The Real Effects of Unconventional Monetary Policy and Market Frictions

Zhuo Chen

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This thesis is composed of three stand-alone research studies relating to the recent unconventional monetary policy adopted by the Bank of Japan (BOJ).

The first study investigates the impact of the BOJ's policy on stock prices and corporate activities. The empirical results show that the policy has generated heterogenous effects on stock prices. Firms with disproportionately higher BOJ investment experience significantly positive stock returns both in the short term and the long term. Corresponding to the positive price impact, the cost of equity capital reduces and firm value increases. However, further tests fail to find evidence of any real impact. Firms that benefit from a reduction in cost of equity capital do not increase external financing, corporate investment and employment. The concentrated capital structure in Japan and the biased investment scheme adopted may explain this weak policy impact.

The second study examines whether and how excess reduction in free float affects stock liquidity. Using the BOJ's equity purchase program as a natural experiment to tackle endogeneity problems, the results show that firms that experience a larger reduction in free float exhibit a reduction in stock liquidity. The negative effect of free float reduction on stock liquidity survives a battery of robustness tests. Further analyses of the underlying channels show that the number of common shareholders and institutional shareholders in a firm significantly decrease. These findings are consistent with a lack of free floating shares introducing frictions in the process of liquidity provision.

The third study examines whether an increase in exchange traded funds (ETF) ownership via indexed investment impedes or improves price efficiency. Utilizing Japan's ETF purchase program as the identification strategy, empirical tests show that prices of stocks that experience an increase in ETF ownership become less efficient in that they deviate more from a random walk and exhibit longer delays in responding to market information. An increase in ETF ownership is also associated with an increase in post-earnings announcement drift, a decline in analyst coverage, and a reduction in the coefficient of current returns to future earnings. These results together suggest that an excessive increase in ETF ownership curbs information arbitrage activities and results in less informative security prices.

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Abstract

This thesis is composed of three stand-alone research studies relating to the recent unconventional monetary policy adopted by the Bank of Japan (BOJ).

The first study investigates the impact of the BOJ's policy on stock prices and corporate activities. The empirical results show that the policy has generated heterogeneous effects on stock prices. Firms with disproportionately higher BOJ investment experience significantly positive stock returns both in the short term and the long term. Corresponding to the positive price impact, the cost of equity capital reduces and firm value increases. However, further tests fail to find evidence of any real impact. Firms that benefit from a reduction in cost of equity capital do not increase external financing, corporate investment and employment. The concentrated capital structure in Japan and the biased investment scheme adopted may explain this weak policy impact.

The second study examines whether and how excess reduction in free float affects stock liquidity. Using the BOJ's equity purchase program as a natural experiment to tackle endogeneity problems, the results show that firms that experience a larger reduction in free float exhibit a reduction in stock liquidity. The negative effect of free float reduction on stock liquidity survives a battery of robustness tests. Further analyses of the underlying channels show that the number of common shareholders and institutional shareholders in a firm significantly decrease. These findings are consistent with a lack of free floating shares introducing frictions in the process of liquidity provision.

The third study examines whether an increase in exchange traded funds (ETF) ownership via indexed investment impedes or improves price efficiency. Utilizing Japan's ETF

purchase program as the identification strategy, empirical tests show that prices of stocks that experience an increase in ETF ownership become less efficient in that they deviate more from a random walk and exhibit longer delays in responding to market information. An increase in ETF ownership is also associated with an increase in post-earnings announcement drift, a decline in analyst coverage, and a reduction in the coefficient of current returns to future earnings. These results together suggest that an excessive increase in ETF ownership curbs information arbitrage activities and results in less informative security prices.

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Chapter 1: Introduction

Monetary policy is generally conducted by central banks through buying and selling short-term financial instruments such as treasury bills to control short-term nominal interest rates and the monetary base. This practice is often referred to as "conventional" monetary policy. Through the effect of nominal interest rates and monetary base on a variety of asset prices, conventional monetary policy is expected to affect the economy by altering the willingness of banks to lend, firms to invest, or individuals to consume or invest.

However, the effectiveness of conventional monetary policy is limited when interest rates are at the zero bound. When interest rates are close to zero, money and bonds become close substitutes. The public will simply hold currency "under the mattress" instead of investing, and consequently any monetary injections by the central banks are unable to circulate in the economy. This concern can date back at least to Keynes (1937). The consequences of near-zero interest rates were proven in the 2007–2009 Global Financial Crisis when conventional monetary policy could do nothing to stimulate economies in the United States, United Kingdom, Europe and Japan. To alleviate financial distress, the Federal Reserve, the Bank of England, the European Central Bank and the Bank of Japan started to adopt unconventional monetary policies including forms of quantitative easing (QE) on an unprecedented scale. Under QE policy, central banks expand their balance sheets by purchasing less liquid and/or risky assets or initiating lending programs with the intention to affect relative asset prices and in turn stimulate economic growth.

Among all the central banks that have undertaken QE actions, the Bank of Japan (BOJ) is the only central bank that has intervened in the equity market through large-scale purchases of equity exchange traded funds (ETFs) in Japan. In an ultimate attempt to fight against Japan's long-lasting deflation, BOJ started to buy considerable amounts of corporate shares through index-related ETFs under Japan's Quantitative and Qualitative Monetary Easing (QQE) program in April 2013. Since then, the central bank has gradually acquired indirect but dominant positions in many of the country's large public corporations. The stated objective of the BOJ's asset purchase program, which includes the purchases of ETFs as well as J-REITs, is to stimulate the economy "with the aim of encouraging the decline in risk premiums to further enhance monetary easing" (BOJ 2010).[1] The investment is implemented following a strict scheme and only invests through index ETFs. The BOJ has been exclusively purchasing all index ETFs tracking Nikkei 225 Stock Average, the Tokyo Stock Price Index (TOPIX), and the JPX-Nikkei Index 400. By the beginning of 2017, the BOJ has invested more than US$124 billion (13.8 trillion yen) in Japanese equity markets via index ETFs, corresponding to approximately 2.5% of the total market capitalization of the Tokyo Stock Exchange First Section.[2]

Against this background, an important question from both a policy and a research perspective is how these monetary policies affect the real economy. Chapter 2 of this thesis empirically examines the real impact of the BOJ's ETF purchase program on Japan's financial market and corporate activities. Results from examining share prices in response to major changes in the program show that firms that are subject to disproportionately higher BOJ investment experience significantly higher announcement returns. The share price response can last as long as one year without reversal, suggesting

[1] Establishment of "Principal Terms and Conditions for Purchases of ETFs and J-REITS Conducted through the Asset Purchase Program." The Bank of Japan, 2010.
http://www.boj.or.jp/en/announcements/release_2010/mok1011b.pdf

[2] As the annual nominal GDP for the year at the end of 2016 is US$4.949 trillion, it makes the total ETF holdings of the BOJ equal to over 2.5% of GDP. (Source: Datastream and Japan Exchange Group)

that the purchase program can increase share prices permanently. Using panel data over four years around the program expansion announcement on October 31, 2014, the results show that cost of equity capital is reduced for firms in which the BOJ disproportionately holds more shares. However, the results fail to show any statistically significant changes in corporate behaviors, including equity and debt issuance, dividend payouts, corporate investment, mergers and acquisitions (M&As) and employment. Possible explanations for the limited real impact of the policy are discussed towards the end of Chapter 2.

The BOJ's asset purchase program provides a natural experiment to not only understand its policy impacts on individual firms but also examine important issues in financial markets. The next two chapters focus on market frictions in financial markets using this event as the main empirical identification.

Chapter 3 examines the effect of free floating shares on stock liquidity. The purchase schedule adopted by the BOJ creates exogenous shocks on the proportion of free floating shares available for trade to the public. Due to the biased capital allocation based on the Nikkei index weight, the event provides an ideal setting to empirically study how inactive block ownership that takes a large number of free floating shares off the market influences stock liquidity. Using a comprehensive sample of all Japanese listed stocks during the period from 2010 to 2016, this study shows that firms that experience a larger reduction in free float due to BOJ purchases exhibit a reduction in stock liquidity and trading activity. To further validate the causal link from free float to stock liquidity, various statistical specifications and robustness tests are employed and the results are confirmed. Further tests that identify the channels through which free float reduces stock liquidity show that a large reduction in free float driven by the investment of the BOJ significantly reduces the number of common shareholders and institutional shareholders of a firm.

These findings are consistent with a lack of free floating shares introducing frictions in the process of liquidity provision.

Chapter 4 investigates how the rapid growth in ETF ownership affects price efficiency of the underlying stocks. The passive investment style of ETFs could impede price efficiency by siphoning off shares available to traders and consequently results in reduced incentive for active traders to expand resources to acquire information. On the contrary, ETF ownership may improve price efficiency by increasing the supply of lendable shares and reduce the cost of information arbitrage faced by short sellers. To test the two competing hypotheses, this study examines the impact of the significant increase in index ETF ownership due to the BOJ’s aggressive purchase schedule. The policy provides a natural experiment to tackle endogeneity problems in previous studies and clearly identify the effect of ETF ownership on stock price efficiency. The results show that prices of stocks that experience a larger increase in ETF ownership due to biased BOJ purchases become less efficient in that they deviate more from a random walk. Stock prices of these firms also exhibit longer delays in responding to market information compared to similar firms with less increase in ETF ownership. Additional tests also reveal that an increase in BOJ ownership is associated with an increase in post-earnings announcement drift, a decline in the number of analysts following the firm, a reduction in the coefficient of current returns to future earnings, and a decline in the number of institutional and individual shareholders. Overall, this study finds an adverse effect of ETF ownership on price efficiency and informativeness.

Finally, Chapter 5 concludes this thesis.

Chapter 2: The Real Effects of Unconventional Monetary Policy: Evidence from the Bank of Japan Equity ETF Purchase Program

2.1. Introduction

Since the Global Financial Crisis (GFC) of 2007–2009, conventional monetary policy has become dysfunctional due to the near-zero interest rates in many economies. Since the liquid short-term government bonds effectively become equivalent to money under zero interest rates, the conventional monetary policy that trades such bonds for money in open market operations becomes meaningless. Therefore, many central banks around the world started to pursue so-called unconventional monetary policies, or Quantitative Easing (QE) policies. QE policies usually involve aggressively increasing the monetary base by initiating large-scale asset purchase and lending programs. Unlike the traditional monetary policies that set target rates, these programs often set explicit quantities and are perceived to be long term. These less conventional policies have attracted extensive attention in the media due to their large size and uncertain impact.

However, the economics and finance literature has not yet provided any clear empirical evidence on whether and how unconventional monetary policy could work. As market data on the effect of the policies gradually become available over time, several recent empirical studies have paid attention to the QE policies implemented by major central banks, including the Federal Reserve, the Bank of England, the European Central Bank and the Bank of Japan (Gagnon et al. 2010, D'Amico and King 2013, Galariotis, Makrichoriti, and Spyrou 2017, Barbon and Gianinazzi 2019, Acharya et al. 2019). In this study, I focus on the Bank of Japan (BOJ)'s equity ETF purchase program and empirically examine the real impact of the program on Japan's financial market and corporate behaviors. While the other central banks mostly target long-term government bonds, housing agency debts or mortgage-backed securities, the BOJ is the only central bank that targets the equity market as part of its monetary policy.

On April 4, 2013, the BOJ announced the introduction of a Quantitative and Qualitative Monetary Easing (QQE) program. The program includes a series of QE actions including large-scale purchases of corporate equity through index-related exchange traded funds (ETFs). Since then, the central bank has gradually acquired indirect but dominant ownership in many large public corporations in Japan.

The BOJ's stock buying program allows a clear examination on how and to what extent Japanese firms' activities are affected. First, since the BOJ only purchases equity through index ETFs without active selection, the investment is exogenous to firms' future performance and growth in the cross-section. Second, the purchase schedule of the program is strictly defined ex-ante and designed to be long term, making short-term changes in economic condition a lesser concern. Finally and most importantly, BOJ's purchase schedule creates exogeneous variation in supply shocks across firms, which is fairly random. A large proportion of the annual BOJ purchases is allocated to the Nikkei 225 index, which is uniquely a price-weighted index. This results in many Nikkei 225 stocks receiving significant excess capital flow relative to their market capitalization. The difference in price weights relative to market-value weights determines the cross-sectional variation in BOJ investment. For example, Fast Retailing Co., as one of the worst distortions in Nikkei, has a weight of about 8% in the Nikkei index but only 0.3% in the much broader value-weighted TOPIX index. As of December 2016, BOJ holds 14% of ownership in Fast Retailing Co. In contrast, Toyota Motor Corporation, which is the largest firm in terms of market capitalization in Japan (3.89% value-weight), has only 1.55% of its ownership held by the BOJ. Unlike monetary policies implemented by the other central banks, the non-fundamental nature of BOJ's purchase schedule allows me to explore the net heterogeneous effect of the policy on stock prices and corporate behaviors across firms.

I exploit the short-term as well as long-term effect on firms around the announcements of major expansions to the purchase program. These announcements provide a sharp setting for the examination of any variation in stock returns, cost of equity and corporate policy. The first crux of the QE policy is the ability of the central bank to increase the price and to reduce the risk premium of assets. I therefore start the analysis by examining share prices in response to major changes in the BOJ's ETF purchase program. In terms of the short-term announcement effect, I focus on three significant announcements made by the BOJ: on October 31, 2014 when the BOJ tripled the annual mark to about 3 trillion yen; on July 29, 2016 when the annual purchase target was doubled to about 6 trillion yen; and on September 21, 2016 when BOJ announced revising its investment schedule to invest more in the TOPIX ETFs and a smaller fraction in the Nikkei 225 index ETFs. I choose these dates because the magnitude of the BOJ's intervention in the equity market only became economically significant after the first expansion announcement. The third announcement on September 21, 2016 is a reversal event, which partly offset the cross-sectional variation in BOJ investment across firms. I expect this event to have an opposite impact on stock prices compared to the two expansion announcements.

The empirical results show that the market reacts highly positively when the BOJ announced expanding its purchase program. The price pressure is statistically significant and economically large. Firms that are subject to disproportionately higher BOJ investment experience significantly higher announcement returns. When the BOJ announced that it will reduce the purchase of the Nikkei index, the result shows a reversal effect on stock returns.

Shleifer (1986) conjectures that when there is an increase in share demand, even if firm fundamentals remain unchanged, the stock price should increase to induce shareholders to provide additional supply. If heterogeneous valuations persist and short-sale constraints are binding, demand curves can slope down in the long run. Following this hypothesis, I would observe long-term abnormal stock returns after the announcements. I next investigate whether the policy impact on stock prices persists in the long term. The results show that share price response can last as long as one year without reversal after the first expansion announcement on October 31, 2014, suggesting that the purchase program can increase share prices persistently. The results also imply that stocks do not have perfect substitutes and demand curves are downward sloping in the long run.

In relation to the impact on share prices, I then examine if such long-term stock reaction transmits into lower cost of equity as expected by the BOJ by using panel data over four years around the 2014 announcement. Although it is also interesting to compare the long-term impacts of the three announcements, especially the expected reverse impact of the BOJ's announcement on September 21, 2016, I am unable to conduct long-term empirical tests since the time between the announcements is too short. In addition, it is hard to observe any long-term impacts of the two announcements after 2014 as the reverse impact of the announcement on September 21, 2016 directly offset any impact of the announcement on July 29, 2016.

I estimate the implied cost of capital (ICC), which is the internal rate of return, for individual firms that is computed from the current share price and forecasted cash flows.

The results suggest that ICC is reduced for firms in which the BOJ disproportionately holds more shares.

The findings so far suggest that the BOJ's asset purchase program has achieved its primary goal to increase share prices and reduce cost of capital. I then examine whether the program has achieved the ultimate goal of stimulating the economy by increasing investment and employment. However, I fail to find statistically significant changes in corporate behaviors, including equity and debt issuance, dividend payouts, corporate investment, M&As and employment. Firms with disproportionately greater BOJ investment do not increase investment nor hire more people to take advantage of the lowered cost of capital. Even firms that have greater dependence on external financing do not show significant increase in equity issue and investment during the period.

Since the objective of the policy is to boost Japan's economy, it is puzzling to see an insignificant real impact of the policy. I propose three possible explanations to why the real impact of the policy is weak and argue that the BOJ relied too much on economic theories when they evaluate the policy without considering specific features of Japan's market. Firstly, I conjecture that the unresponsiveness of corporate activity to stock prices might be because most Japanese firms do not heavily depend on the public equity market for financing. The capital structure of Japanese firms features concentrated equity ownership by affiliated stakeholders and reliance on a major bank for stable debt financing. Using equity issuance data for public firms in 37 countries over the period from 2000 to 2017, I find that public firms in Japan seldom issue equity compared to firms in developed countries as well as in developing countries. Corporate investment of Japan firms is also much less sensitive to stock prices compared to similar firms in the other countries. Secondly, nearly half of the BOJ's annual purchases are in Nikkei 225 firms, which are also included in the TOPIX index. The BOJ also invests in the TOPIX index, which means Nikkei 225 firms are subject to double investment. Such biased investment in Japan's largest firms might also explain why higher stock prices fail to translate into equity issuance and investment in the cross-section. The traditional life cycle theory suggests that large firms usually depend less on external financing to fund investment but use much cheaper internally generated cash flows. Hence, investment by these firms tends to be less sensitive to stock prices. I confirm this theory by empirically showing that both the frequency of equity issue and the level of investment-price-sensitivity of Nikkei 225 firms are much lower than those of other public firms in Japan. An investment schedule that puts a large portion of capital into these firms may have reduced the effectiveness of the policy significantly. Finally, the confidence of Japan's business enterprises about business conditions remains unchanged over the sample period, which may also explain the limited real impact of the policy on Japan's economy.

