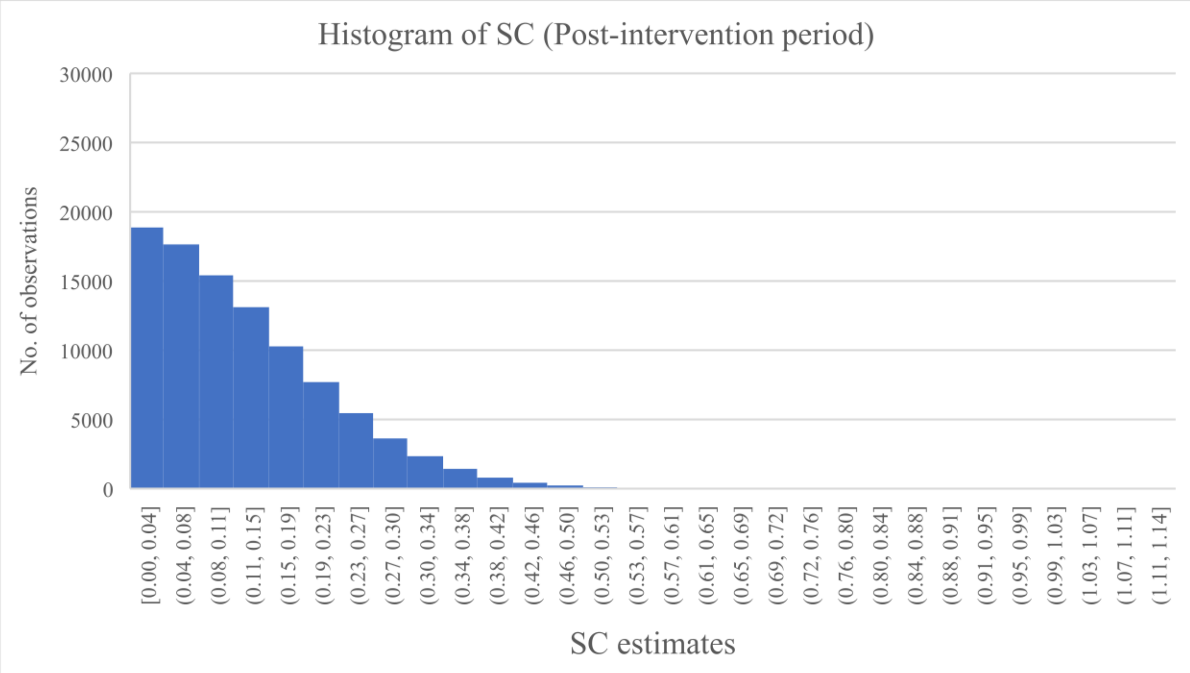
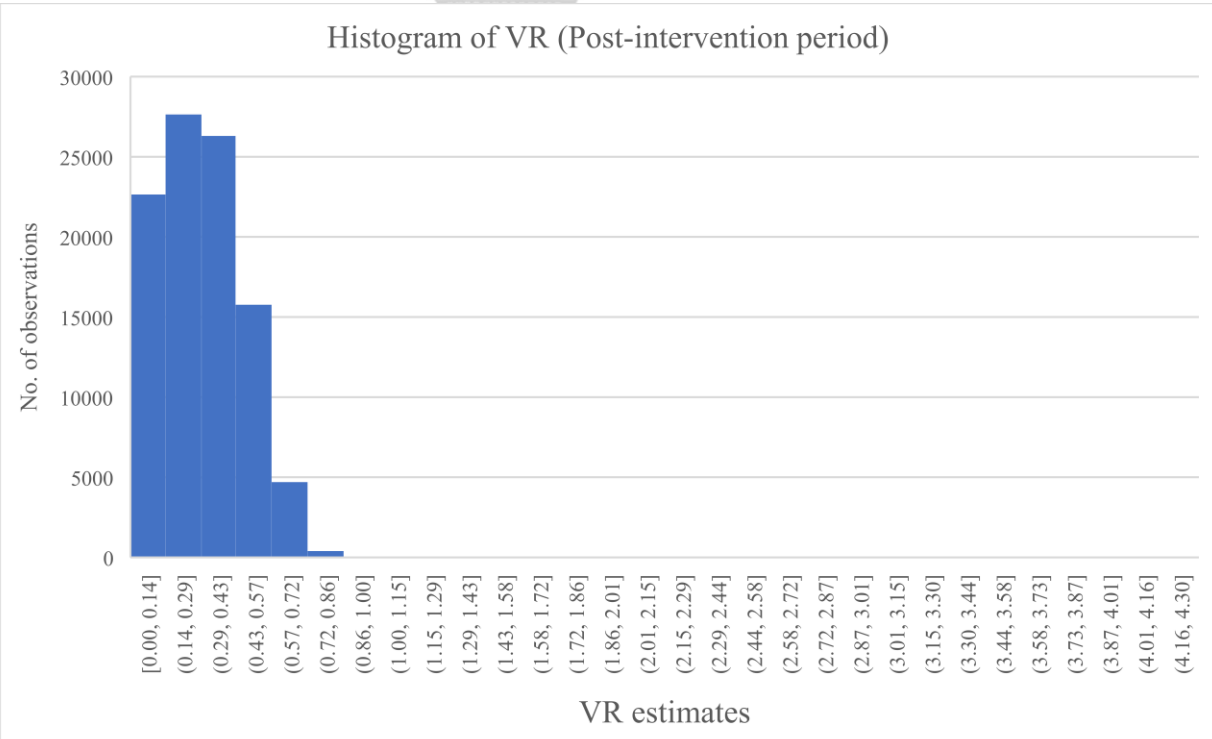