This study contributes to the literature that examines the impact of the unconventional monetary policy that has been conducted by major central banks around the world after the GFC. Since central banks mostly purchase government bonds for QE policy, very few have purchased assets issued by private firms.[3] The BOJ's purchase of equity ETFs is unprecedented and unique in the history of central bank policies.[4] Therefore, this study

[3] The European Central Bank has purchased corporate bonds and sovereign bonds since 2009. For the impact and channels of ECB policies, see Krishnamurthy, Nagel, and Vissing-Jorgensen (2018). The US Federal Reserve's large-scale asset purchases announced in 2008 include government-sponsored enterprise (GSE) debt and agency mortgage-backed securities (MBS), which are guaranteed by government agencies. The Bank of England has only purchased government bonds.

[4] The Hong Kong Government purchased Hang Seng Index shares when speculators attacked the Hong Kong currency and its stock markets in 1997 during the Asian Financial Crisis. The aim of the share purchase by the government at that time was to stabilize the stock market. The central bank of Switzerland, the Swiss National Bank (SNB), has large purchases of shares in their portfolio. However, the SNB operates as a commercial bank that is 48% privately owned, while it issues bank notes and is responsible for the monetary policy of the country. Therefore, the nature of share purchases of the SNB is not considered part of its public function.

offers important policy implications on the unconventional monetary policy in uncharted territory. Gagnon et al. (2010) and D’Amico and King (2013) examine the effect of the Federal Reserve’s QE policy in US economy and find that the policy has a wide-spread effect on securities and reduces bond yields by about 30 basis points over the course of the program. Galariotis, Makrichoriti, and Spyrou (2017) examine the effect of monetary policy on economic expectation and find that the European Central Bank’s conventional monetary policies have a significantly positive effect on economic expectation, while its unconventional monetary policies have a negative effect on expectations. Acharya et al. (2019) study the European Central Bank’s Outright Monetary Transactions program and find that the policy fails to have a real impact on economic activity due to “zombie lending” by banks. Barbon and Gianinazzi (2019) are the first to study the Japanese central bank’s ETF purchase program, using a structural asset pricing model to investigate the net portfolio balance effect of the program as a result of a change in systematic risk. This study focuses on the impact of the BOJ’s QE policy on cost of equity and corporate policies. I control for systematic risk in the regression analyses and still find a price difference. A recent study, Charoenwong, Morck, and Wiwattanakantang (2019), also examines the impacts of the BOJ’s ETF purchase program. The authors find that stock returns increase significantly on actual BOJ purchase days and the abnormal stock returns persist only for a short term. In terms of the real impacts, the authors find that firms take advantage of the price run-ups and issue more shares but do not undertake real tangible capital investments. Distinct from Charoenwong, Morck, and Wiwattanakantang (2019), my study employs an event study setting and identifies a long-term stock price impact of the BOJ’s purchase program. Contrary to the findings in Charoenwong, Morck, and Wiwattanakantang (2019), we do not find an increase in stock issuance among Japanese firms, especially large Nikkei 225 firms which are the major recipients of BOJ investment. I also provide more insightful explanations for the weak real impact of the policy.

This study also contributes to the literature that investigates the long-term stock price effect of uninformed supply shocks. The positive and persistent price impact of BOJ purchases provides evidence that demand curves are downward sloping over horizons of at least one year. It is widely documented that the demand curve for stocks slopes down in the short term from a few hours to a few months (see for example, Kraus and Stoll 1972, Shleifer 1986, Kaul, Mehrotra, and Morck 2000, Greenwood 2005, Chang, Hong, and Liskovich 2015). However, the literature does not have a consensus on whether the demand curve for stocks slopes down in the long term due to a lack of natural experiments for clear identification. Many empirical studies use index addition or redefinition events, which are not perfectly exogenous to firm fundamentals at the cross-section. The supply shocks driven by these events are also hard to quantify. The BOJ's ETF purchase program provides an ideal setting to empirically study the shape of the long-term demand curves. This chapter suggests that central banks need to undertake thorough analysis before they implement aggressive monetary easing policies and should consider the structure of their local market when designing these policies.

The remainder of the chapter is organized as following: Section 2.2 presents more details of the BOJ's ETF purchase program; Section 2.3 describes the data and sample construction; Section 2.4 examines the impact of the program on stock prices and cost of equity; Section 2.5 investigates the real impact of the program on corporate behaviors; Section 2.6 discusses possible mechanisms through which the unconventional monetary policy is expected to work and offers explanations for the findings on the effect of the program; and Section 2.7 presents conclusions.

2.2. BOJ's Asset Purchase Program

Japan has been experiencing mild but persistent deflation since the 1990s. To fight against its long-standing deflation and stimulate economic growth, Japan's central bank, the BOJ, has maintained interest rates at close to zero since then for decades. The central bank announced the adoption of Quantitative Easing (QE) for the first time on March 19, 2001, after the standard monetary policy was ineffective at combating deflation in Japan. In 2010, the BOJ introduced a second episode of QE and began investing in domestic equities via index-related ETFs. However, the interventions were weak. The amount of purchases was modest at an annual rate of about 450 billion yen. After Shinzo Abe won the election as Prime Minister in December 2012, a much more aggressive policy framework was advocated. On April 4, 2013, the BOJ launched the Quantitative and Qualitative Monetary Easing (QQE), which marked a new phase of monetary easing in Japan.

Under the QQE, the BOJ committed to an asset purchase program which is much larger in terms of scale and pace. The BOJ sets an initial purchase target amount of 1 trillion yen (US$10 billion) in index-related ETFs to be purchased by a pre-announced date annually. The purchase program has been expanded on various occasions since then. On October 31, 2014, the central bank tripled the annual rate to about 3.3 trillion yen, which starts to make the magnitude of the intervention on the equity market economically significant. The most recent expansion in the annual target amount was on July 29, 2016 when the BOJ once again doubled its purchases in the equity market to an annual rate of about 6 trillion yen (about US$53 billion). At the beginning of 2017, the BOJ held more than 13 trillion yen of indirect ownership in Japan's equity markets via index ETFs.

The BOJ does not purchase individual equity shares directly but only buys index-linked ETFs that are purchased through trust banks and recorded as "Pecuniary Trusts" on the central bank's balance sheet. The trust bank places orders to brokerage firms whose role is to purchase the constituent shares from the market and deliver to the ETF sponsors in exchange for the ETFs. The trust banks, playing the fiduciary role, safekeep the shares on behalf of the ETF sponsors. Thus, the underlying shares of the ETFs are held under the name of the trust banks. The annual capital allocation is spread across ETFs tracking the Nikkei 225 Stock Average, the Tokyo Stock Price Index (TOPIX), and the JPX-Nikkei Index 400 strictly based on their concurrent market capitalization.[5] This means approximately over 50% of the capital flows into ETFs tracking the Nikkei 225 index, around 40% into the TOPIX, and a small fraction (less than 5%) into the JPX-Nikkei 400.

One of the major criticisms of the BOJ's capital allocation rule is that the large allocation of capital based on the special weighting system of the Nikkei index creates distortions in the market. The Nikkei 225 index adopts a price-weighting (not the traditional value-weighted) system, which means the weight of an index stock is a function of its price at the time it enters the index. Therefore, many stocks in the Nikkei index are receiving excess capital flow relative to their market capitalization, resulting in the BOJ effectively becoming a major shareholder of many firms with holdings that exceed the market value weight. For example, Fast Retailing Co., as one of the worst distortions in Nikkei, has a

[5] The JPX-Nikkei Index 400 was first added to the purchase program in November 2014.

weight of about 8% in the Nikkei index but only 0.3% in the much broader value-weighted TOPIX index.

Table 2.1 lists the top 10 Japanese firms with the highest BOJ indirect ownership and the top 10 largest Japan firms by market capitalization. The table compares BOJ ownership, market capitalization, the TOPIX index weights and the Nikkei index weights of these firms. Comparing the two lists, there is a large variation across these firms in terms of the two index weights. None of the top 10 largest firms are in the top 10 largest BOJ ownership list. For example, BOJ holds more than 17% of indirect ownership in Mitsumi Electric Co. Ltd while the firm's market capitalization is only about 50 billion yen. In contrast, the average BOJ ownership in the top 10 largest firms, which are 300 to 80 times larger than Mitsumi Electric Co. Ltd, is only about 2.5%.

Table 2.1: List of Firms with Top BOJ holdings and Top Market Capitalization

This table lists the top 10 firms with the highest BOJ indirect ownership and the top 10 largest Japan firms by market capitalization and shows their TOPIX index weights and Nikkei index weights as in December 2016. Firm-level BOJ holdings are directly obtained from Quick, while data on index weights are from Bloomberg.

Firm Name	BOJ Ownership	Market Capitalization (in billion yen)	TOPIX Index Weight	Nikkei Index Weight
Top 10 BOJ Ownership				
Mitsumi Electric Co Ltd	17.59%	49.945	0.01%	0.14%
Advantest Corp	15.39%	235.808	0.05%	0.65%
Fast Retailing Co Ltd	14.04%	2062.268	0.32%	8.64%
Taiyo Yuden Co Ltd	13.10%	135.539	0.03%	0.27%
TDK Corp	12.50%	942.329	0.20%	1.62%
Familymart UNY Holdings Co Ltd	12.41%	547.064	0.15%	1.52%
Toho Zinc Co Ltd	11.84%	54.129	0.01%	0.09%
Trend Micro Inc	11.45%	507.238	0.10%	0.85%
Comsys Holdings Corp	11.19%	183.606	0.04%	0.40%
Konami Holdings Corp	10.91%	386.877	0.08%	0.80%
Top 10 Market Capitalization				
Toyota Motor Corp	1.55%	15756.693	3.89%	1.40%
Mitsubishi UFJ Financial Group	1.75%	7438.509	2.31%	0.14%
Nippon Telegraph & Telephone	1.32%	5931.532	1.68%	0.19%
Softbank Group Corp	5.18%	5821.974	1.54%	4.26%
Honda Motor Co Ltd	3.19%	5378.215	1.41%	1.40%
KDDI Corp	4.46%	5252.953	1.34%	3.68%
Sumitomo Mitsui Financial Gr	1.91%	5011.567	1.55%	0.09%
Mizuho Financial Group Inc	1.78%	4432.094	1.24%	0.04%
Japan Tobacco Inc	1.71%	4370.179	1.13%	0.81%
Sony Corp	2.77%	4141.610	1.10%	0.69%

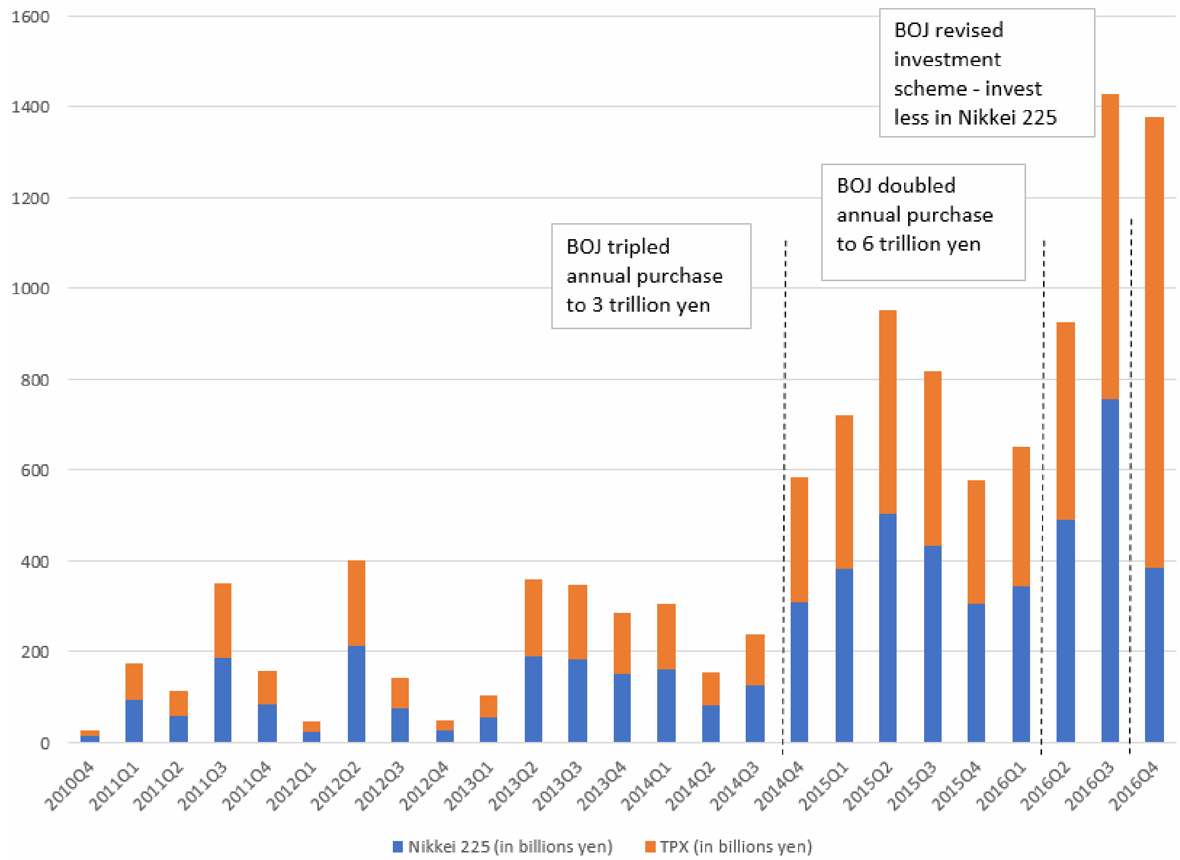
To address the cross-sectional bias in investment, the BOJ changed its capital allocation rule and assigned a higher proportion of its annual purchase amount to TOPIX ETFs on September 21, 2016. Specifically, it started to allocate 2.7 trillion yen solely in TOPIX ETFs and the remainder of the annual purchases (3 trillion yen) were allocated across all ETFs tracking the three indices based on market capitalization as before.

Figure 2.1 shows the time-series amount of quarterly BOJ purchases in billions of yen over the period from 2010 Quarter 4 to 2016 Quarter 4. The blue bar corresponds to the amount of purchases in Nikkei 225 index ETFs, while the orange bar represents purchases for TOPIX index ETFs. The vertical dash lines indicate changes in the purchase program in terms of target purchase amounts and investment scheme. In the first policy update, BOJ increased the annual target amount from 1 trillion to 3 trillion yen. In the second policy update, BOJ raised the annual target amount again to 6 trillion yen. In the third policy update, BOJ adjusted its investment scheme and invested less in ETFs tracking the Nikkei 225 index. The graph clearly shows major policy changes along the time-series of quarterly BOJ purchases.

Within the QQE framework, the BOJ also increased holdings in Japanese government bonds (JGBs) and Japan real estate investment trusts (J-REITs). The purchases in JGBs are much larger at an annual rate of 50 trillion yen on April 4, 2013, which was then increased to 80 trillion yen on October 31, 2014. No change in the purchase of JGBs has been made since then. The purchase of J-REITs is relatively much smaller with an annual purchase rate of 90 billion yen. Holdings in JGBs contribute to most of the expansion in the BOJ’s balance sheet.

Figure 2.1: Quarterly BOJ Purchases of Equity ETFs

This figure presents the amount of quarterly purchases of equity ETFs by the Bank of Japan in billions of yen from the beginning of its quantitative easing policy till the end of 2016. Each quarterly purchase is broken down into Nikkei 225 index ETFs (blue bars) and TOPIX index ETFs (orange bars). Data on the daily aggregate ETF purchases are obtained from the BOJ's official website.



2.3. Data and Sample Construction

I collect data from several sources. Firm-level stock trading data and financial data, including historical stock prices, trading volumes and accounting figures, are obtained from the Datastream/Worldscope database. Firm-level BOJ holdings as the percentage of total shares outstanding are directly obtained from Quick. Quick is a financial information vendor in the Nikkei Group. It gathers and processes economic data on Japan's financial markets. Quick constructed firm-level BOJ holdings data by consolidating the daily aggregate ETF purchases published on the BOJ's official website and private data from trust banks. The data I have are the actual amount of ownership held by the BOJ in index member firms of the Nikkei 225 index, the TOPIX index and the JPX-Nikkei Index 400. To construct the expected amount of BOJ purchases following its announced investment scheme, I obtain the lists of Nikkei and TOPIX index members and index weights from Bloomberg. The analyst forecasts data used for the construction of the ICC measures are extracted from the I/B/E/S database. Equity issuance data are from the Securities Data Company (SDC) Platinum database. I also obtain mergers and acquisitions data of Japanese firms from the SDC database.

The main sample covers the period from 2010 to 2016 and includes all domestic common stocks listed on the First Section of the Tokyo Stock Exchange. All sample firms are required to have non-missing financial data and no less than 30 days of trading data during a quarter. Due to heavy regulations, financial and utilities firms may have different corporate behaviors. I hence exclude these firms from the sample.