Figure 6 Histogram of VR during post-intervention period



Up to this point, SC and VR estimates for each stock i in quarter q allows us to partly analyze the price efficiency of stocks without having to do regression. In doing so, we first separate SC and VR estimates into 2 sub periods, pre-intervention and post-intervention period, then we do T-test to examine whether price efficiency of stocks with exposure and stocks with no exposure to the purchase are significantly different in that period. Besides, SC and VR estimates are divided into 2 groups according to its exposure to the purchase, one with exposure and another with no exposure to the BOJ purchase. We then perform T-test to confirm whether price efficiency of the period prior to the intervention and after the intervention are significantly different within that group. The results of T-Test for each pair is shown in **Table 2**. An overall result from t-test suggests that price efficiency of stocks outside the BOJ basket are worse than those in the BOJ purchase basket not only in the pre-intervention period but also in the post-intervention period. In addition, price efficiency of stocks with exposure to the purchase seem to improve after BOJ intervened. However, price efficiency of stocks with no exposure during the period of pre- and post-intervention seem to have insignificant change.

Table 2 The results of t-test of the difference in mean SC and VR by groups of stocks and by periods. Pre and post represent pre-intervention and post-intervention period. While G0 and non-G0 represent stocks with no exposure to BOJ purchase and stocks with exposure to the purchase respectively.

Result of T-test: all stocks

	Obs	Mean_pre	Mean_post	diff	Std. Err.	t_value	p_value
$SC_{pre} - SC_{post}$	132161	0.1280	0.1261	0.0019	0.0006	3.0840	0.0020
$VR_{pre} - VR_{post}$	132108	0.3015	0.2879	0.0136	0.0011	12.6778	0.0000

Result of T-test: Pre intervention period

	Obs	Mean_G0	Mean_non G0	diff	Std. Err.	t_value	p_value
$SC_{G0} - SC_{non\ G0}$	34606	0.1450	0.1230	0.0219	0.0013	17.2161	0.0000
$VR_{G0} - VR_{non\ G0}$	34603	0.3352	0.2917	0.0435	0.0022	19.8058	0.0000

Result of T-test: Post intervention period

	Obs	Mean_G0	Mean_non G0	diff	Std. Err.	t_value	p_value
$SC_{G0} - SC_{non\ G0}$	97555	0.1434	0.1205	0.0229	0.0007	32.0176	0.0000
$VR_{G0} - VR_{non\ G0}$	97505	0.3293	0.2746	0.0546	0.0013	43.5754	0.0000

Result of T-test: stocks with exposure

	Obs	Mean_pre	Mean_post	diff	Std. Err.	t_value	p_value
$SC_{pre} - SC_{post}$	100646	0.1230	0.1205	0.0025	0.0007	3.7464	0.0002
$VR_{pre} - VR_{post}$	100624	0.2917	0.2746	0.0171	0.0012	14.3927	0.0000

Result of T-test: stocks with no exposure

	Obs	Mean_pre	Mean_post	diff	Std. Err.	t_value	p_value
$SC_{pre} - SC_{post}$	31515	0.1450	0.1434	0.0016	0.0014	1.0973	0.2725
$VR_{pre} - VR_{post}$	31484	0.3352	0.3293	0.0059	0.0024	2.4903	0.0128

4.2 Proxy for grouping stocks according to their exposure to the BOJ purchase

In order to test H2, a proxy to differentiate stocks by their exposure to the BOJ ETF purchase has been constructed. The weight of each stock i purchased through ETFs by BOJ is used as a proxy for grouping. Since Principal Terms and conditions of ETFs purchase by the Bank of Japan is targeting at equity index ETFs tracking the Tokyo Stock Price Index (TOPIX), the Nikkei 225 Stock Average, or the JPX-Nikkei Index 400 (JPX-Nikkei 400), therefore the weight of each stock i purchased through ETFs by BOJ is calculated by taking multiplication of weight of stock i in the indexes and the weight of each index purchased by the BOJ.

$$\boldsymbol{w_{i,t} = (w_{i,t}^{N225} \cdot w_{BOJ,t}^{N225}) + (w_{i,t}^{N400} \cdot w_{BOJ,t}^{N400}) + (w_{i,t}^{TOPIX} \cdot w_{BOJ,t}^{TOPIX})}$$

where $w_{i,t}^{N225}$, $w_{i,t}^{N400}$ and $w_{i,t}^{TOPIX}$ are weight of stock i in the indexes. $w_{BOJ,t}^{N225}$, $w_{BOJ,t}^{N400}$ and $w_{BOJ,t}^{TOPIX}$ are weight of stock i purchased through ETFs by the BOJ. $w_{i,t}^{N225}$, $w_{i,t}^{N400}$ and $w_{i,t}^{TOPIX}$ can be obtained from Bloomberg. Weights of the three indexes base on different calculation methods, weight in Nikkei 225 index is price-weighted while JPX-Nikkei 400 and TOPIX are free float-adjusted market capitalizations. Nikkei 225 and JPX-Nikkei 400 update its weight quarterly whereas TOPIX updates weight monthly. All the three indexes announce its updated weight on the last business day of the following month. Therefore, the weights are constant for each quarter for stocks in Nikkei 225 and JPX-Nikkei 400 indexes and constant across months for stocks in TOPIX.

Regarding the BOJ rule-driven ETFs purchase, the amount purchase would roughly be proportionate to the total market value of that ETFs issued until September

2016. Therefore, $w_{BOJ,t}^{N225}$, $w_{BOJ,t}^{N400}$ and $w_{BOJ,t}^{TOPIX}$ are calculated based on market capitalization of each targeted ETF divided by total market capitalization of all targeted ETFs. Later, the purchase policy was amended and became effective in October 2016 that the amount of the annual purchase of ¥5.7 trillion, ¥2.7 trillion will be allocated to only ETF that track the TOPIX while another ¥3 trillion will be allocated to ETFs that track any of the three indexes based on the proportion of total market value of that ETFs issued.

- Weight from October 2010 to September 2016

$$w_{BOJ,t}^{N225,N400,TOPIX} = \frac{Market\ value\ of\ each\ ETF}{Total\ market\ value\ of\ all\ ETFs}$$

- Weight from October 2016 onward

$$w_{BOJ,t}^{TOPIX} = \frac{2.7}{5.7} + \left(\frac{3}{5.7}\, x \,\frac{Market\ value\ of\ each\ ETF}{Total\ market\ value\ of\ all\ ETFs}\right)$$

$$w_{BOJ,t}^{N225,N400} = \frac{3}{5.7}\, x \,\frac{Market\ value\ of\ each\ ETF}{Total\ market\ value\ of\ all\ ETFs}$$

Then, the weight of individual stock in total BOJ purchase for day t are summed up across the whole sample period for individual stocks and used to rank stocks from the lowest percentage weight to the highest percentage weight and group into 6 groups denoted as $G0_{i,q}$, $G1_{i,q}$, $G2_{i,q}$, $G3_{i,q}$, $G4_{i,q}$ and $G5_{i,q}$ respectively. ($G0_{i,q}$= without, $G1_{i,q}$ = lowest, $G2_{i,q}$ = low, $G3_{i,q}$ = moderate, $G4_{i,q}$ = high and $G5_{i,q}$ = highest). Table 3 shows descriptive data of weight in each group.

Table 3

Summary statistics of sum of weight for each stock i in day t across the whole period in each group according the exposure to the BOJ purchase.

	Obs	Mean	Std. Dev.	Minimum	Maximum
Weight of stocks in G0	935	-	-	-	-
Weight of stocks in G1	428	1.4391	0.5500	0.2956	2.4080
Weight of stocks in G2	429	3.7399	0.8611	2.4174	5.4221
Weight of stocks in G3	428	8.5396	2.1470	5.4248	12.9243
Weight of stocks in G4	429	26.5041	11.5226	12.9391	55.0054
Weight of stocks in G5	429	519.2697	753.6794	55.0998	6500.9290

Integrating 4.1 and 4.2, we obtain summary statistics of price efficiency as proxied by SC and VR by separating into groups of stocks as shown in Table 4. It is obvious that price efficiency of stocks with no exposure and less exposure are worsen than stocks with higher exposure to the purchase.

Table 4

Summary statistics of degree of price efficiency represented by SC and VR across groups.

Variable	Obs (i,q)	Mean	Std. Dev.	Min	Max
SC of G0	31515	*0.1438*	0.1084	0.0000	0.7889
SC of G1	18146	*0.1372*	0.1044	0.0000	1.1437
SC of G2	19772	*0.1277*	0.0965	0.0000	0.7421
SC of G3	20514	*0.1197*	0.0908	0.0000	0.7387
SC of G4	20862	*0.1159*	0.0880	0.0000	0.6195
SC of G5	21352	*0.1080*	0.0820	0.0000	0.6516

Variable	Obs (i,q)	Mean	Std. Dev.	Min	Max
VR of G0	31484	*0.3308*	0.1818	0.0000	2.6164
VR of G1	18137	*0.3027*	0.1791	0.0000	4.3013
VR of G2	19764	*0.2829*	0.1685	0.0000	2.9380
VR of G3	20514	*0.2725*	0.1613	0.0000	1.9670
VR of G4	20858	*0.2732*	0.1590	0.0000	0.8537
VR of G5	21351	*0.2680*	0.1539	0.0000	0.9963