Table 2.2 reports the summary statistics for the variables used in the empirical analyses. Panel A presents the distribution of the sample by industries using the Fama-French 48 industry classification. Firms from the business services, retail, construction and transport sectors take the largest share of the sample, each accounting for more than 7% of all firms as of 2014. Panel B shows the summary statistics for the cross-sectional price effect of the first BOJ investment expansion announcement under QQE on October 31, 2014, when BOJ announced the tripling of the annual mark of its investment in the equity market to about 3 trillion yen. The summarized raw return figures primarily show that on average the market reacts highly positively to the expansion of the ETF purchase program. The mean raw returns are 7.1% over 2 weeks and 24.2% over 1 year after the announcement. Panel C shows the summary statistics for the panel sample. The ICC measures and Tobin's Q are constructed at quarterly frequency, while most of the other financial variables are at annual frequency due to the availability of the financial statement data.

Table 2.2: Sample Distribution and Summary Statistics

This table presents the summary statistics of variables used in the empirical analyses. Panel A presents the distribution of the sample by Fama-French 48 industries. Panel B shows the summary statistics for the cross-sectional price effect of the first BOJ investment expansion announcement under the QQE on October 31, 2014, when BOJ announced tripling the annual mark of its investment in the equity market to about 3 trillion yen. Announcement impact is measured by raw return or abnormal return over 1 month, 3 months, 6 months and 1 year after the announcement. Panel C shows the summary statistics for variables used in the panel regression analyses. The ICC models are defined in the Appendix.

Panel A: Sample Distribution by Industries

Industry	N	%
Agriculture	7	0.43%
Aircraft	3	0.18%
Apparel	19	1.17%
Automobiles & Trucks	73	4.48%
Beer & Liquor	6	0.37%
Business Services	141	8.66%
Business Supplies	25	1.54%
Candy & Soda	17	1.04%
Chemicals	96	5.90%
Chips Electronic Equipment	72	4.42%
Communication	11	0.68%
Computers	54	3.32%
Construction	123	7.56%
Construction Materials	54	3.32%
Consumer Goods	40	2.46%
Defense	1	0.06%
Electrical Equipment	38	2.33%
Entertainment	21	1.29%
Fabricated Products	7	0.43%
Food Products	47	2.89%
Healthcare	7	0.43%
Machinery	117	7.19%
Measuring & Control Equipment	36	2.21%
Medical Equipment	16	0.98%
Non-Metallic & Industrial Metal Mining	3	0.18%
Personal Services	31	1.90%
Petroleum & Natural Gas	11	0.68%
Pharmaceutical Products	41	2.52%
Printing & Publishing	11	0.68%
Recreation	22	1.35%
Restaurants, Hotels, Motels	46	2.83%
Retail	136	8.35%
Rubber & Plastic Products	22	1.35%
Shipbuilding & Railroad Equipment	6	0.37%
Shipping Containers	4	0.25%
Steel Works	48	2.95%
Textiles	20	1.23%
Tobacco Products	1	0.06%
Transportation	71	4.36%
Wholesale	124	7.62%
Total	1,628	100%

Panel B: Announcement Returns

Variable	N	Mean	1st Percentile	Median	99th Percentile
Raw Returns 2 weeks	1,626	0.071	-0.089	0.066	0.265
Raw Returns 1 month	1,626	0.091	-0.118	0.076	0.41
Raw Returns 3 months	1,626	0.125	-0.183	0.101	0.582
Raw Returns 6 months	1,626	0.236	-0.189	0.207	0.867
Raw Returns 1 year	1,626	0.242	-0.378	0.198	1.339
Abnormal Returns 2 weeks	1,626	-0.001	-0.157	-0.004	0.19
Abnormal Returns 1 month	1,626	-0.002	-0.205	-0.012	0.306
Abnormal Returns 3 months	1,626	-0.006	-0.298	-0.026	0.471
Abnormal Returns 6 months	1,626	-0.011	-0.424	-0.042	0.691
Abnormal Returns 1 year	1,626	-0.005	-0.595	-0.052	1.225

Panel C: ICC and Firm Fundamentals

Variables	N	Mean	1st Percentile	Median	99th Percentile
GLS Model	12,950	0.056	0.023	0.048	0.218
OJ Model	11,743	0.090	0.032	0.075	0.324
MPEG Model	11,389	0.077	0.016	0.061	0.340
CT Model	11,838	0.084	0.036	0.072	0.292
Average of 4 models	10,659	0.080	0.036	0.066	0.292
Tobin’s Q	23,286	2.499	1.000	2.000	4.000
Annual Issue Amount	5,821	-0.001	-0.053	0	0.067
Net Cash Flow from Financing	5,821	-0.012	-0.128	-0.016	0.188
Short-Term Debt Issue	5,816	0.05	0	0.024	0.312
Long-Term Debt Issue	5,804	0.006	-0.097	0	0.186
Total-Term Debt Issue	5,816	0.005	-0.11	0	0.216
Dividend Payout / Total Assets	5,832	0.42	0	0.311	1
Dividend Payout / Net Income	5,825	0.013	0	0.008	0.087
Capital Expenditure	5,814	0.036	0	0.027	0.178
Acquisition of Assets	5,832	0.003	-0.002	0	0.088
R&D Expenditure	5,832	0.017	0	0.004	0.158
Cash Flow from Investing	5,821	0.043	-0.073	0.035	0.219
Employees	5,670	7.829	4.718	7.699	11.613
Q*	5,801	1.168	0.546	0.986	4.019
Cash Flows	5,821	0.064	-0.079	0.061	0.263
Size	5,828	18.749	15.651	18.444	23.377
Leverage	5,827	0.18	0	0.137	0.681
Sale Growth	5,823	0.053	-0.224	0.039	0.5
ROA	5,661	0.056	-0.087	0.048	0.25
Cash	5,820	0.2	0.014	0.162	0.744
Amihud	5,832	-2.212	-7.086	-1.979	2.214
Turnover	5,816	-5.874	-8.272	-5.801	-3.5
Volatility	5,832	0.049	0.006	0.038	0.235

2.4. BOJ's ETF Purchase Program and Cost of Equity

In this section, I examine stock prices and cost of equity in response to the BOJ's ETF purchase program. I first investigate the cross-sectional abnormal returns around three events in which the BOJ announced major changes to its equity purchase program. The first two events were when the BOJ announced a large expansion of its equity purchase program on October 31, 2014 and July 29, 2016. The third event was when the BOJ revised its capital allocation and reduced the fraction of annual capital allocation to ETFs tracking the Nikkei 225 index on September 21, 2016. After these announcements, the BOJ purchased ETFs in accordance with the announced policy. The actual purchases are allocated on different days where the BOJ keeps the variation of the purchase amount relatively small from day to day. If the market expects the policy to have an effect on stock prices, the two expansion announcements and the allocation revision announcement should have opposite impacts on firms that are subject to disproportionately more investment from the BOJ.

I then examine longer term (1, 3, 6 and 12 months) impacts on the cross-section of share prices after the first expansion announcement under QQE on October 31, 2014. The BOJ's long-term commitment to the policy induces a long-lasting shock to supply. If the demand curve is downward sloping, the policy may impose a long-term impact on stock prices.

In relation to the impact on share prices, I also estimate the impact on implied cost of capital over a four-year period around the first expansion announcement. The primary goal of the policy is to reduce cost of financing through the impact on equity prices. If the share prices are affected by the BOJ intervention, the cost of equity capital should also be affected given the expected future cash flows. In addition, I also examine the effect on firm valuation as measured by Tobin's Q.

2.4.1. Short-term Announcement Effect on Stock Prices

To test the short-term price impact of the policy, I conduct cross-sectional regressions of event returns on expected changes in firm-level BOJ investment over the next year implied from the BOJ announcements. I estimate this regression using a sample of all firms listed in the First Section of the Tokyo Stock Exchange for each of the three events separately. Although BOJ purchases might affect the prices on a daily basis, the regression result is driven by the cross-sectional variation due to the disproportionate capital allocation of the policy.

I calculate the expected amount of BOJ investment, the main explanatory variable, based on the previous annual investment amount and the new capital allocation rule announced by the BOJ at the time of each announcement. Specifically, I first estimate the expected amount of BOJ investment in each firm by multiplying the firm's index weight at the time of the announcement with the annual target amount of BOJ purchases allocated to the index to which the firm belongs. For Nikkei firms that receive investment from the BOJ through both the Nikkei index ETFs and the TOPIX ETFs, this measure is the sum of the expected BOJ investments through all ETFs. The one-year forward-looking change in BOJ ownership following each announcement is then defined as the difference between the expected amount of BOJ investment in the firm according to the new capital allocation amount rule and that of the previous BOJ announcement. For the announcement on September 21, 2016 as a reversal event, I multiply the changes in expected BOJ investment by -1 for easier interpretation. In other words, the higher the value, the larger the decrease in the amount of BOJ investment in the firm after the announcement.

I measure the short-term price impact of three announcements made by the BOJ by calculating the raw return and the abnormal return over the 10-day window, (-1, +10), around the announcement dates. The announcement days are October 31, 2014 when the BOJ tripled the annual mark to about 3 trillion yen; July 29, 2016 when the annual purchase target was doubled to about 6 trillion yen; and September 21, 2016 when BOJ announced revising the investment scheme to invest more in the TOPIX ETFs and less in the Nikkei 225 index ETFs.

Raw return is the cumulative daily stock return over the corresponding period. Abnormal return is the cumulative abnormal return with respect to a market model estimated in the pre-event window. The market model is estimated over an estimation window of 146 days to 21 days prior to the announcement by regressing daily stock returns of a firm on a constant and the daily returns of the TOPIX index returns as follows:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + u_{i,t},$$

where $R_{i,t}$ is the equity return for firm $_i$, $R_{m,t}$ is the return of the TOPIX index.[6]

The other contemporaneous control variables include the log of market capitalization (*Size*), the Amihud's stock illiquidity ratio (*Amihud*) over the quarter prior to the announcement, the market beta (*Beta*) estimated from the same market model using one-year daily data ending four months prior to the announcement, and the Nikkei dummy

[6] The results are robust to the choice of benchmark portfolio using an equally weighted portfolio of all securities.

that equals one if the firm is included in the Nikkei 225 index, and zero otherwise. Industry fixed effects are included to control for variation in stock returns across industries.

In Table 2.3, I show the short-term effects over the 10-day window, (-1, +10), around the announcement dates. For the first two announcements of October 31, 2014 and July 29, 2016, I find a positive and significant short-term impact of the expected BOJ purchases on stock prices. Firms that are subject to disproportionately higher BOJ investment experience significantly higher announcement returns over the two windows as measured by raw returns and abnormal returns. As shown in the table, a 1% additional investment from the BOJ increases stock price by 1.88% during two weeks around the 2014 announcement and pushes up the price with a similar magnitude of 1.72% around the 2016 announcement. When the BOJ announced that it will reduce the purchase of the Nikkei index ETFs, the result shows a negative and significant effect on stock returns, which corresponds to the anticipated reduction in BOJ holdings.

Figure 2.2 shows the time-series of the equally-weighted average cumulative raw returns from 10 days before to 150 days after the BOJ's purchase expansion announcement of October 31, 2014. The purple line corresponds to the average of firms with relatively higher BOJ investment, firms with the ratio of Nikkei index weight to weight in a value-weighted index being greater than 3.[7] The orange line represents the average return of all other firms in the sample. Before the announcement date, the returns of the two groups

[7] I choose 3 as the cut-off point as it is a relatively large deviation, i.e. the capital allocation in the firms is 3 times a balance allocation based on market capitalization. This cut-off also allows for a relatively large sample (72 firms). Changing the cut-off to 2 (96 firms) and 4 (53 firms) produce similar graphs. The graphs are included in the Appendix.

are similar but begin to diverge immediately after the announcement. The increasing trend of stock returns shown in the graph is consistent with the regression results.

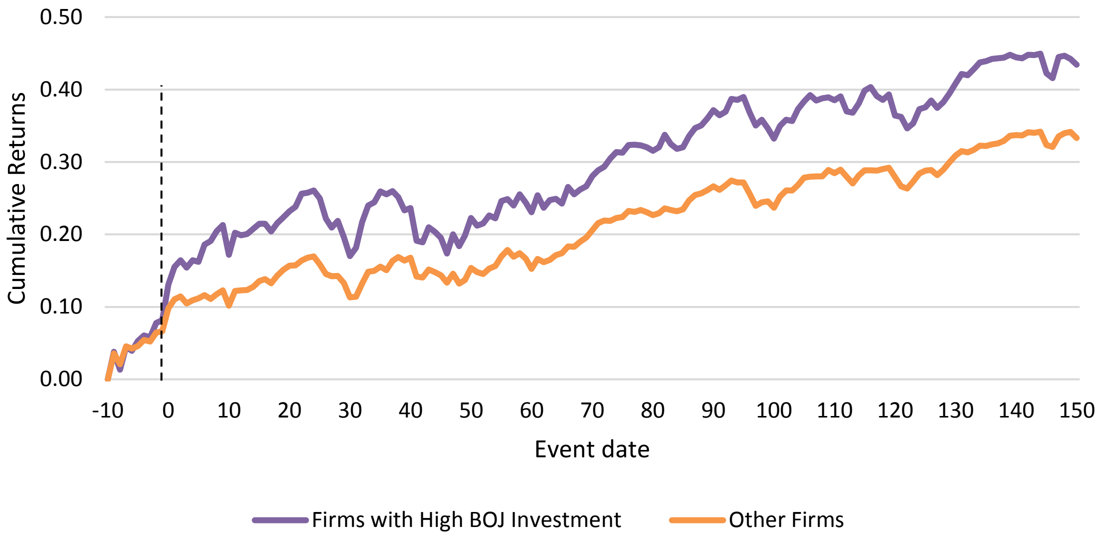
Table 2.3: Short-term Announcement Effects of BOJ Investment Updates

This table presents the short-term price impact of three announcements made by the BOJ. Announcement impact is measured by raw return or abnormal return over the 10-day window, (-1, +10), around the announcement dates. The announcement days are October 31, 2014 when the BOJ tripled the annual mark to about 3 trillion yen, July 29, 2016 when the annual purchase target was doubled to about 6 trillion yen, and September 21, 2016 when BOJ announced revising the investment scheme to invest more in the TOPIX ETFs and less in the Nikkei 225 index ETFs. The main explanatory variable, Expected BOJ Investment, is the expected change in the amount of BOJ investment calculated based on the previous annual investment amount and the new capital allocation rule announced by the BOJ. Size is the log of market value of equity. Amihud is defined as the log of the average of the daily Amihud (2002) illiquidity ratio over the quarter prior to the announcement calculated as $1{,}000{,}000 \times \frac{1}{D_{i,t}} \times \sum_{d=1}^{D} \left|Return_{i,t}\right| / Volume_{i,t}$. Beta is estimated from the following regression using one-year daily data ending four months prior to the announcement: $R_{i,t} = \alpha_i + \beta_i R_{m,t} + u_{i,t}$,where $R_{i,t}$ is the equity return for firm i, $R_{m,t}$ is the return of the TOPIX index. Nikkei Dummy equals one if the firm is included in the Nikkei 225 index, and zero otherwise. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	31-Oct-14		29-Jul-16		21-Sep-16	
	Raw Returns	Abnormal Returns	Raw Returns	Abnormal Returns	Raw Returns	Abnormal Returns
	(1)	(2)	(3)	(4)	(5)	(6)
Expected BOJ Investment	**1.880*** **	**1.577*** **	**1.722*** **	**2.278*** **	**-0.975** **	**-1.277*** **
	(4.116)	**(3.504)**	**(3.139)**	**(4.225)**	**(-2.570)**	**(-3.450)**
Size	0.022***	0.008***	-0.002	-0.000	0.003	0.004**
	(8.508)	(3.311)	(-0.663)	(-0.067)	(1.591)	(2.448)
Amihud	0.012***	0.011***	-0.002	-0.000	0.003*	0.003*
	(5.988)	(5.554)	(-0.886)	(-0.198)	(1.859)	(1.826)
Beta	0.045***	0.040***	-0.010	-0.010	0.039***	0.036***
	(6.911)	(6.336)	(-1.182)	(-1.282)	(7.065)	(6.550)
Nikkei Dummy	0.002	0.003	-0.005	-0.022***	-0.017***	-0.005
	(0.323)	(0.404)	(-0.608)	(-2.941)	(-3.268)	(-0.957)
Observations	1,626	1,626	1,626	1,626	1,626	1,626
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.125	0.125	0.024	0.024	0.113	0.113

Figure 2.2: Time-series of Cumulative Event Returns

This figure shows the time-series of the equally-weighted average cumulative raw returns around the BOJ's purchases expansion announcement of October 31, 2014. The purple line corresponds to the average of firms with relatively higher BOJ investment – the ratio of its Nikkei index weight to weight in a value-weighted index being greater than 3. The orange line is the average of the other public firms in the sample.