4.3 Testing an impact of BOJ ETFs purchase on Price Efficiency of stocks

To examine the impact of BOJ ETF purchase on price efficiency of the underlying securities, regression model from Xu and Yin (2017) on the contemporaneous effect of ETF trading on the price efficiency has been adopted. Control variables include market capitalization (MK) of each stock, Amihud illiquidity factor (ILLIQ) and Momentum factor (MOM) of individual stock. First-lagged dependent variable ($Y_{i,q-1}$) is added into the model in order to measure the persistent of price efficiency and control for time lag effect. A dummy variable POST controls for the period prior to the intervention and the period after the intervention. Since there is a possibility of fixed effect that may cause endogeneity problem, the appropriate estimation is to use Arellano Bond estimator rather than OLS estimator. However, results from OLS estimation will also be exhibited as a benchmark as employed by Xu and Yin (2017). Negative coefficient from the estimation suggest positive impact on price efficiency and vice versa.

To test the relation, we run two models as follows.

I. $Y_{i,q} = c_0 + c_1 POST_{i,q} + \beta_1(BETV_q w_{i,q}) + \beta_2 MK_{i,q} + \beta_3 ILLIQ_{i,q} + \beta_4 MOM_{i,q} + \gamma Y_{i,q-1} + e_{i,q}$

where

$Y_{i,q}$ has two settings, $SC_{i,q}$ and $VR_{i,q}$, both variables proxy for price inefficiency which can be obtained from 4.1) where i represents all stocks traded in Tokyo Stock Exchange (TSE).

$POST_{i,q}$ is a dummy variable used to capture the period of "Post-intervention" taking value 1 if the data is in the period of the last quarter of 2010 onward, and 0 otherwise.

$BETV_q$ represents aggregate BOJ ETF trading volume in quarter q which is the summation of daily purchases in that quarter, unit is in billion Yen.

$w_{i,q}$ is the weight of each stock i purchased through ETFs by BOJ on the first day of quarter q. Calculation method is described in 4.2)unit is in percentage.

$MK_{i,q}$ represents market capitalization of the stock i in quarter q where market capitalization at the first day of each quarter are taken to represents the market capitalization in that quarter, unit is in million Yen. Market capitalization is the control variable mostly used by ample studies about efficiency and/or volatility.

$ILLIQ_{i,q}$ is the Amihud illiquidity ratio[2] calculated by taking average daily absolute return, $|r_t|$, divided by average volume trading in ¥, $¥V_t$, for stock i in quarter q. As evident by Chordia, Roll and Putnin (2015) that liquidity has positive relation to the efficiency.

$MOM_{i,q}$ represents share price momentum at the first day of each quarter. Wang and Xu (2015) find a strong relation between the momentum of Jegadeesh and Titman (1993) and market volatility.

$Y_{i,q-1}$ is the first-lagged of dependent variable used to indicate the persistent of price efficiency

II. $$Y_{i,q} = c_0 + c_1 POST_{i,q} + \beta_1 BETV_q + \beta_2 BETV_q G1_{i,q} + \beta_3 BETV_q G2_{i,q} + \beta_4 BETV_q G3_{i,q} + \beta_5 BETV_q G4_{i,q} + \beta_6 BETV_q G5_{i,q} + \beta_7 MK_{i,q} + \beta_8 ILLIQ_{i,q} + \beta_9 MOM_{i,q} + \gamma Y_{i,q-1} + e_{i,q}$$

Equation II, dummy variables, $G1_{i,q}$, $G2_{i,q}$, $G3_{i,q}$, $G4_{i,q}$ and $G5_{i,q}$, have been added as an interaction term with $BETV_q$ to indicate group of stocks in order to capture the difference in an impact on price efficiency among groups which is extended from Equation I. Dummy variables indicating groups take value 1 if stock i is the stock with BOJ ETF purchase in lowest/low/moderate/high/highest weight respectively and 0 otherwise. Table 5 below displays pairwise correlation of all variables.

[2] Amihud illiquidity measure formula is $ILLIQ_{i,q} = \frac{1}{N}\sum_{t=1}^{T}\frac{|r_t|}{¥V_t}$

Yakov Amihud. Illiquidity and stock returns: Cross-section and time-series effects. Journal of Financial Markets, 5:31–56, 2002.

Table 5

The table provides correlation matrix between variables. SC is the absolute serial correlation of stocks return in Tokyo Stock Exchange. VR is the absolute excess variance ratio of stocks return in Tokyo Stock Exchange. Level of exposure to the BOJ ETFs purchase is represented by weight, denoted by w. BOJ ETF trading volume (BETV) are in billion yen. Market capitalization in million yen is represented by MK, the illiquidity measure (ILLIQ) and Momentum factor (MOM) are control variables.