2.4.2. Post-announcement Long-term Effect on Stock Prices

I then examine the longer-term effects of the policy over 1 month to 12 months for the 2014 announcement using the same empirical identification as in Section 2.4.1. I measure the long-run abnormal returns of the policy over several post-announcement periods up to one year after the October 31, 2014 announcement. Long-run abnormal return is defined as the buy-and-hold abnormal returns (BHAR) over the corresponding period relative to the benchmark return:

$$BHAR_{i,T} = \prod_{t=1}^{T}\left(1 + R_{i,t}\right) - \prod_{t=1}^{T}\left(1 + R_{benchmark,t}\right)$$

To construct the benchmark portfolio, I follow the two-dimensional sorting procedures suggested by Barber and Lyon (1997). I first sort sample firms into size quintiles by market capitalization at the end of each month. I then divide the smallest size quintile into quartiles, which results in eight size groups. For each size group, I further sort firms into quintiles by book-to-market ratio (BM). BM ratio is calculated as the book value of equity divided by the market value of equity at the end of the previous quarter. This conditional double-sorting results in 40 size-BM portfolios.[8]

The benchmark return of a firm, $R_{benchmark}$, is calculated as the equally weighted daily return of all firms in the size-BM portfolio it belongs to. The size-BM benchmark portfolios are rebalanced every month. This method of using reference portfolios assumes

[8] The results are robust to alternative benchmark portfolios constructed by sorting sample firms into 5×5 size-BM portfolios.

that all firms in a particular size-BM portfolio at a given time have the same expected return.

In Table 2.4, expected BOJ investment at the announcement is significantly positively associated with the long-term returns over 1 month to 1 year. In addition, the coefficient becomes larger over a longer period of time after the announcement, suggesting that stock returns keep increasing without reversal up to at least 1 year after the announcement. The results show that BOJ's easing policy has an impact on share prices over the long term. The results also suggest that share prices are downward sloping along the demand curve.

Table 2.4: Long-term Announcement Effect

This table presents the long-term price effect of the first BOJ investment expansion announcement under QQE on October 31, 2014. Announcement impact is measured by raw return or abnormal return over 1 month, 3 months, 6 months and 1 year after the announcement. BOJ announced tripling the annual mark of its investment in the equity market to about 3 trillion yen on October 31, 2014. The main explanatory variable, Expected BOJ Investment, is the expected change in the amount of BOJ investment calculated based on the previous annual investment amount and the new capital allocation rule announced by the BOJ. Size is the log of market value of equity. Amihud is defined as the log of the average of the daily Amihud (2002) illiquidity ratio over the quarter prior to the announcement calculated as $1{,}000{,}000 \times \frac{1}{D_{i,t}} \times \sum_{d=1}^{D} \left|Return_{i,t}\right| / Volume_{i,t}$. Beta is estimated from the following regression using one-year daily data ending four months prior to the announcement: $R_{i,t} = \alpha_i + \beta_i R_{m,t} + u_{i,t}$, where $R_{i,t}$ is the equity return for firm $_i$, $R_{m,t}$ is the return of the TOPIX index. Nikkei Dummy equals one if the firm is included in the Nikkei 225 index, and zero otherwise. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	Raw Returns				Abnormal Returns			
	1 month	3 months	6 months	1 year	1 month	3 months	6 months	1 year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Expected BOJ Investment	**2.036*** **	**2.873*** **	**3.699** **	**6.182*** **	**1.991*** **	**2.710** **	**3.019** **	**3.583**
	(3.013)	**(2.662)**	**(2.437)**	**(2.587)**	**(3.039)**	**(2.574)**	**(1.963)**	**(1.538)**
Size	0.014***	0.023***	0.053***	0.072***	0.003	0.012**	0.033***	0.042***
	(3.618)	(3.756)	(6.288)	(5.363)	(0.704)	(2.008)	(3.789)	(3.158)
Amihud	0.003	0.004	0.012*	0.024**	0.005*	0.005	0.018***	0.020*
	(1.125)	(0.901)	(1.825)	(2.233)	(1.804)	(1.017)	(2.697)	(1.905)
Beta	0.058***	-0.003	0.017	-0.082**	0.052***	-0.001	0.014	-0.083**
	(6.044)	(-0.181)	(0.783)	(-2.406)	(5.599)	(-0.052)	(0.648)	(-2.512)
Nikkei Dummy	-0.002	-0.038**	-0.049**	-0.086**	-0.008	-0.041**	-0.062**	-0.064*
	(-0.202)	(-2.198)	(-1.978)	(-2.213)	(-0.729)	(-2.387)	(-2.463)	(-1.695)

Observations	1,626	1,626	1,626	1,626	1,626	1,626	1,626	1,626
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.167	0.068	0.112	0.071	0.096	0.039	0.036	0.056

2.4.3. Effect on ICC and Tobin's Q

Using a sample that spans a period of four years and includes quarterly data eight quarters before and eight quarters after the first BOJ investment expansion announcement under the QQE on October 31, 2014, I directly estimate the impact of the BOJ holdings on the cost of equity capital and Tobin's Q. I employ a panel regression that exploits both the cross-sectional and time-series variation in the effect of BOJ investment on cost of equity and Tobin's Q around the 2014 expansion announcement. The main explanatory variable, BOJ Ownership, is the total fraction of shares held by BOJ at the end of a quarter deducting the amount of BOJ ownership in the firm held one month before the announcement.

I perform the regression using two samples, a sample of Nikkei 225 index member firms and a sample of all firms listed on Tokyo Stock Exchange First Section (i.e. TOPIX index member firms). I control for a series of firm-level characteristics that are found to influence cost of equity in the literature, which include *Size*, Amihud (2002) illiquidity ratio, *Beta*, the log of the average of daily stock turnover over a quarter calculated as the ratio of the number of shares traded to the number of shares outstanding (*Turnover*), the standard deviation of daily stock returns over previous quarter (*Volatility*), *Leverage*, which is calculated as the sum of long-term debts and current liabilities divided by the sum of long-term debts, current liabilities and book value of equity, and *Long-term growth* which is the average long-term growth forecast in the previous quarter as reported in the I/BE/S database. Firm fixed effects control for time-invariant differences between firms. Time fixed effects control for time-varying differences.

To measure firms' cost of equity capital, I estimate the implied cost of capital (ICC), which is the internal rate of return that equates a firm's current stock price to the present value of its expected future cash flows. I adopt four models to measure ICC, including 1) the GLS residual income valuation model by Gebhardt, Lee, and Swaminathan (2001); 2) the OJ earnings growth valuation model by Ohlson and Juettner-Nauroth (2005); 3) the MPEG model developed by Easton (2004); and 4) the CT residual income valuation model by Claus and Thomas (2001). The models are widely adopted in the literature (Dhaliwal et al. 2005, Lau, Ng, and Zhang 2010, Chava and Purnanandam 2010, Christensen, Hail, and Leuz 2016) and differ in the use of underlying assumptions, earnings forecast data, forecast horizon and the incorporation of inflation. I closely follow the specification and assumptions of these models and elaborate the details of each model below. In addition, I include a fifth proxy as a robustness check by taking the average of the four estimates from the above models following Hail and Leuz (2006) and Lau, Ng, and Zhang (2010). Detailed description of these models is included in the Appendix.

When constructing the ICC estimates based on these models, I require firms to have available EPS forecast one year ahead and two years ahead from the I/B/E/S. Depending on data availability, firm-years with missing analysts' forecasts beyond two years are set equal to the previous year's forecast multiplied by the long-term growth rate. Payout ratios are restricted between 0 and 1.

I measure the valuation of firms using Tobin's Q. Quarterly Tobin's Q is calculated as the ratio of the market value of assets to the book value of assets. The market value of assets is the sum of the book value of debt and the market value of equity. The book value of assets is the total assets from the financial reports obtained from Worldscope.

2.4.3.1. Panel Regression Results

Table 2.5 shows the panel regression results for ICC. The results show that the increase in BOJ holdings around the expansion announcement have significantly negative effects on all ICC measures for both the Nikkei sample and the full sample. The results suggest that BOJ holdings effectively reduced the equity funding cost of firms, particularly for firms in which the BOJ's holdings are disproportionately higher. The BOJ purchase induced price impact I found in the previous section has effectively translated into lower cost of equity.

Table 2.6 reports the panel regression results for Tobin's Q. The coefficients on BOJ ownership estimated using both samples are positive and significant, indicating that higher BOJ ownership is positively associated with Q. The results suggest that BOJ's ETF purchase program has a significant impact on the stock prices of firms that experience disproportionately greater purchases, which are consistent with the policy pushing up stock prices and the market valuation of firms.

Table 2.5: Effect on Implied Cost of Capital (ICC) around the Announcement

This table presents the panel regression estimates for the effect of BOJ ownership on ICC around the first BOJ investment expansion announcement under QQE on October 31, 2014. The sample spans a period of four years and includes quarterly data eight quarters before and eight quarters after the first BOJ investment expansion announcement under QQE on October 31, 2014. Panel A reports the results using a sample of Nikkei 225 firms. Panel B uses a sample of all Japanese firms listed on the First Section of the Tokyo Stock Exchange. The dependent variables are the quarterly measures of ICC. The ICC models are explained in the Appendix. The main explanatory variable, BOJ Ownership, is the total fraction of shares held by BOJ at the end of a quarter deducting the amount of BOJ ownership in the firm held one month before the announcement. Size is the log of market value of equity. Amihud is defined as the log of the average of the daily Amihud (2002) illiquidity ratio over the quarter prior to the announcement calculated as $1{,}000{,}000 \times \frac{1}{D_{i,t}} \times \sum_{d=1}^{D} \left|Return_{i,t}\right| / Volume_{i,t}$. Beta is estimated from the following regression using one-year daily data ending four months prior to the announcement: $R_{i,t} = \alpha_i + \beta_i R_{m,t} + u_{i,t}$,where $R_{i,t}$ is the equity return for firm $_i$, $R_{m,t}$ is the return of the TOPIX index. Turnover is the log of the average of daily stock turnover over a quarter calculated as the ratio of the number of shares traded to the number of shares outstanding. Volatility is the standard deviation of daily stock returns over the previous quarter. Leverage is calculated as the sum of long-term debts and current liabilities divided by the sum of long-term debts, current liabilities and book value of equity. Long-term growth is the average long-term growth forecast reported in the previous quarter. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: Nikkei Firms

	(1) GLS Model	(2) OJ Model	(3) MPEG Model	(4) CT Model	(5) Average of 4 models
BOJ Ownership	**-0.311*** **	**-0.417** **	**-0.483** **	**-0.721** **	**-0.600** **
	(-3.966)	**(-2.463)**	**(-2.168)**	**(-2.395)**	**(-2.700)**
Beta	0.002**	0.006**	0.014***	0.002	0.006**
	(2.520)	(2.232)	(4.232)	(0.376)	(2.326)
Amihud	0.014***	0.021***	0.048***	0.025***	0.028***
	(5.455)	(4.353)	(6.565)	(3.707)	(5.089)
Turnover	0.001	0.003	0.009	-0.003	0.002
	(0.613)	(0.800)	(1.328)	(-0.442)	(0.374)
Size	-0.014***	-0.012***	-0.028***	-0.025***	-0.021***
	(-8.248)	(-3.249)	(-5.536)	(-4.261)	(-5.794)
Volatility	0.386*	0.090	0.386***	0.090	0.023
	(1.862)	(0.794)	(2.786)	(0.619)	(0.191)
Leverage	-0.011	0.001	-0.055	0.067	0.009
	(-0.685)	(0.019)	(-1.313)	(1.323)	(0.231)
Long-term Growth	0.008**	0.045**	0.028*	0.085**	0.037**
	(2.291)	(2.538)	(1.962)	(2.816)	(2.346)
Observations	2,933	2,630	2,617	2,630	2,456
Firm FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.923	0.708	0.669	0.571	0.761

Panel B: Full Sample

	(1) GLS Model	(2) OJ Model	(3) MPEG Model	(4) CT Model	(5) Average of 4 models
BOJ Ownership	**-0.178***** **(-8.839)**	**-0.134***** **(-6.597)**	**-0.033** **(-0.727)**	**-0.329*** **(-1.850)**	**-0.258***** **(-7.001)**
Beta	0.000 (0.411)	0.006*** (3.891)	0.010*** (5.680)	0.004* (1.744)	0.006*** (3.464)
Amihud	0.007*** (3.969)	0.009*** (4.403)	0.017*** (4.870)	0.011*** (3.642)	0.012*** (4.275)
Turnover	-0.002*** (-13.064)	0.001 (1.046)	0.001** (2.429)	-0.002** (-2.237)	-0.000 (-0.793)
Size	-0.017*** (-17.274)	-0.015*** (-7.074)	-0.023*** (-9.294)	-0.028*** (-9.065)	-0.023*** (-10.578)
Volatility	0.232*** (4.846)	0.127*** (2.856)	0.266*** (5.043)	0.111 (1.490)	0.197*** (3.673)
Leverage	-0.016** (-2.832)	-0.015 (-1.191)	-0.022 (-1.416)	0.016 (0.770)	-0.008 (-0.478)
Long-term Growth	0.010*** (5.322)	0.069*** (5.549)	0.063*** (4.568)	0.102*** (5.283)	0.053*** (4.300)
Observations	12,714	11,601	11,509	11,267	10,538
Firm FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.892	0.646	0.611	0.579	0.714

Table 2.6: Effect on Tobin's Q around the Announcement

This table presents the panel regression estimates for the effect of BOJ ownership on Tobin's Q around the first BOJ investment expansion announcement under QQE on October 31, 2014. The sample spans a period of four years and includes quarterly data eight quarters before and eight quarters after the first BOJ investment expansion announcement under QQE on October 31, 2014. The dependent variable is Tobin's Q defined as the market value of equity plus book value of total assets minus the book value of equity divided by book value of total assets. The main explanatory variable, BOJ Ownership, is the total fraction of shares held by BOJ at the end of a quarter deducting the amount of BOJ ownership in the firm held prior to the announcement. Size is the log of total book value of assets. Amihud is defined as the log of the average of the daily Amihud (2002) illiquidity ratio over the quarter prior to the announcement calculated as $1{,}000{,}000 \times \frac{1}{D_{i,t}} \times \sum_{d=1}^{D} \left| Return_{i,t} \right| / Volume_{i,t}$. Beta is estimated from the following regression using one-year daily data ending four months prior to the announcement: $R_{i,t} = \alpha_i + \beta_i R_{m,t} + u_{i,t}$,where $R_{i,t}$ is the equity return for firm $_i$, $R_{m,t}$ is the return of the TOPIX index. Turnover is the log of the average of daily stock turnover over a quarter calculated as the ratio of the number of shares traded to the number of shares outstanding. Volatility is the standard deviation of daily stock returns over the previous quarter. Leverage is calculated as the sum of long-term debts and current liabilities divided by the sum of long-term debts, current liabilities and book value of equity. Long-term growth is the average long-term growth forecast reported in the previous quarter. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	(1)	(2)
BOJ Ownership	**3.469****	**2.267*****
	(2.564)	**(4.340)**
Beta	0.022	0.077
	(0.570)	(1.624)
Amihud	-0.086**	-0.134***
	(-2.693)	(-4.239)
Turnover	-0.001	0.085***
	(-0.061)	(4.992)
Size	0.060	0.182**
	(0.743)	(2.143)
Volatility	1.601	-2.056
	(1.433)	(-1.191)
Leverage	-0.842***	-0.478***
	(-3.768)	(-2.955)
Long-term Growth	-0.016	-0.011
	(-1.409)	(-0.729)
Observations	2,941	12,856
Firm FE	Yes	Yes
Time FE	Yes	Yes
Sample	Nikkei	TOPIX
Adj. R-squared	0.865	0.853

2.4.3.2. Matched Sample

Regression results from Section 2.4.3.1 show a negative relation between BOJ ownership and ICC and a positive relation between BOJ ownership and Tobin's Q. However, these results may be specious if there are nonlinearities between cost of equity capital and the control variables. To address this potential misspecification, I conduct the panel regression using a matched sample. I match Nikkei firms with relatively greater BOJ investment – those with the ratio of Nikkei index weight to weight in a value-weighted index being greater than 3 – with similar control firms using a propensity score matching (PSM) procedure, where matching is based on all control variables included in the panel regression at the time one quarter prior to the 2014 announcement.[9] Specifically, within the same industry using the Fama French 48 industry classification, I find a control firm with the smallest difference in propensity scores. After the matching procedure, I compare the ICC and Tobin's Q of firms that ideally differ only in BOJ ownership.

Table 2.7 presents the results using the matched sample. Columns 1–5 present the results for ICC measures and Column 6 for Tobin's Q. The coefficients on BOJ ownership remain significant and have consistent signs with the results in Table 2.6. The results suggest that the impact of BOJ ownership I document is not a product of nonlinearities.

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[9] A Nikkei weight to market value weight ratio of 3 means the firm receives more than three times the BOJ investment compared to an unbiased capital allocation following market value weight. The results are not sensitive to alternative threshold values including 2, 4 and 5.