	SC	**L.SC**	**VR**	**L.VR**	**w**	**BETV**	**BETV·w**	**MK**	**ILLIQ**	**MOM**
SC	1.0000									
L.SC	0.0798	1.0000								
VR	0.3936	0.0965	1.0000							
L.VR	0.0953	0.3959	0.1479	1.0000						
w	-0.0410	-0.0421	-0.0372	-0.0356	1.0000					
BETV	-0.0340	-0.0199	-0.0242	-0.0122	0.0709	1.0000				
BETV·w	-0.0340	-0.0355	-0.0272	-0.0283	0.7805	0.1741	1.0000			
MK	-0.0503	-0.0500	-0.0366	-0.0365	0.7310	0.0401	0.6812	1.0000		
ILLIQ	0.0061	0.0062	0.0097	0.0047	-0.0061	-0.0232	-0.0050	-0.0069	1.0000	
MOM	0.0018	0.0019	-0.0007	-0.0004	-0.0061	-0.0026	-0.0049	-0.0070	0.0003	1.0000

5. Results

Equation I is to answer the first research question: Does the BOJ intervention enhance or deteriorate price efficiency of the stocks in Tokyo Stock Exchange (TSE)? Dummy variable POST captures the difference in price efficiency prior to the intervention and after the intervention. While BETV·w indicates whether the higher exposure to the purchase exhibit greater impact on price efficiency of stocks. The results from the estimations are reported in Table 6. Results from both OLS estimation and Arellano Bond estimation are highly consistent. It is obvious from the negative coefficient of POST that in the period after the BOJ intervention, price efficiency of stocks in Tokyo Stock Exchange significantly increased. In contrast, coefficient of BETV·w from both estimations are positive meaning that stocks with higher exposure to the BOJ purchase face lower degree of price efficiency. The result is consistent with H1 that the BOJ intervention leads to price inefficiency of stocks, however result is statistically insignificant, implying that the weight exposure to the purchase has no significant impact on price efficiency of stocks. The prediction for such insignificance is that the data used to run the model include all stocks in the exchange, not only stocks with exposure to the purchase but also stocks with no exposure (G0), therefore the value of BETV·w for stocks in G0 which is accountable for 30% of the dataset are forced to be zero, hence coefficient become insignificant. To solve, data of stocks in G0 has been removed from the dataset, yet the result is still insignificant as displayed in Appendix A. The final prediction is that the data might not be monotone, no clear relation, therefore the result is insignificant.

Negative coefficient of MK supports prior literatures which state that higher market capitalization is relative to higher price efficiency of that stocks. Despite, liquidity has no significant impact on price efficiency as indicated by Arellano Bond estimator, under OLS, liquidity of stocks enhances price efficiency which is in line with previous literatures. Momentum factor (MOM) plays no significant role in either improving or deteriorate price efficiency of stocks.

Table 6

The table displays an impact of BOJ ETFs purchase on price efficiency of the stocks from the regression of price inefficiency measure (SC and VR) against BOJ ETFs purchasing volume. OLS estimation is run as a benchmark, results are exhibited in column (1) and (2). Whereas, column (3) and (4) are the results from Arellano Bond estimation using Two-Step system GMM.

$$Y_{i,q} = c_0 + c_1 POST_{i,q} + \beta_1 (BETV_q w_{i,q}) + \beta_2 MK_{i,q} + \beta_3 ILLIQ_{i,q} + \beta_4 MOM_{i,q} + \gamma Y_{i,q-1} + e_{i,q}$$

	OLS	OLS	GMM	GMM
	(1)	(2)	(3)	(4)
VARIABLES	SC	VR	SC	VR
POST	-0.0025***	-0.0173***	-0.0012	-0.0178***
	(0.000753)	(0.00131)	(0.00102)	(0.00237)
MK	$-6.85 \cdot 10^{-9}$***	$-7.83 \cdot 10^{-9}$***	$-7.79 \cdot 10^{-9}$***	$-7.74 \cdot 10^{-9}$*
	$(6.13 \cdot 10^{-10})$	$(1.07 \cdot 10^{-9})$	$(2.87 \cdot 10^{-9})$	$(3.99 \cdot 10^{-9})$
ILLIQ	0.0002*	0.0005**	0.0002	0.0003
	(0.000109)	(0.000190)	(0.000148)	(0.000342)
MOM	$4.53 \cdot 10^{-12}$	$1.18 \cdot 10^{-12}$	$5.08 \cdot 10^{-12}$**	$1.60 \cdot 10^{-12}$
	(0)	(0)	(0)	(0)