Table 2.7: Matched Sample

This table presents the panel regression estimates for the effect of BOJ ownership on ICC and Tobin's Q around the first BOJ investment expansion announcement under QQE on October 31, 2014 using a matched sample. I match Nikkei firms that are subject to relatively greater BOJ investment – the ratio of its Nikkei index weight to weight in a value-weighted index being greater than 3 – with control firms using a propensity score matching (PSM) procedure. The sample spans a period of four years and includes quarterly data eight quarters before and eight quarters after the first BOJ investment expansion announcement under QQE on October 31, 2014. The main explanatory variable, BOJ Ownership, is the total fraction of shares held by BOJ at the end of a quarter deducting the amount of BOJ ownership in the firm held one month before the announcement. In Columns 1-5, Size is the log of market value of equity. In Column 6, Size is the log of total book value of assets. Amihud is defined as the log of the average of the daily Amihud (2002) illiquidity ratio over the quarter prior to the announcement calculated as $1{,}000{,}000 \times \frac{1}{D_{i,t}} \times \sum_{d=1}^{D} \left|Return_{i,t}\right| / Volume_{i,t}$. Beta is estimated from the following regression using one-year daily data ending four months prior to the announcement: $R_{i,t} = \alpha_i + \beta_i R_{m,t} + u_{i,t}$, where $R_{i,t}$ is the equity return for firm $_i$, $R_{m,t}$ is the return of the TOPIX index. Turnover is the log of the average of daily stock turnover over a quarter calculated as the ratio of the number of shares traded to the number of shares outstanding. Volatility is the standard deviation of daily stock returns over the previous quarter. Leverage is calculated as the sum of long-term debts and current liabilities divided by the sum of long-term debts, current liabilities and book value of equity. Long-term growth is the average long-term growth forecast reported in the previous quarter. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	(1) GLS Model	(2) OJ Model	(3) MPEG Model	(4) CT Model	(5) Average of 4 models	(6) Tobin's Q
BOJ Ownership	**-0.282***	**-0.476****	**-0.654*****	**-0.995****	**-0.793***	**3.982****
	(-2.079)	**(-2.724)**	**(-2.962)**	**(-2.308)**	**(-1.754)**	**(2.306)**
Beta	0.002	0.008**	0.005	-0.002	0.001	-0.194**
	(1.374)	(2.842)	(1.268)	(-0.250)	(0.292)	(-2.414)
Turnover	0.007**	0.007**	0.010**	0.007**	0.005	0.009
	(2.815)	(2.631)	(2.524)	(2.538)	(1.638)	(0.140)
Amihud	0.012***	0.017***	0.038***	0.028***	0.027***	0.033
	(4.385)	(3.217)	(5.025)	(3.355)	(3.970)	(0.816)
Size	0.001	-0.000	-0.001	-0.006**	-0.005**	0.087**
	(0.513)	(-0.144)	(-0.550)	(-2.757)	(-2.760)	(2.442)
Volatility	-0.443**	0.401	0.667*	-0.339	0.082	20.528***
	(-2.796)	(1.629)	(1.803)	(-0.953)	(0.254)	(3.596)
Leverage	0.042**	0.061***	0.071***	0.063***	0.075***	-0.843**
	(2.807)	(4.153)	(3.800)	(2.943)	(3.579)	(-2.532)
Long-term Growth	0.003	0.039*	0.031	0.067**	0.031*	0.064
	(0.821)	(1.864)	(1.459)	(2.146)	(1.768)	(1.309)
Observations	1,932	1,764	1,752	1,274	1,188	1,932
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.544	0.558	0.472	0.629	0.650	0.549

2.5. BOJ’s ETF Purchase Program and Corporate Policies

Have firms’ real decisions been affected given the significant impact of the policy on stock prices and ICC? Traditional corporate finance theories predict that firms will issue more shares, increase investment, and employ more people in response to a lower cost of capital. To government policy makers, the ultimate goal of a monetary easing is to have a positive real impact on the economy. In this section, I empirically analyze the impact of the BOJ’s ETF purchase program on various aspects of corporate policies.

I regress a series of corporate fundamentals including equity issues, debt issues, dividend payouts, corporate investment and employment on BOJ ownership, using panel data that spans a period of four years around the BOJ’s announcement on October 31, 2014. Since the fiscal year end of Japanese firms varies largely in a year, I carefully balance the sample around the event date. The sample includes two fiscal years before the announcement, the event year and one year after. The event year of a firm is the fiscal year ending at least one quarter after the announcement date. The main explanatory variable is the total fraction of shares held by BOJ at the end of the fiscal year deducting the amount of BOJ ownership in the firm held at the end of the fiscal year prior to the announcement.

The control variables are the log of total book value of assets, the Amihud (2002)’s illiquidity ratio over the year prior to the announcement, stock turnover, stock return volatility, firm financial leverage, cash flows from operation as reported in the cash flow statement, sales growth, ROA, cash holdings and dividend payouts. In addition, I also control for the part of stock price that is not related to BOJ purchases, Q*, which could contain unobservable information on marginal productivity. Specifically, Q* is Tobin's Q excluding the price effect of BOJ investment and is estimated by regressing Tobin's Q on BOJ Ownership and the same set of control variables. I also include firm fixed effects and time fixed effects in all specifications.

2.5.1. Equity Issue

Equity issuance data are from the SDC database which provides the precise timing of issuance. Based on information from the data, I construct a dummy variable that equals one if the firm issued shares in the secondary equity market during the year, and zero otherwise. I also aggregate the amount of equity issues over a year and the number of shares issued by the total number of shares outstanding at the end of the previous year. For robustness, I also use information from the financial statements as reported in the Worldscope database. I construct two measures of equity issues based on data from the financial reports. The first measure, annual issue amount, is calculated as sale of common and preferred stocks minus purchases of common and preferred stocks, scaled by book value of total assets at the end of the previous fiscal year. The second measure is net cash flow from financing as reported in the cash flow statement, again scaled by total assets at the end of the previous fiscal year. The two measures capture all public and private issues as well as expired issues and share repurchases.

Table 2.8 reports the regression results for the effect of BOJ ownership on equity issuance. The first column shows the results using the conditional logit model. As very few firms issued shares during the sample period, the model has a very small sample. The remaining columns still use a linear regression model. The coefficients on BOJ ownership in all specifications are not significant, suggesting no significant impact on equity issue. The results are consistent across both the Nikkei sample and the full sample.

Table 2.8: Effect on Equity Issue after the Announcement

This table presents the regression estimates for the effect of BOJ ownership on equity issue around the first BOJ investment expansion announcement under QQE on October 31, 2014. Panel A reports the results using a sample of Nikkei 225 firms. Panel B uses a sample of all Japanese firms listed on the First Section of the Tokyo Stock Exchange. In Column 1 of both panels, I estimate the model using the conditional logit regression, while linear regression is used for the remaining columns. BOJ Ownership is the total fraction of shares held by BOJ at the end of a year deducting the amount of BOJ ownership in the firm held prior to the announcement. Size is the log of total book value of assets. Q* is Tobin's Q excluding the price effect of BOJ investment and is estimated by regressing Tobin's Q on BOJ Ownership and the same set of control variables. Amihud is the Amihud (2002) illiquidity ratio over the year prior to the announcement. Turnover is the log of the average of daily stock turnover over the previous year. Volatility is the standard deviation of daily stock returns over the previous year. Leverage is calculated as the sum of long-term debts and current liabilities divided by the sum of long-term debts, current liabilities and book value of equity. Cash Flows is cash flows from operation as reported in the cash flow statement, scaled by book value of total assets. Sales Growth is the change in the value of sales revenue scaled by lagged total sales revenue. ROA is defined as the earnings before interests and tax scaled by lagged total assets. Cash is the level of cash holdings scaled by lagged total assets. Payout Ratio is the dividends paid plus the net purchase of common and preferred stock scaled by total assets. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and time.

Panel A: Nikkei Firms

	(1) SEO Dummy	(2) Annual Issue Amount from SDC	(3) Annual Issue Amount	(4) Net Cash Flow from Financing
BOJ Ownership	**-13.259**	**-0.074**	**-0.106**	**0.253**
	(-0.147)	**(-0.694)**	**(-1.910)**	**(0.951)**
Size	4.929	-0.014*	-0.008	-0.047**
	(1.197)	(-1.807)	(-1.580)	(-2.107)
Q*	1.083	0.008	-0.003	0.011
	(0.382)	(1.596)	(-0.700)	(1.143)
Cash Flows	0.412	-0.002	0.006	-0.158***
	(0.026)	(-0.064)	(0.341)	(-2.958)
Leverage	-0.560	0.016	0.033	-0.335***
	(-0.095)	(0.737)	(1.129)	(-5.928)
Sale Growth	-0.481	-0.001	0.005	-0.036**
	(-0.114)	(-0.066)	(0.915)	(-2.297)
ROA	-5.853	0.001	-0.033	-0.017
	(-0.662)	(0.021)	(-0.942)	(-0.214)
Cash	22.373	0.002	-0.005	-0.045
	(1.581)	(0.164)	(-0.730)	(-0.889)
Amihud	-0.849	0.010***	-0.001	0.008
	(-0.764)	(3.193)	(-0.359)	(1.060)
Turnover	-1.205	0.008*	0.002	-0.002
	(-0.837)	(1.797)	(0.775)	(-0.177)
Volatility	48.595	-0.504**	6.597***	18.696
	(0.916)	(-2.401)	(8,090.972)	(1.560)
Payout Ratio	-0.781	-0.000	0.000	-0.002*
	(-0.784)	(-0.128)	(0.103)	(-1.809)
Observations	60	747	747	750
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Adj. R-squared	0.039	0.039	0.309	0.305

Panel B: Full Sample

	(1) SEO Dummy	(2) Annual Issue Amount from SDC	(3) Annual Issue Amount	(4) Net Cash Flow from Financing
BOJ Ownership	**13.470**	**0.051**	**-0.025**	**-0.175**
	(0.281)	**(0.959)**	**(-0.473)**	**(-0.918)**
Size	-1.493**	-0.005***	-0.026	-0.059***
	(-2.410)	(-2.596)	(-1.693)	(-5.362)
Q*	0.737**	0.002*	0.008	0.016***
	(2.358)	(1.875)	(1.465)	(3.505)
Cash Flows	-0.409	0.008**	-0.011	-0.003
	(-0.364)	(2.082)	(-0.701)	(-0.158)
Leverage	4.791**	0.027***	0.059*	-0.331***
	(2.558)	(5.043)	(2.409)	(-10.842)
Sale Growth	1.148	0.001	0.003	0.006
	(1.293)	(0.426)	(1.014)	(0.658)
ROA	-0.528	-0.039***	0.001	-0.069**
	(-0.334)	(-7.112)	(0.081)	(-2.081)
Cash	-3.209**	-0.002	-0.006	-0.030**
	(-2.116)	(-0.988)	(-0.923)	(-2.412)
Amihud	0.089	0.003***	0.002	0.000
	(0.402)	(3.739)	(1.858)	(0.094)
Turnover	-0.186	0.003***	0.001	0.001
	(-0.728)	(3.180)	(0.859)	(0.224)
Volatility	40.402***	0.064	2.899	4.559
	(3.767)	(1.547)	(2.066)	(1.475)
Payout Ratio	-0.089	-0.000	0.000	-0.000
	(-0.697)	(-0.260)	(0.446)	(-0.826)
Observations	509	5,588	5,586	5,606
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Adj. R-squared	0.011	0.011	0.170	0.310

2.5.2. Debt Issue

Table 2.9 reports the regression estimates for the effect on debt issue. Panel A reports the results using the Nikkei sample and Panel B for a full sample. I construct both short-term, long-term and total debt issuance measures. Short-term issue is defined as notes payable scaled by previous year-end total assets. Long-term debt issue is defined as change in book value of long-term debt plus change in the current portion of long-term debt, scaled by previous year-end total assets. Total debt issue is the sum of short-term and long-term debt issue. The results are still not statistically significant, indicating no significant increases in debt issues after the policy expansion announcement.

2.5.3. Dividend Payout

If lower cost of capital leads to more investment opportunities, firms may cut dividends in order to save more internal cash flows for future investment. Table 2.10 examines the effect on dividend policy. I measure dividend payout ratio as the level of dividends paid plus the net purchase of common and preferred stock, scaled by either total assets or net income. Columns 1 and 2 show the results for a sample of Nikkei 225 index member firms and Columns 3 and 4 show results for a sample of all public firms in the TOPIX index. BOJ ownership still does not have a significant impact on corporate dividend payouts. The results show that there is no significant change in the level of dividend payouts after the announcement of the policy update.

Table 2.9: Effect on Debt Issue after the Announcement

This table presents the regression estimates for the effect of BOJ ownership on debt issue around the first BOJ investment expansion announcement under QQE on October 31, 2014. Columns 1–3 report the results using a sample of Nikkei 225 firms. Columns 4–6 uses a sample of all Japanese firms listed on the First Section of the Tokyo Stock Exchange. BOJ Ownership is the total fraction of shares held by BOJ at the end of a year deducting the amount of BOJ ownership in the firm held prior to the announcement. Size is the log of total book value of assets. Q* is Tobin's Q excluding the price effect of BOJ investment and is estimated by regressing Tobin's Q on BOJ Ownership and the same set of control variables. Amihud is the Amihud (2002) illiquidity ratio over the year prior to the announcement. Turnover is the log of the average of daily stock turnover over the previous year. Volatility is the standard deviation of daily stock returns over the previous year. Leverage is calculated as the sum of long-term debts and current liabilities divided by the sum of long-term debts, current liabilities and book value of equity. Cash Flows is cash flows from operation as reported in the cash flow statement, scaled by book value of total assets. Sales Growth is the change in the value of sales revenue scaled by lagged total sales revenue. ROA is defined as the earnings before interest and tax scaled by lagged total assets. Cash is the level of cash holdings scaled by lagged total assets. Payout Ratio is the dividends paid plus the net purchase of common and preferred stock scaled by total assets. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and time.

	(1) Short-Term Debt Issue	(2) Long-Term Debt Issue	(3) Total Debt Issue	(4) Short-Term Debt Issue	(5) Long-Term Debt Issue	(6) Total Debt Issue
BOJ Ownership	**-0.015**	**0.477**	**0.017**	**-0.212***	**-0.191**	**-0.346**
	(-0.078)	**(1.499)**	**(0.652)**	**(-2.461)**	**(-1.137)**	**(-2.048)**
Size	0.016	0.012	0.006	0.006	0.012**	0.011*
	(1.767)	(1.007)	(0.365)	(1.998)	(4.635)	(2.722)
Q*	-0.093**	-0.073*	-0.175**	-0.009	-0.048**	-0.012
	(-4.597)	(-2.558)	(-3.722)	(-0.459)	(-3.367)	(-0.603)
Cash Flows	-0.022	-0.075**	-0.112**	-0.017	-0.034**	-0.054**
	(-1.082)	(-4.696)	(-5.265)	(-1.832)	(-3.263)	(-4.610)
Leverage	0.024	-0.331**	-0.575**	0.065	-0.312**	-0.528**
	(0.537)	(-5.778)	(-3.840)	(1.224)	(-3.805)	(-4.539)
Sale Growth	-0.017	-0.016	-0.025	-0.003	-0.002	-0.001
	(-1.322)	(-0.979)	(-0.765)	(-0.437)	(-0.101)	(-0.106)
ROA	0.087	-0.053	-0.036	0.028	-0.015	-0.028
	(2.084)	(-0.685)	(-0.567)	(0.888)	(-0.683)	(-0.723)
Cash	0.027	-0.079**	0.006	-0.006	-0.020*	-0.016
	(1.194)	(-4.924)	(0.131)	(-1.501)	(-3.025)	(-1.823)
Amihud	0.016*	0.015*	0.016	0.002	0.001	-0.004
	(2.470)	(2.561)	(1.392)	(0.454)	(0.497)	(-1.226)
Turnover	-0.004	0.025	0.000	0.002	0.001	-0.002
	(-0.337)	(2.177)	(0.034)	(0.685)	(0.656)	(-0.854)
Volatility	12.960	-2.203	18.571	-1.123	3.518	5.147
	(1.254)	(-0.273)	(1.473)	(-0.807)	(0.977)	(1.140)
Payout Ratio	0.000	-0.001	-0.001	0.000	-0.000	-0.000
	(0.052)	(-0.739)	(-0.670)	(0.269)	(-0.700)	(-1.626)
Observations	746	746	746	5,581	5,570	5,582
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Nikkei	Nikkei	Nikkei	TOPIX	TOPIX	TOPIX

Adj. R-squared	0.829	0.173	0.347	0.808	0.150	0.302

Table 2.10: Effect on Dividend Payout after the Announcement

This table presents the regression estimates for the effect of BOJ ownership on dividend payout around the first BOJ investment expansion announcement under QQE on October 31, 2014. Columns 1–3 report the results using a sample of Nikkei 225 firms. Columns 4–6 use a sample of all Japanese firms listed on the First Section of the Tokyo Stock Exchange. BOJ Ownership is the total fraction of shares held by BOJ at the end of a year deducting the amount of BOJ ownership in the firm held prior to the announcement. Size is the log of total book value of assets. Q* is Tobin's Q excluding the price effect of BOJ investment and is estimated by regressing Tobin's Q on BOJ Ownership and the same set of control variables. Amihud is the Amihud (2002) illiquidity ratio over the year prior to the announcement. Turnover is the log of the average of daily stock turnover over the previous year. Volatility is the standard deviation of daily stock returns over the previous year. Leverage is calculated as the sum of long-term debts and current liabilities divided by the sum of long-term debts, current liabilities and book value of equity. Cash Flows is cash flows from operation as reported in the cash flow statement, scaled by book value of total assets. Sales Growth is the change in the value of sales revenue scaled by lagged total sales revenue. ROA is defined as the earnings before interest and tax scaled by lagged total assets. Cash is the level of cash holdings scaled by lagged total assets. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and time.

	(1) Dividend Payout / Total Assets	(2) Dividend Payout / Net Income	(3) Dividend Payout / Total Assets	(4) Dividend Payout / Net Income
BOJ Ownership	**0.996**	**0.138**	**1.007**	**0.106**
	(0.550)	**(0.912)**	**(0.738)**	**(0.865)**
Q*	-0.115	0.006	-0.044	0.003
	(-2.348)	(1.567)	(-1.389)	(1.725)
Cash Flows	-0.043	0.020	-0.139	0.011*
	(-0.101)	(1.130)	(-2.003)	(3.015)
Size	0.763**	0.012*	0.458***	0.006*
	(5.393)	(2.623)	(10.497)	(2.355)
Leverage	-1.566*	0.005	-0.523**	-0.007
	(-2.602)	(0.257)	(-3.535)	(-0.978)
Sale Growth	-0.343*	-0.003	-0.155	0.002
	(-2.583)	(-0.528)	(-1.804)	(1.142)
ROA	0.909	0.047**	0.438	0.020*
	(0.942)	(3.192)	(1.754)	(2.697)
Cash	-0.005	0.015	-0.038	0.001
	(-0.018)	(1.484)	(-1.315)	(0.406)
Amihud	0.196	-0.001	0.013	-0.001
	(2.092)	(-0.472)	(1.285)	(-1.611)
Turnover	0.186	-0.001	0.004	-0.000
	(1.376)	(-0.643)	(0.450)	(-0.414)
Volatility	-6.411	6.985	-52.626**	-0.470
	(-0.078)	(1.857)	(-3.291)	(-0.777)
Observations	718	718	5,544	5,542
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Sample	Nikkei	Nikkei	TOPIX	TOPIX
Adj. R-squared	0.294	0.621	0.369	0.584

2.5.4. Corporate Investment and the Number of Employees

To investigate the effect on corporate investment, I use several measures that capture different aspects of corporate investment, including capital expenditure, the costs spent on acquisition of assets, R&D expenditure, cash flows from investing and the percentage change in the value of total assets relative to the previous fiscal year. All the variables are scaled by total assets as reported by the end of the previous fiscal year. In addition, I construct an M&A indicator variable, which equals to one if the firm undertook M&As during the year, and zero otherwise. I also test for the effect on employment using the log of the number of total employees hired by a firm during the year. Data on M&As are obtained from the SDC database. The other measures are constructed based on data from the financial statements compiled by the Worldscope.

Table 2.11 reports the regression results using these measures as the dependent variables. The main explanatory variable, BOJ ownership, is still not statistically nor economically significant. The results indicate that firms with disproportionately greater BOJ investment do not increase investment nor hire more people to take advantage of the lowered cost of capital.

Table 2.11: Effect on Investment and Employment after the Announcement

This table presents the regression estimates for the effect of BOJ ownership on corporate investment and employment level around the first BOJ investment expansion announcement under QQE on October 31, 2014. Panel A reports the results using a sample of Nikkei 225 firms. Panel B uses a sample of all Japanese firms listed on the First Section of the Tokyo Stock Exchange. BOJ Ownership is the total fraction of shares held by BOJ at the end of a year deducting the amount of BOJ ownership in the firm held prior to the announcement. Size is the log of total book value of assets. Q* is Tobin's Q excluding the price effect of BOJ investment and is estimated by regressing Tobin's Q on BOJ Ownership and the same set of control variables. Amihud is the Amihud (2002) illiquidity ratio over the year prior to the announcement. Turnover is the log of the average of daily stock turnover over the previous year. Volatility is the standard deviation of daily stock returns over the previous year. Leverage is calculated as the sum of long-term debts and current liabilities divided by the sum of long-term debts, current liabilities and book value of equity. Cash Flows is cash flows from operation as reported in the cash flow statement, scaled by book value of total assets. Sales Growth is the change in the value of sales revenue scaled by lagged total sales revenue. ROA is defined as the earnings before interest and tax scaled by lagged total assets. Cash is the level of cash holdings scaled by lagged total assets. Payout Ratio is the dividends paid plus the net purchase of common and preferred stock scaled by total assets. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and time.

Panel A: Nikkei Firms

	(1) Capital Expenditure	(2) Acquisition of Assets	(3) R&D Expenditure	(4) Cash Flow from Investing	(5) Asset Growth	(6) M&As	(7) Employees
BOJ Ownership	**-0.013**	**0.047**	**0.020**	**-0.029**	**0.343**	**1.074**	**0.414**
	(-0.170)	**(0.470)**	**(0.138)**	**(-0.189)**	**(1.024)**	**(0.161)**	**(0.711)**
Q*	0.012**	0.001	-0.004	0.022*	0.018	0.019	0.003
	(3.594)	(0.151)	(-0.959)	(2.706)	(1.135)	(0.147)	(0.702)
Cash Flows	-0.053*	-0.031	-0.004	-0.062	-0.113	-0.777	0.014
	(-2.846)	(-1.969)	(-0.281)	(-2.109)	(-1.305)	(-1.579)	(0.579)
Size	-0.018*	-0.024*	-0.002	-0.049**	-0.504***	-0.603**	0.035**
	(-2.395)	(-2.949)	(-0.243)	(-3.286)	(-6.206)	(-2.554)	(5.336)
Leverage	-0.062**	0.001	-0.024	-0.109*	-0.045	-0.089	-0.011
	(-5.148)	(0.079)	(-1.763)	(-2.893)	(-0.473)	(-0.116)	(-0.758)
Sale Growth	-0.008	-0.005	-0.002	-0.023	-0.007	-0.359	-0.002
	(-0.769)	(-0.784)	(-0.233)	(-1.728)	(-0.194)	(-1.206)	(-0.224)
ROA	0.023	0.014	-0.012	0.096*	-0.005	3.688***	-0.029
	(1.252)	(0.745)	(-0.261)	(2.595)	(-0.030)	(3.824)	(-1.639)
Cash	0.002	0.009	-0.007	0.010	-0.031	1.052***	-0.024*
	(0.167)	(0.667)	(-0.661)	(0.306)	(-0.459)	(2.741)	(-2.612)
Amihud	-0.000	-0.001	-0.000	-0.002	-0.051***	0.025	-0.003
	(-0.196)	(-0.379)	(-0.049)	(-0.438)	(-3.378)	(0.231)	(-2.132)
Turnover	-0.001	-0.003	0.000	-0.019	-0.054**	0.076	-0.006
	(-0.383)	(-0.691)	(0.046)	(-2.144)	(-2.595)	(0.575)	(-1.569)
Volatility	5.116	2.655	0.458	9.537	73.603***	-4.698	0.561
	(1.319)	(0.513)	(0.288)	(1.598)	(3.680)	(-0.707)	(0.180)
Payout Ratio	-0.000	0.000	0.000	0.000	0.000	0.000	0.001
	(-0.386)	(1.506)	(0.193)	(0.099)	(0.091)	(0.035)	(1.205)
Observations	747	747	747	747	747	423	744
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.745	0.103	0.956	0.439	0.579		0.995

Panel B: Full Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Capital Expenditure	Acquisition of Assets	R&D Expenditure	Cash Flow from Investing	Asset Growth	M&As	Employees
BOJ Ownership	**-0.012**	**0.091**	**0.002**	**-0.157**	**-0.162**	**3.702**	**-0.150**
	(-0.593)	**(1.402)**	**(0.027)**	**(-1.529)**	**(-1.258)**	**(0.327)**	**(-1.963)**
Q*	0.007*	0.004**	-0.000	0.015*	0.014**	0.058	0.005
	(2.996)	(3.483)	(-0.494)	(3.156)	(2.402)	(0.119)	(1.799)
Cash Flows	-0.003	-0.006	0.003	-0.014	-0.006	-6.836***	-0.004
	(-0.499)	(-1.359)	(1.065)	(-1.025)	(-0.250)	(-2.679)	(-0.450)
Size	-0.012**	-0.007	0.001	-0.035**	-0.135***	-0.726	0.051***
	(-3.423)	(-2.091)	(1.234)	(-3.554)	(-8.252)	(-1.131)	(6.988)
Leverage	-0.037	-0.033*	-0.004	-0.172**	-0.097**	0.552	-0.013
	(-2.266)	(-3.173)	(-1.205)	(-4.644)	(-2.541)	(0.257)	(-1.090)
Sale Growth	-0.003	-0.005	-0.004	-0.008	0.015	0.372	-0.004
	(-1.037)	(-2.175)	(-2.144)	(-1.147)	(1.329)	(0.465)	(-0.725)
ROA	-0.007	0.005	0.003	0.017	-0.001	10.427***	-0.036
	(-1.101)	(0.902)	(1.069)	(0.824)	(-0.026)	(3.087)	(-2.085)
Cash	0.008	0.003	0.000	0.034	-0.015	1.912	-0.003
	(1.575)	(1.243)	(0.112)	(1.953)	(-1.380)	(1.326)	(-0.500)
Amihud	-0.005*	-0.000	0.000	-0.007**	-0.007**	0.022	-0.001
	(-2.634)	(-0.833)	(0.005)	(-3.541)	(-2.349)	(0.070)	(-0.374)
Turnover	-0.004	-0.000	-0.000	-0.007*	-0.005	-0.025	-0.001
	(-2.127)	(-0.065)	(-0.043)	(-2.758)	(-1.458)	(-0.060)	(-0.460)
Volatility	-0.200	0.017	-0.075	2.436	2.944	-21.353	1.482
	(-0.124)	(0.019)	(-0.289)	(0.976)	(0.699)	(-1.001)	(0.411)
Payout Ratio	-0.000	-0.000	0.000	-0.000	0.000*	-0.036*	0.000
	(-0.219)	(-1.040)	(0.415)	(-0.930)	(1.718)	(-1.925)	(0.554)
Observations	5,580	5,588	5,588	5,586	5,588	2,553	5,435
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-squared	0.679	0.170	0.956	0.444	0.964		0.992

2.5.5. Financing Dependent Firms

It may be argued that as the BOJ is buying the entire market, the stock prices of all firms should be pushed up. Moreover, if money is not a perfect substitute for stocks, the large demand pressure from the central bank will force investors to rebalance their portfolios, moving from firms that are heavily invested in by the BOJ to other alternative stocks. To ensure market clearing, the prices of not only biased stocks but also substitutes are expected to increase. In this case, firms with stronger financing constraints may have greater incentive to take advantage of the lowered cost of capital. Given the puzzling low effect of BOJ investment on the corporate policies of Japanese firms, I examine if BOJ investment has significant impact on firms with greater financial constraints. I use two measures widely adopted in the literature to measure equity dependence, including the KZ index following Lamont, Polk, and Saaá-Requejo (2001) and the SA index following Hadlock and Pierce (2010).

The KZ index was first developed by Kaplan and Zingales (1997) and formalized by Lamont, Polk, and Saaá-Requejo (2001). The KZ index is calculated as:

$$-1.002(Cash\,Flow/K) + 0.283(Q) + 3.139(Debt/K) - 39.368(Dividend/K) - 1.315(Cash/K)$$

where Cash Flow is income before extraordinary items plus depreciation and amortization, Debt is the sum of long-term debt and current liabilities, Dividend is the amount of cash dividend paid during the year, K is the value of property, plant and equipment and Q and Cash are as defined earlier.

The SA index is argued by Hadlock and Pierce (2010) to be a more valid proxy for financial constraint levels and is calculated as:

$$-0.737(Size) + 0.043(Size^2) - 0.040(Age)$$

For both indices, a higher index value means a higher financial constraint level. They are calculated using information one year prior to the announcement for each firm.

Table 2.12 reports the estimates from regressing corporate policy measures on the interaction of the financial constraint measures and a post dummy, a series of control variables, and firm and year fixed effects. The post dummy takes the value of one for fiscal years after the purchase expansion announcement in 2014. The coefficient of the interaction term estimates the marginal effects on firms with greater financial constraints after the announcement. The estimates are statistically insignificant and economically close to zero. Despite a greater need for external financing, firms that have financial constraints do not change their financing and investing behavior after the BOJ expands its equity purchase program.

A concern with the SA index and KZ index is that they are developed based on the US market and hence may not be suitable for Japan's market. However, data on the actual use of Japanese firms' external financing is not available. Even if we can construct proxies based on their accounting figures, it would reflect the equilibrium between the demand for external funds and its supply. The supply of financing is what this study aims to test, however I am unable to disentangle this information. To address this concern, I use a measure of industry level equity finance dependence following Rajan and Zingales (1996). The amount of external finance used by all firms is measured using that of US firms in an industry. This approach assumes that technological differences cause some industries to depend more on external finance than others and such differences persist across the US and Japan. This assumption is plausible as the level of demand for a certain product, its stage in the life cycle, and its cash harvest period are likely to be similar across countries. Moreover, using data on US firms also allows for an exogenous identification of an industry's technological demand for external financing in Japan.

Specifically, to capture the amount of desired investment that cannot be financed through internal sources, i.e., the cash flow generated by the same business, a firm's dependence on external finance is defined as the difference between capital expenditures and cash flow from operations divided by capital expenditures. Dependence on external equity finance is defined as the ratio of the net amount of equity issues (Sale of Common and Preferred Stock minus Purchase of Common and Preferred Stock) to capital expenditures.

To summarize the data at industry level, I first calculate a firm's dependence on external finance by taking the sum of the firm's use of external finance over the sample period and then dividing by the sum of capital expenditure over the sample period. I then take the industry median to summarise firm level ratios at industry level. Table 2.12 Panel C and D present the results, which are consistence with the results using the SA index and KZ index.

Table 2.12: External Financing Dependent Firms

This table presents the regression results for the variation in the effect of BOJ investment for financing dependent firms and nondependent firms. The sample spans a period of four years and includes annual data eight two years before and two years after the first BOJ investment expansion announcement under QQE on October 31, 2014. Panel A reports the results for the SA index and Panel B for the KZ index. BOJ Ownership is the total fraction of shares held by BOJ at the end of a year deducting the amount of BOJ ownership in the firm held prior to the announcement. Size is the log of total book value of assets. Q* is Tobin's Q excluding the price effect of BOJ investment and is estimated by regressing Tobin's Q on BOJ Ownership and the same set of control variables. Amihud is the Amihud (2002) illiquidity ratio over the year prior to the announcement. Turnover is the log of the average of daily stock turnover over the previous year. Volatility is the standard deviation of daily stock returns over the previous year. Leverage is calculated as the sum of long-term debts and current liabilities divided by the sum of long-term debts, current liabilities and book value of equity. Cash Flows is cash flows from operation as reported in the cash flow statement, scaled by book value of total assets. Sales Growth is the change in the value of sales revenue scaled by lagged total sales revenue. ROA is defined as the earnings before interest and tax scaled by lagged total assets. Cash is the level of cash holdings scaled by lagged total assets. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and time.