L.SC	0.0780***		0.105***	
	(0.00292)		(0.0394)	
BETV·w	0.0003	0.0003	0.0006	0.0010
	(0.000322)	(0.000561)	(0.000406)	(0.000891)
L.VR		0.142***		0.0294
		(0.00291)		(0.0224)
Constant	0.120***	0.266***	0.112***	0.293***
	(0.000784)	(0.00149)	(0.00508)	(0.00722)
Observations	115,939	115,892	115,939	115,892
Number of stocks			2,980	2,977
R-squared	0.009	0.023		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Results from Equation II is reported in Table 7 under OLS estimator as a benchmark and Arellano Bond estimator. The result clearly suggests the significant impact of BOJ ETFs purchase (BETV) on price efficiency, not only stocks that are affected from the purchase but also stocks that are not purchased through the scheme. Positive coefficient of BETV indicate that price efficiency of stocks outside BOJ basket (denoted as G0) is worsen. While stocks with BOJ exposure (G1, G2, G3, G4, G5) all exhibit negative coefficients implying positive impact on price efficiency. The result confirms the finding from prior literatures that trading volume, in this paper referred to BETV, has significant impact on price efficiency. The evident is however inconsistent with H2. As we originally relied more in the earlier studies that the government intervention plays significant role in increasing stock prices, with the BOJ intervention, market participants should expect stock prices to increase, therefore the return would be predictable by the market, hence predict price inefficiency. The contradict result could be that the purchase by the BOJ is random and unpredictable by the market, instead of deteriorating price efficiency of stocks, the BOJ intervention otherwise plays significant role in improving price efficiency of stocks. Whereas, results of control variables are consistent with Equation I.

We then test for linear combination of estimated coefficient from the estimation to confirm whether the impact of price efficiency in each group are significantly different from zero, results are shown in Table 8. It suggests that price efficiency of stock in G2, G3, G4 and G5 increase significantly at around 1.1-1.2% of standard deviation of SC and at around 0.7-0.9% of standard deviation of VR. However, test for linear combination of G1 shows different results between OLS and Arellano Bond estimator. Under OLS, price efficiency of stocks in G1 decrease while Arellano Bond exhibit an improvement in price efficiency, though lower than those in G2, G3, G4 and G5 at only 0.41% of standard deviation of SC, the value is statistically significant. Considering the level of impact on price efficiency across groups, coefficients negatively increase from G0 to G5 suggesting that price efficiency tend to increase as stocks expose to higher level of purchase.

We further test whether the increase in price efficiency from a group with lower exposure to a group with higher exposure is statistically significant. In doing so, we test linear combination of the difference in estimated coefficient between each two groups, whether the difference is statistically significant. Table 9 shows the result of the test. It is found that price efficiency of stocks in G2 is significantly higher than that of stocks in G1 and stocks in G1 have significantly higher level of price efficiency than stocks in G0. However, we find no significance difference in price efficiency among G2, G3, G4 and G5. Considering summary statistics of SC and VR across groups in Table 4, the reason for no significance difference in price efficiency among G2, G3, G4 and G5 could be that degree of price efficiency of these groups are already high, therefore leaving less room for price efficiency to improve further. Results are consistent under Arellano Bond estimation for both SC and VR but inconsistent in the difference of price efficiency of each group under OLS estimation.

Table 7

The table shows results from Equation II, including dummy variables indicating groups to capture the impact of price efficiency across different groups, $G1_{i,q}$, $G2_{i,q}$, $G3_{i,q}$, $G4_{i,q}$ and $G5_{i,q}$. Column (5) and (6) are the results from OLS estimation while column (7) and (8) shows results from Arellano Bond estimation using Two-Step system GMM.

$$Y_{i,q} = c_0 + c_1 POST_{i,q} + \beta_1 BETV_q + \beta_2 BETV_q G1_{i,q} + \beta_3 BETV_q G2_{i,q} + \beta_4 BETV_q G3_{i,q} + \beta_5 BETV_q G4_{i,q} + \beta_6 BETV_q G5_{i,q} + \beta_7 MK_{i,q} + \beta_8 ILLIQ_{i,q} + \beta_9 MOM_{i,q} + \gamma Y_{i,q-1} + e_{i,q}$$

	OLS	OLS	GMM	GMM
	(5)	(6)	(7)	(8)
VARIABLES	SC	VR	SC	VR
POST	0.0024***	-0.0163***	0.0037***	-0.0145***
	(0.000856)	(0.00149)	(0.00111)	(0.00258)
BETV	0.0006***	0.0022***	0.0002	0.0016***
	$(7.40 \cdot 10^{-5})$	(0.000129)	(0.000127)	(0.000300)
BETVG1	-0.0007***	-0.0019***	-0.0006***	-0.0020***
	(0.000102)	(0.000178)	(0.000187)	(0.000445)
BETVG2	-0.0015***	-0.0031***	-0.0013***	-0.0027***
	(0.000101)	(0.000176)	(0.000164)	(0.000423)
BETVG3	-0.0019***	-0.0033***	-0.0014***	-0.0031***
	(0.000101)	(0.000176)	(0.000165)	(0.000404)
BETVG4	-0.0018***	-0.0036***	-0.0013***	-0.0032***
	(0.000101)	(0.000175)	(0.000167)	(0.000398)