Panel A: SA Index

	(1) Annual Issue Amount	(2) Capital Expenditure	(3) Employees	(4) Annual Issue Amount	(5) Capital Expenditure	(6) Employees
SA*Post	**-0.001**	**0.004**	**-0.030**	**0.000**	**-0.002**	**-0.010**
	(-0.933)	**(1.442)**	**(-1.794)**	**(0.267)**	**(-0.959)**	**(-1.035)**
Q*	-0.003	0.012**	0.042	0.009	0.005	0.014
	(-0.917)	(3.539)	(1.132)	(1.764)	(2.297)	(0.767)
Cash Flows	0.006	-0.050*	0.060	-0.010	-0.002	-0.006
	(0.311)	(-2.520)	(0.310)	(-0.656)	(-0.397)	(-0.082)
Size	-0.009	-0.019*	0.359**	-0.026	-0.011*	0.351***
	(-1.538)	(-2.820)	(4.688)	(-1.780)	(-2.749)	(6.417)
Leverage	0.030	-0.061**	-0.118	0.057*	-0.043*	-0.105
	(0.989)	(-5.277)	(-0.827)	(2.465)	(-2.832)	(-1.181)
Sale Growth	0.005	-0.008	-0.002	0.003	-0.001	-0.009
	(0.920)	(-0.766)	(-0.039)	(0.874)	(-0.541)	(-0.178)
ROA	-0.037	0.023	-0.274	-0.007	-0.007	-0.192
	(-1.004)	(1.190)	(-1.679)	(-0.796)	(-1.017)	(-2.326)
Cash	-0.004	0.003	-0.169	-0.006	0.008	-0.034
	(-0.541)	(0.193)	(-1.983)	(-1.032)	(1.759)	(-0.813)
Amihud	-0.001	0.001	-0.030	0.003	-0.004*	-0.001
	(-0.620)	(0.289)	(-1.874)	(2.003)	(-2.555)	(-0.209)
Turnover	0.002	-0.000	-0.061	0.002	-0.003	-0.004
	(0.595)	(-0.025)	(-1.667)	(1.195)	(-1.870)	(-0.426)
Volatility	6.700***	4.558	16.435	3.124	0.523	12.708
	(3,471.326)	(1.252)	(0.596)	(2.155)	(0.367)	(0.874)
Observations	752	752	749	5,608	5,602	5,456
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Nikkei	Nikkei	Nikkei	TOPIX	TOPIX	TOPIX
Adj. R-squared	0.312	0.746	0.995	0.188	0.681	0.994

Panel B: KZ Index

	(1)	(2)	(3)	(4)	(5)	(6)
	Annual Issue Amount	Capital Expenditure	Employees	Annual Issue Amount	Capital Expenditure	Employees
KZ*Post	**-0.002**	**0.004**	**-0.011**	**0.000**	**0.002**	**-0.001**
	(-1.160)	**(1.164)**	**(-0.679)**	**(0.302)**	**(0.911)**	**(-0.197)**
MB	-0.004	0.013**	0.041	0.008	0.006*	0.023
	(-0.914)	(3.337)	(1.164)	(1.481)	(2.757)	(1.439)
Cash Flows	0.007	-0.053*	0.073	-0.011	-0.003	-0.027
	(0.406)	(-2.627)	(0.370)	(-0.727)	(-0.528)	(-0.404)
Size	-0.009	-0.018*	0.353**	-0.026	-0.013**	0.365***
	(-1.729)	(-2.502)	(4.892)	(-1.686)	(-3.642)	(6.860)
Leverage	0.028	-0.059**	-0.127	0.060*	-0.036	-0.105
	(0.910)	(-5.189)	(-0.976)	(2.436)	(-2.265)	(-1.311)
Sale Growth	0.005	-0.009	-0.000	0.003	-0.003	-0.016
	(0.912)	(-0.810)	(-0.004)	(0.933)	(-1.098)	(-0.376)
ROA	-0.035	0.019	-0.254	0.001	-0.009	-0.234
	(-0.968)	(1.081)	(-1.490)	(0.082)	(-1.375)	(-2.263)
Cash	-0.003	0.001	-0.164	-0.006	0.008	-0.027
	(-0.428)	(0.081)	(-2.074)	(-0.862)	(1.538)	(-0.726)
Amihud	-0.001	-0.000	-0.025	0.002	-0.005*	-0.002
	(-0.439)	(-0.058)	(-1.583)	(1.673)	(-2.717)	(-0.217)
Turnover	0.003	-0.002	-0.052	0.001	-0.004	-0.005
	(0.851)	(-0.568)	(-1.504)	(0.822)	(-2.232)	(-0.415)
Volatility	5.489***	6.900	5.585	2.930	0.096	10.198
	(3,294.435)	(1.654)	(0.218)	(1.961)	(0.063)	(0.611)
Observations	752	752	749	5,608	5,602	5,456
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	TOPIX	TOPIX	TOPIX	Nikkei	Nikkei	Nikkei
Adj. R-squared	0.314	0.747	0.995	0.176	0.677	0.994

Panel C: Equity Dependence

VARIABLES	(1) Annual Issue Amount	(2) Capital Expenditure	(3) Employees	(4) Annual Issue Amount	(5) Capital Expenditure	(6) Employees
Equity Dependence*Post	**-0.000**	**-0.000**	**-0.009**	**-0.000**	**-0.000**	**-0.002**
	(-0.841)	**(-0.183)**	**(-1.532)**	**(-1.246)**	**(-0.307)**	**(-1.637)**
MB	-0.002	0.014**	0.070	0.009	0.006	0.021
	(-0.463)	(3.442)	(1.219)	(1.453)	(2.139)	(1.563)
Cash Flows	0.010	-0.072**	-0.119	-0.011	-0.005	-0.002
	(0.333)	(-4.243)	(-0.425)	(-0.692)	(-0.920)	(-0.027)
Size	-0.014*	-0.025*	0.343**	-0.034	-0.012*	0.398***
	(-2.490)	(-2.915)	(4.061)	(-1.870)	(-2.842)	(9.151)
Leverage	0.038	-0.073**	-0.105	0.068*	-0.049*	-0.153
	(1.091)	(-5.693)	(-0.849)	(2.576)	(-2.813)	(-1.683)
Sale Growth	0.009	-0.006	0.028	0.006	-0.002	-0.037
	(1.545)	(-0.510)	(0.533)	(1.639)	(-0.471)	(-0.772)
ROA	-0.045	0.012	-0.274	0.002	-0.007	-0.262*
	(-1.193)	(0.575)	(-1.458)	(0.245)	(-0.905)	(-2.564)
Cash	-0.017	0.040	-0.071	-0.007	0.007	-0.029
	(-1.041)	(1.873)	(-0.396)	(-0.882)	(1.398)	(-0.836)
Amihud	-0.002	0.001	-0.023	0.002	-0.003	0.002
	(-1.022)	(0.595)	(-1.080)	(1.556)	(-1.910)	(0.336)
Turnover	0.003	-0.000	-0.051	0.001	-0.003	0.001
	(1.104)	(-0.146)	(-1.503)	(0.403)	(-1.578)	(0.165)
Volatility	8.243	7.294	19.887	4.131	0.132	2.085
	(1.942)	(2.053)	(0.527)	(2.149)	(0.091)	(0.148)
Observations	754	754	751	5,793	5,787	5,623
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Nikkei	Nikkei	Nikkei	TOPIX	TOPIX	TOPIX
Adj. R-squared	0.2916	0.7301	0.9956	0.1874	0.6689	0.9935

Panel D: External Finance Dependence

VARIABLES	(1) Annual Issue Amount	(2) Capital Expenditure	(3) Employees	(4) Annual Issue Amount	(5) Capital Expenditure	(6) Employees
External Finance Dependence*Post	**-0.000**	**-0.000**	**-0.009**	**-0.000**	**-0.000**	**-0.002**
	(-0.817)	**(-0.565)**	**(-1.454)**	**(-1.096)**	**(-0.375)**	**(-1.605)**
MB	-0.002	0.014**	0.069	0.009	0.006	0.021
	(-0.408)	(3.410)	(1.205)	(1.450)	(2.148)	(1.568)
Cash Flows	0.009	-0.071**	-0.112	-0.011	-0.005	-0.002
	(0.318)	(-4.232)	(-0.406)	(-0.691)	(-0.920)	(-0.027)
Size	-0.014*	-0.025*	0.343**	-0.034	-0.012*	0.398***
	(-2.507)	(-2.925)	(4.048)	(-1.871)	(-2.836)	(9.152)
Leverage	0.038	-0.072**	-0.104	0.068*	-0.049*	-0.153
	(1.084)	(-5.689)	(-0.838)	(2.577)	(-2.814)	(-1.677)
Sale Growth	0.009	-0.006	0.026	0.006	-0.002	-0.037
	(1.527)	(-0.517)	(0.495)	(1.648)	(-0.474)	(-0.777)
ROA	-0.045	0.012	-0.269	0.002	-0.007	-0.261*
	(-1.197)	(0.588)	(-1.457)	(0.254)	(-0.913)	(-2.567)
Cash	-0.017	0.040	-0.077	-0.007	0.007	-0.029
	(-1.039)	(1.864)	(-0.431)	(-0.883)	(1.394)	(-0.840)
Amihud	-0.002	0.001	-0.024	0.002	-0.003	0.002
	(-0.978)	(0.575)	(-1.148)	(1.552)	(-1.911)	(0.330)
Turnover	0.003	-0.001	-0.053	0.001	-0.003	0.001
	(1.047)	(-0.184)	(-1.539)	(0.401)	(-1.578)	(0.162)
Volatility	8.404	7.359	21.141	4.130	0.133	2.060
	(1.973)	(2.082)	(0.565)	(2.146)	(0.092)	(0.147)
Observations	754	754	751	5,793	5,787	5,623
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Nikkei	Nikkei	Nikkei	TOPIX	TOPIX	TOPIX
Adj. R-squared	0.2936	0.7300	0.9956	0.1873	0.6689	0.9935

2.6. Discussions on the Effect of the BOJ's ETF Purchase Program

Bernanke and Reinhart (2004) discuss several mechanisms through which aggressive monetary easing is expected to work when interest rates are low. Firstly, if investors do not consider all securities as perfect substitutes, large purchases by the central bank would have the potential to increase relative security prices and reduce risk premium in the markets. Consequently, the private sector would face a lower cost of capital and have greater incentive to make real investments that in turn create jobs and enhance growth. The authors also point out that the strong commitment by the central bank to continuously expanding the size of its balance sheet could have a positive signaling effect. Investors would interpret the policy as the central bank's assurance that monetary easing will continue until certain economic conditions are achieved.

In the case of the BOJ's ETF purchase program, I have documented a positive and significant price impact but no real impact in encouraging corporate investment and employment. Given that the policy has successfully pushed up stock prices and lowered the cost of equity capital for firms that are heavily invested in by the BOJ, it is puzzling to see no significant increase in corporate investment. In this section, I discuss possible explanations for these findings.

2.6.1. The Dependence on Public Equity Issuance

According to the first mechanism mentioned by Bernanke and Reinhart (2004), a lower cost of capital due to higher asset prices would directly translate into more investment and other real effects. However, the chain breaks in Japan at the point where a lowered cost of capital does not encourage more equity issue and investments. I conjecture that one of the possible explanations for this missing real impact of the policy could be the relatively less active public equity market in Japan. It has been well documented that Japan is a relationship-based bank-centered system (see for example Aoki 1990, Rajan and Zingales 1998, Weinstein and Yafeh 1998, and Morck and Nakamura 1999). In contrast to a market-oriented system as in the United States and United Kingdom, Japan's financial system is dominated by large banks, which play an important role in corporate control as both major creditors and shareholders (Prowse 1990, 1992). Most large Japanese firms are predominantly held by these banks as well as by long-standing business partners and client firms, forming closely linked business groups (keiretsu). It is often argued that the keiretsu structure cultivates stable business relationships and the growth of the group rather than maximizing the value of individual stocks (Bird 1991). According to Berglöf and Perotti (1994), around 84% of public firms listed on the Tokyo Stock Exchange First Section are members of a keiretsu.

The structure was blamed for Japan's prolonged economic recession and some studies have found that the power of big banks has somewhat loosened after regulatory reforms and the restructure of major banks in Japan since the 1990s.[10] However, despite the pressure toward evolution, keiretsu affiliation continues to persist in Japan as it is deeply immersed in the Japanese organizational structure and conforms to the collectivist culture of Japan (McGuire and Dow 2009). With elaborate cross-holdings and a highly intertwined network of stable financial stakeholders, I believe the public equity market

[10] See McGuire and Dow (2003) and Yoshikawa and McGuire (2008) for a summary of these studies.

plays a relatively less important role in corporate financing in Japan compared to other countries.

Table 2.13 compares the level and frequency of equity issuance by publicly listed firms in Japan with those of other countries. Following Hanselaar, Stulz, and van Dijk (2018) on the choice of 37 developed and developing countries, I obtain data on all public equity issuance that takes place in these countries from the SDC database. The sample covers the period from 2000 to 2017. I filter the sample following Hanselaar, Stulz, and van Dijk (2018). I only include issues of common stock and issues from non-utilities and non-financial firms. I also only include share issues that took place in the domestic exchange in the country where the firms' headquarters are located. I aggregate the number of equity issues and the value of proceeds from issue by country and scale the figures by the total number of firm-years and total market capitalization respectively. I sort the countries by the average percentage of issuing firms relative to the total number of public firms.

Japan ranks the second lowest in terms of issue frequency (2.82%) among developed countries, only slightly higher than Israel (2.27%). Even compared to developing countries, most developing countries have a higher equity issue frequency than Japan except Greece (1.7%) and Colombia (2.57%). In terms of issue value, the average total value of issuance proceeds relative to total market capitalization in Japan is 0.22%, which is the lowest among all the countries in the sample. Australia, Canada, the United Kingdom and South Korea are among the most active equity markets in the world. The statistics confirm that the public equity market in Japan is highly inactive.

Table 2.13: Equity Issuance by Countries

This table reports the level and frequency of equity issuance in Japan and the other countries. Data on equity issuance are obtained from the SDC database. The sample covers 37 countries over the period from 2000 to 2017.

Country	No. of Equity Issue	No. of Firm-Years	% of Firms Issued Equity	Total Proceeds from Issuance (US$Million)	% Issuance Proceeds relative to Total Market Cap.
Developed Countries					
Japan	**845**	**29,951**	**2.82**	**114,049**	**0.22**
France	756	13,565	5.57	54,412	0.23
Switzerland	152	4,204	3.62	36,449	0.24
Israel	112	4,801	2.27	4,093	0.28
Spain	190	2,563	7.41	35,865	0.35
Sweden	761	6,691	11.37	24,983	0.36
Denmark	158	3,015	5.24	11,175	0.42
Germany	801	13,782	5.81	79,954	0.44
Netherlands	171	2,240	7.63	42,709	0.47
Finland	118	2,138	5.52	12,772	0.48
United States	8,401	114,426	7.34	1,122,722	0.56
Italy	214	4,664	4.59	55,475	0.58
Hong Kong	2,464	21,723	11.34	171,235	0.82
United Kingdom	5,056	28,863	17.52	296,718	0.99
Belgium	131	2,397	5.47	34,594	1.01
Singapore	1,321	11,188	11.81	57,393	1.13
New Zealand	258	2,116	12.19	8,523	1.16
Norway	394	3,332	11.82	31,836	1.19
Austria	79	1,401	5.64	23,210	1.25
Canada	5,440	28,250	19.26	278,338	2.15
Australia	10,589	27,253	38.85	283,804	3.05
Developing Countries					
Colombia	22	700	2.57	3,445	0.22
Mexico	81	1,932	4.19	21,081	0.42
Russia	154	2,863	4.92	29,839	0.49
Poland	221	5,415	4.08	8,924	0.52
South Africa	237	5,678	4.17	27,981	0.54
Chile	122	3,156	3.87	21,881	0.72
Indonesia	218	6,866	3.18	23,571	0.72
Thailand	518	8,644	5.99	27,836	0.91
Malaysia	1,198	16,061	7.46	37,372	0.96
Philippines	194	3,856	5.03	19,491	0.97
Portugal	47	974	4.83	13,111	1.01
Greece	77	4,534	1.70	14,249	1.06
South Korea	2,895	25,783	11.23	98,946	1.13
Egypt	132	1,729	7.63	8,731	1.17
India	1,679	31,289	5.37	129,904	1.23
Brazil	214	2,376	9.01	88,647	1.58

I then directly compare the sensitivity of investment to stock prices in Japan with other countries. I collect annual performance and financial data for public firms in the 37 countries from 2000 to 2017 from Datastream. I employ the standard investment-price sensitivity regression with corporate capital expenditure as the dependent variable and Tobin's Q as the independent variable. I also control for the level of internal cash flows which is the first-order source of funding for investment. All regressions include firm and country-year fixed effects. Cash flow is defined as income before extraordinary items plus depreciation and amortization divided by total book value assets at the end of the previous fiscal year. To capture the difference in investment-price sensitivity between Japan and other countries, I additionally include the interaction of a Japan dummy and Tobin's Q in the regression.

Table 2.14 reports the regression estimates. Columns 1 and 2 report the results using a sample of all countries, while Columns 3 and 4 report the results for the developed countries as listed in Table 2.13. The coefficients on Q and Cash Flow are positive and statistically significant. The results from the international sample are consistent with the general findings that corporate investment on average is positively related to both stock prices and cash flows. The coefficient on the interaction term is however negative and statistically significant, indicating that corporate investment in Japan is significantly less sensitive to stock prices compared to other countries.

Table 2.14: Comparing Investment-Price Sensitivity of Japan Firms with Other Countries

This table presents the estimates from regressing corporate capital expenditure on Tobin's Q, cash flows, and the interaction of Japan dummy and Tobin's Q. The sample covers 37 countries over the period from 2000 to 2017. Columns 1 and 2 report the results using a sample of all countries, while Columns 3 and 4 report the results for developed countries. Cash flow is defined as income before extraordinary items plus depreciation and amortization divided by total book value assets at the end of the previous fiscal year. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and clustered by country.

	(1)	(2)	(3)	(4)
Tobin's Q	0.008***	0.009***	0.012***	0.014***
	(8.230)	(8.515)	(5.154)	(5.160)
Cash Flow	0.001*	0.001*	0.001*	0.001**
	(2.166)	(2.262)	(2.494)	(2.822)
Japan*Q		**-0.007*****		**-0.012*****
		(-4.899)		**(-3.827)**
Observations	326,184	326,184	242,224	242,224
Firm FE	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes
Sample	All Countries		Developed Countries	
Adj. R-squared	0.376	0.392	0.435	0.442

2.6.2. Biased Investment in Large Firms

The lack of real impacts of the policy could also be attributed to the BOJ's biased allocation of annual purchases to Nikkei 225 firms. Nikkei 225 index constituents are top blue-chip firms listed on the First Section of Tokyo Stock Exchange. As the TOPIX index includes all firms publicly listed in the First Section of Tokyo Stock Exchange, the allocation of almost half of the capital into the Nikkei 225 index results in a double investment in Nikkei firms. Many theoretical and empirical studies have found that firms depend less on external financing along the life cycle (see for example, DeAngelo, DeAngelo, and Stulz 2010). Young firms with high market-to-book ratios and low operating cash flows more frequently issue stock to fund investment, whereas mature firms tend to fund investment using internally generated cash flows. Therefore, Nikkei 225 firms are expected to benefit less from an increase in stock prices and a lower cost of capital that is still not low enough compared to internal funds.