BETVG5	-0.0020***	-0.0039***	-0.0012***	-0.0030***
	(0.000107)	(0.000187)	(0.000198)	(0.000401)
MK	$-4.27 \cdot 10^{-9}$***	$-3.64 \cdot 10^{-9}$***	$-4.75 \cdot 10^{-9}$***	$-3.38 \cdot 10^{-9}$
	$(4.44 \cdot 10^{-10})$	$(7.73 \cdot 10^{-10})$	$(1.84 \cdot 10^{-9})$	$(2.48 \cdot 10^{-9})$
ILLIQ	0.0002*	0.0005**	0.0002	0.0003
	(0.000109)	(0.000189)	(0.000126)	(0.000328)
MOM	$1.51 \cdot 10^{-12}$	$-4.72 \cdot 10^{-12}$	$2.45 \cdot 10^{-12}$	$-4.13 \cdot 10^{-12}$
	(0)	(0)	(0)	(0)
L.SC	0.0715***		0.0985**	
	(0.00292)		(0.0391)	
L.VR		0.135***		0.0209
		(0.00292)		(0.0225)
Constant	0.120***	0.267***	0.114***	0.295***
	(0.000779)	(0.00148)	(0.00505)	(0.00723)
Observations	115,939	115,892	115,939	115,892
Number of stocks		2,980	2,977	
R-squared	0.015	0.029		

Standard errors in parentheses

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

Table 8

Test for linear combinations of coefficients of each group to see whether impact on price efficiency is significantly different from zero.

	OLS	OLS	GMM	GMM
	(5)	(6)	(7)	(8)
	SC	VR	SC	VR
$\beta_1 + \beta_2$	-0.0001	0.0003*	-0.0004***	-0.0004
$\beta_1 + \beta_3$	-0.0010***	-0.0008***	-0.0011***	-0.0011***
$\beta_1 + \beta_4$	-0.0013***	-0.0011***	-0.0012***	-0.0015***
$\beta_1 + \beta_5$	-0.0013***	-0.0014***	-0.0011***	-0.0016***
$\beta_1 + \beta_6$	-0.0014***	-0.0017***	-0.0011***	-0.0015***

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

Table 9

The table provide result from the test of linear combination of the difference in estimated coefficients between each two groups. P-value of one-tailed test for of each pair is in parentheses.

	OLS (5) SC	OLS (6) VR	GMM (7) SC	GMM (8) VR
β_2	-0.0007***	-0.0019***	-0.0006***	-0.0020***
	(0.000)	(0.000)	(0.001)	(0.000)
$\beta_3 - \beta_2$	-0.0009***	-0.0011***	-0.0007***	-0.0008*
	(0.000)	(0.000)	(0.000)	(0.091)
$\beta_4 - \beta_3$	-0.0003***	-0.0002	-0.0001	-0.0004
	(0.004)	(0.119)	(0.258)	(0.166)
$\beta_5 - \beta_4$	0.0000	-0.0003*	0.0001	-0.0001
	(0.337)	(0.075)	(0.212)	(0.390)
$\beta_6 - \beta_5$	-0.0002	-0.0003*	0.0000	0.0002
	(0.101)	(0.063)	(0.467)	(0.313)

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

According to the estimation method employed in Equation I and Equation II, even though the results from both estimations are pretty much consistent and predict the impact in the same direction, however as mentioned earlier that there is a possibility of fixed effect that may cause endogeneity problem, results obtained from OLS estimation might be inconsistent. Therefore, the results from Arellano Bond estimator are treated as a more reliable result. Table 10 is to summarize results obtained from Arellano Bond estimator for both equations. Therefore, hereinafter, only the results from Arellano Bond estimation will be discussed.

Table 10

Results from Arellano Bond estimation under Two-Step System GMM from Table 6 and Table 7.

VARIABLES	(3) SC	(4) VR	(7) SC	(8) VR
POST	-0.0012	-0.0178***	0.0037***	-0.0145***
	(0.00102)	(0.00237)	(0.00111)	(0.00258)
BETV			0.0002	0.0016***
			(0.000127)	(0.000300)
BETVG1			-0.0006***	-0.0020***
			(0.000187)	(0.000445)
BETVG2			-0.0013***	-0.0027***
			(0.000164)	(0.000423)
BETVG3			-0.0014***	-0.0031***
			(0.000165)	(0.000404)
BETVG4			-0.0013***	-0.0032***
			(0.000167)	(0.000398)
BETVG5			-0.0013***	-0.0030***
			(0.000198)	(0.000401)
MK	$-7.79 \cdot 10^{-9}$***	$-7.74 \cdot 10^{-9}$*	$-4.75 \cdot 10^{-9}$***	$-3.38 \cdot 10^{-9}$
	$(2.87 \cdot 10^{-9})$	$(3.99 \cdot 10^{-9})$	$(1.84 \cdot 10^{-9})$	$(2.48 \cdot 10^{-9})$
ILLIQ	0.0002	0.0003	0.0002	0.0003
	(0.000148)	(0.000342)	(0.000126)	(0.000328)
MOM	$5.08 \cdot 10^{-12}$**	$1.60 \cdot 10^{-12}$	$2.45 \cdot 10^{-12}$	$-4.13 \cdot 10^{-12}$
	(0)	(0)	(0)	(0)
L.SC	0.105***		0.0985**	
	(0.0394)		(0.0391)	
BETV·w	0.0006	0.0010		
	(0.000406)	(0.000891)		
L.VR		0.0294		0.0209
		(0.0224)		(0.0225)
Constant	0.112***	0.293***	0.114***	0.295***
	(0.00508)	(0.00722)	(0.00505)	(0.00723)
Observations	115,939	115,892	115,939	115,892
Number of stocks	2,980	2,977	2,980	2,977

Standard errors in parentheses

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

Examining the results from the two explained variables, SC and VR, results are quite consistent between the two equations, however with some difference. First, the model with explained variable SC suggests that the period after BOJ intervention, price efficiency of stocks decrease while the model with explained variable VR indicates the opposite. The second, price efficiency of stocks outside BOJ purchase basket as observed via BETV are significantly worsen proven by positive VR but statistically significant from SC point of view. The differences in result could be from the low correlation at only 0.4 between SC and VR as displayed in Table 5.

Taken into account the rationale behind SC and VR, such inconsistent results provided by these 2 variables is because they capture different aspects of price efficiency. SC focuses mainly on the predictability of stock returns while VR is used to justify random walk process. Even VR estimates deviate far from zero which is contradict to the random walk, yet the return may still be unpredictable as suggested by low SC estimates. As the estimation of SC turn out to be already low, therefore leaving less room for price efficiency to increase further causing inconsistent in results. However, the key results remain unaffected.

6. Conclusion

This paper answers the research questions by providing empirical evidence on the impact of BOJ ETFs purchase on price efficiency of stocks. Although we first foresee in the first hypothesis that the BOJ intervention would lead to price inefficiency of stocks, the result suggests that such negative impact is insignificant. In other words, stocks with higher exposure to the purchase do not necessarily face lower price efficiency which possibly due to an incapability to capture the trend as the data might not be monotone.

Stocks are then grouped according to their weight exposures to the purchase in order to test for the difference in impact of price efficiency across groups. We discover that the sorting helps differentiate the impact, stocks that are not in the BOJ purchase basket experience the decrease in price efficiency while price efficiency of stocks that are the BOJ targets have been improved. In addition, the paper also finds that the higher the exposure of stocks to BOJ purchase, the higher the level of price efficiency, yet this is inconsistent with the second hypothesis that stocks with greater BOJ purchase are expected to have lower level of price efficiency. The contrast between the hypothesis and result was because of the more reliance on previous studies of impact from BOJ intervention on stock prices at first, as those papers find that stock price did improve as a result of the intervention, thus stock prices or stock returns should be predictable which is conflicted with price efficiency paradigm. The opposite evident provided by this paper could be that the purchase by the BOJ is random and unpredictable so that traders are unable to speculate. Therefore, we conclude that the intervention by Bank of Japan has positive impact on the price efficiency of underlying stocks that are part of the ETFs purchased by the bank.

Although we have differentiated the impact of BOJ ETFs purchase into the period before the intervention and the period after the intervention, we however do not classify deeper in the period of post intervention. Based on the fact that the BOJ policy to purchase ETFs was taken place since 2010 till 2019, therefore over an extended period of time, price efficiency could be different from early post-intervention to late post-intervention period since the market participant's view on the scheme might change over time as BOJ continues its purchase. Hence, the addition of the time variable remains for future research.

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Appendix A

The table exhibits an impact of BOJ ETFs purchase on price efficiency on the underlying stocks from Equation I. The data of stocks in G0 has been removed to run the model. Results in column (1) and (2) are under OLS estimation and column (3) and (4) are under Arellano Bond estimation using Two-Step system GMM.

	OLS	OLS	TSS	TSS
	(1)	(2)	(3)	(4)
VARIABLES	SC	VR	SC	VR
POST	-0.0027***	-0.0212***	-0.0015	-0.0216***
	(0.000820)	(0.00145)	(0.00125)	(0.00263)
BETW*w	0.0003	0.0004	0.0005	0.0013
	(0.000309)	(0.000547)	(0.000404)	(0.000911)
MK	-5.19e-09***	-4.29e-09***	-6.06e-09***	-3.62e-09
	(5.90e-10)	(1.04e-09)	(2.22e-09)	(2.28e-09)
ILLIQ	0.0002*	0.0004**	0.0002	0.0002
	(0.000107)	(0.000189)	(0.000182)	(0.000308)
MOM	-4.29e-05***	-5.09e-05**	-3.49e-05**	-7.41e-06
	(1.14e-05)	(2.02e-05)	(1.49e-05)	(3.27e-05)
L.SC	0.0615***		0.0219	
	(0.00335)		(0.0386)	
L.VR		0.0950***		0.0256
		(0.00336)		(0.0213)
Constant	0.117***	0.271***	0.117***	0.284***
	(0.000858)	(0.00165)	(0.00482)	(0.00680)
Observations	88,182	88,163	88,182	88,163
R-squared	0.006	0.012		
Number of stocks			2,141	2,141

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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