In Table 2.15, I compare the value and frequency of seasonal equity issuance by Nikkei 225 firms and the other public firms listed on the First Section of the Tokyo Stock Exchange by year. Consistent with the life cycle theory, Nikkei 225 firms issue shares much less frequently compared to the other listed firms. For example, only three (1.36%) Nikkei 225 firms issued shares during 2017 and the relative issuance value is only 0.04% compared to 0.22% for non-Nikkei public firms. In terms of investment-price sensitivity, I use a similar regression specification as in Table 2.14 using a sample of public firms in Japan. I interact a Nikkei index firm dummy with Tobin's Q. The coefficient on this interaction term shows the difference in investment-price sensitivity between Nikkei firms and the other firms. The regression results are shown in Table 2.16. Compared to other public firms in Japan, investment of Nikkei 225 firms is significantly less sensitive to stock prices, which confirms the life cycle theory.

Table 2.15: The Distribution of Equity Issuance in Nikkei 225 Firms and Others by Year

This table compares the value and frequency of seasonal equity issuance by Nikkei 225 firms and the other public firms listed on the First Section of the Tokyo Stock Exchange by year. Data on equity issuance are obtained from the SDC database. The sample covers the period from 2000 to 2017.

	Nikkei Firms					Non-Nikkei Firms				
Year	No. of Equity Issue	No. of Firm-Years	% of Firms Issued Equity	Total Proceeds from Issuance (US$Million)	Issuance Proceeds relative to Total Market Cap. (%)	No. of Equity Issue	No. of Firm-Years	% of Firms Issued Equity	Total Proceeds from Issuance (US$Million)	Issuance Proceeds relative to Total Market Cap. (%)
2000	3	209	1.44	1641.5	0.11	18	1,172	1.54	3021.6	0.24
2001	1	217	0.46	720	0.06	11	1,210	0.91	995.9	0.11
2002	4	215	1.86	1016.5	0.10	39	1,227	3.18	3177.4	0.40
2003	6	215	2.79	3172.6	0.39	37	1,256	2.95	2151.4	0.32
2004	5	217	2.30	3416.8	0.26	60	1,327	4.52	5801.1	0.52
2005	3	222	1.35	877.3	0.06	76	1,405	5.41	6788.2	0.56
2006	10	218	4.59	6542.7	0.33	60	1,453	4.13	5131.5	0.32
2007	4	217	1.84	1699.6	0.08	49	1,481	3.31	3962.2	0.27
2008	3	221	1.36	2053.7	0.12	26	1,485	1.75	2739.1	0.25
2009	11	219	5.02	8814.7	0.70	52	1,468	3.54	6054.0	0.65
2010	5	221	2.26	1411.5	0.08	41	1,439	2.85	4652.9	0.38
2011	5	221	2.26	2632.5	0.15	28	1,439	1.95	1819.0	0.15
2012	5	220	2.27	2124.5	0.12	28	1,457	1.92	2146.9	0.17
2013	5	221	2.26	4987.7	0.31	64	1,539	4.16	4573.1	0.37
2014	5	221	2.26	2514.9	0.14	54	1,604	3.37	3169.0	0.22
2015	5	223	2.24	2585.4	0.13	52	1,667	3.12	4310.2	0.26
2016	3	224	1.34	1209.5	0.06	24	1,701	1.41	1140.3	0.06
2017	3	220	1.36	826.6	0.04	40	1,680	2.38	4166.9	0.22

Table 2.16: Comparing Investment-Price Sensitivity of Nikkei 225 Firms with Other Firms in Japan

This table presents the estimates from regressing corporate capital expenditure on Tobin's Q, cash flows, and the interaction of Nikkei 225 index firm dummy and Tobin's Q. The sample covers publicly listed firms in Japan over the period from 2000 to 2017. Cash flow is defined as income before extraordinary items plus depreciation and amortization divided by total book value assets at the end of the previous fiscal year. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and clustered by firm.

	(1)	(2)	(3)
Tobin's Q	0.001**	0.002***	0.002***
	(2.320)	(3.055)	(3.885)
Cash Flow	0.122***	0.107***	0.110***
	(10.175)	(14.171)	(15.714)
Nikkei*Q			**-0.001****
			(-2.845)
Observations	3,512	23,213	26,732
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Sample	Nikkei	Non-Nikkei	Full
Adj. R-squared	0.545	0.588	0.604

2.6.3. Business Confidence

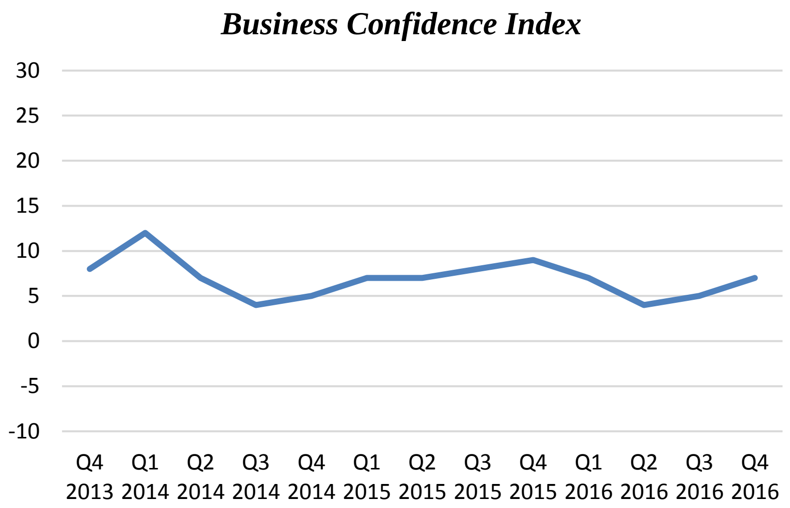
The stock market would be a sideshow if there are few growth opportunities for investment. If business confidence about future growth does not change, enterprises would hold up their expansion plans even with a lower cost of capital. I find that the confidence of Japan’s business enterprises and their perception about the investment climate remain unchanged during the period when the BOJ hugely expanded its ETF purchase program. This may also explain the limited real impact of the policy on Japan’s economy.

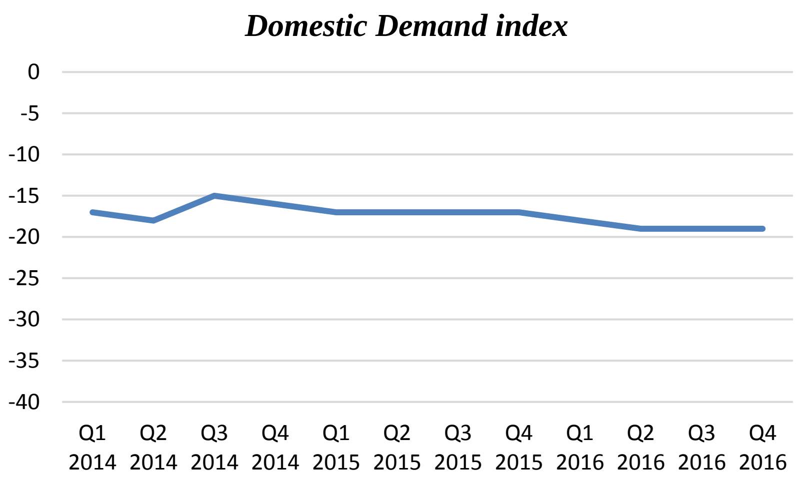
I use three response indices from the Tankan survey to measure enterprises’ perception about business growth, including the Business Confidence Index, the Domestic Demand Index and the Production Capacity Index. The Tankan economic survey of enterprise is an economic survey conducted by the Bank of Japan. A sample of 220,000 business enterprises with no less than 20 million yen in capital from all sectors are surveyed every quarter and asked to evaluate current business trends and future expectation. The indices range from +100 to -100. The Business Confidence Index is constructed based on the net percentage of respondents who reported “Favorable” for judgment of general business conditions. The Domestic Demand Index reflects the net percentage of respondents who reported “Excess demand” for “judgement of domestic supply and demand conditions for major products or services”. The higher the value of the two indices, the greater optimism on business growth which potentially induces future investment. The Production Capacity Index is constructed based on the net percentage of respondents who reported “Excessive capacity” for the evaluation of production capacity. A higher index value indicates that responding enterprises feel less need to expand production and invest in business equipment.

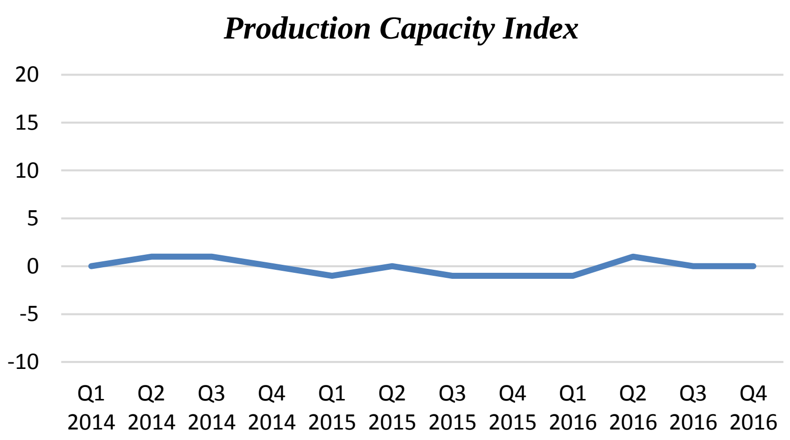
Figure 2.3 shows the quarterly values of the three indices over the period from 2014 Quarter 1 to 2016 Quarter 4. All the three indices are stable without significant changes over the period despite major changes in the BOJ's expansionary policy. The time-series of the indices indicate that belief about domestic demand among Japanese firms does not improve positively over time. This may partly explain why firms do not increase investment and hire more employees during the period.

Figure 2.3: The Time-series of the Tankan Indices in Japan

This figure shows the quarterly values of three indices from the Tankan Survey of Japanese Businesses over the period from 2014 Quarter 1 to 2016 Quarter 4. I show the actual value of the indices for the sentiment of all industries.







2.7. Conclusion

This study assesses the extent to which the BOJ's ETF purchase program had the desired effects on cost of capital and corporate activity. It examines the short-term as well as long-term effect on firms around the announcements of major expansions to the purchase program by exploiting the exogeneity and the cross-sectional dimension of the BOJ's purchase schedule. I find that the market reacted highly positively on the two occasions when the BOJ announced expanding its purchase program. The positive price response lasted as long as one year without reversal after the first expansion announcement. Since the BOJ's intention is to influence the market risk premium without having any differential impacts on the systematic risk of individual firms, the policy is expected to increase the stock prices for the entire equity market. The results however suggest that the policy effect might not have been neutral across different firms due to the biased investment schedule away from the value-weighted market portfolio.

Using panel data over four years around the expansion announcement on October 31, 2014, I also investigate the effect of the policy on cost of capital and corporate behavior. I find that cost of equity capital proxied by the ICC measures is reduced for firms in which the BOJ disproportionately holds more shares than other firms. However, I fail to find any statistically significant changes in corporate behaviors, including equity and debt issuance, dividend payouts, corporate investment, M&As and employment. The policy seems to have a limited real impact.

I propose a few possible explanations to attempt to understand why the real impact of the policy is weak. I conjecture that the unresponsiveness of corporate activity to stock prices might be because most Japanese firms do not depend on the public equity market for financing. The over-weighted capital injection into Nikkei 225 firms, which have low need for external capital and low level of investment-price sensitivity, may also hinder the effectiveness of the policy. In addition, the confidence of Japan's business enterprises about business conditions remains unchanged over the sample period, which may also explain the limited real impact of the policy on Japan's economy.

Results in this study have important policy as well as asset pricing implications. I uncover the potential side effects of large-scale government purchases on the security market which require thorough consideration of the optimal purchase plan. I suggest that the BOJ should balance its investment across all firms without bias and should also consider supporting the stock prices of young and growth firms to maximize the policy impact on the real economy. Japan's experiment with direct intervention in the equity market offers valuable lessons for other central banks. The BOJ's ETF purchase program also provides an ideal setting to empirically study the shape of long-term demand curves. The positive and persistent price impact of BOJ purchases provides evidence that demand curves are downward sloping over horizons of at least one year.

Appendix

Implied Cost of Capital Measures

I compute the implied cost of capital (ICC) using predicted fundamental information and the current share price. ICC is the internal rate of return (IRR) that equates the current stock price with the present value of forecast free cash flows. Since the computation of ICC depends on different specification of the present value model, I use five different methods based on four models for the sake of robustness. I use the models by Gebhardt, Lee and Swaminathan (2001), Ohlson and Juettner-Nauroth (2005), Easton (2004) and Claus and Thomas (2001). In addition, I also calculate the average of the four ICC measures as the fifth proxy.

The first model, the Gebhardt, Lee and Swaminathan (2001) GLS residual income valuation model assumes clean surplus accounting. The forecast horizon is set to three years and forecast earnings beyond three years is set to linearly decay to the industry median by the 12th year and stay constant thereafter. I use the Fama-French 12 industry classification and industry median is calculated with figures over the past 10 years. The valuation model is given by:

$$P_t = BV_t + \sum_{\tau=1}^{T} \frac{\widehat{EPS}_{t+\tau} - r_{GLS} BV_{t+\tau-1}}{(1 + r_{GLS})^{\tau}} + \frac{\widehat{EPS}_{t+T+1} - r_{GLS} BV_{t+T}}{r_{GLS}(1 + r_{GLS})^{T}}$$

where

P_t is the market price of a firm’s stock at time *t*.

r_{GLS} is the implied cost of equity under the GLS model.

$\widehat{EPS}_{t+\tau}$ is the analyst forecast earnings per share as reported by the I/B/E/S.

BV_t is the book value per share at time t. $BV_{t+\tau} = BV_{t+\tau-1} + \widehat{EPS}_{t+\tau}(1 - DPR_{t+\tau})$. $DPR_{t+\tau}$ is the expected dividend payout ratio at time $t+\tau$, which is set to DPR_0/EPS_0.

The second model, the OJ earnings growth valuation model by Ohlson and Juettner-Nauroth (2005), set a forecast horizon to one year. Forecast earnings are assumed to then grow at a short-term rate that fades to a perpetual rate. DPS is assumed to be constant. The valuation model is given by:

$$r_{OJ} = A + \sqrt{A^2 + \frac{\widehat{EPS}_{t+1}}{P_t}(g - (\gamma - 1))}$$

where

r_{OJ} is the implied cost of equity under the OJ model.

$A = 0.5(\frac{\widehat{DPS}_{t+1}}{P_t} + (\gamma - 1))$; $\widehat{DPS}_{t+1} = DPS_0$.

The short-term growth rate, $g = \left[\frac{\widehat{EPS}_{t+2} - \widehat{EPS}_{t+1}}{\widehat{EPS}_{t+1}} + \widehat{g_{LT}}\right]/2$; $\widehat{g_{LT}}$ is the forecasted long-term rate from I/B/E/S.

The perpetual growth rate in earnings, γ, is set to the current risk-free rate in Japan.

The third model I use, Easton (2004)'s MPEG model, assumes perpetual growth in earnings after the initial period. It requires using one year ahead and two year ahead forecasts for earnings per share (EPS) as well as one year ahead expected dividend per share (DPS). The valuation model is given by:

$$P_t = \frac{\widehat{EPS}_{t+2} + r_{MPEG}\widehat{DPS}_{t+1} + \widehat{EPS}_{t+1}}{{r_{MPEG}}^2}$$

where

r_{MPEG} is the implied cost of equity under the MPEG model.

$\widehat{DPS}_{t+1} = DPS_0$.

The fourth model, the Claus and Thomas (2001) CT residual income valuation model, assumes clean surplus accounting and set a forecast horizon of 5 years. Forecasted residual earnings beyond the forecast horizon is assumed to grow at the expected inflation rate and DPS is assumed to remain constant at 50%. The valuation model is given by:

$$P_t = BV_t + \sum_{\tau=1}^{T} \frac{\widehat{EPS}_{t+\tau} - r_{CT} BV_{t+\tau-1}}{(1 + r_{CT})^{\tau}} + \frac{(\widehat{EPS}_{t+T} - r_{CT} BV_{t+T-1})(1 + g)}{(r_{CT} - g)(1 + r_{CT})^{T}}$$

where

r_{CT} is the implied cost of equity under the CT model.

g is the growth rate set at the risk-free rate.

Finally, I construct a fifth measure as a robustness proxy. For each firm in a given year, I take the average of the four estimates from the above models following Hail and Leuz (2006) and Lau, Ng, and Zhang (2010).

Time-series of Cumulative Event Returns using different cut-offs

The ratio of its Nikkei index weight to weight in a value-weighted index being greater than 2:

The ratio of its Nikkei index weight to weight in a value-weighted index being greater than 4:

Chapter 3: Free Float Reduction and Stock Liquidity

3.1. Introduction

This study examines the effect of free floating shares on stock liquidity. A firm's free float is the portion of its shares that are freely traded on the market by the public. This definition excludes shares owned by corporate insiders and blockholders who hold shares in the firms over a long period of time. Empirically identifying the direct effect of free float on liquidity is challenging. First, measuring the number of free floating shares is difficult because corporate ownership structure is often complicated making it hard to determine the identities and trading patterns of a firm's blockholders. Second, certain qualitative firm characteristics can endogenously determine both ownership structure and liquidity. Last, long-term holders may have different preferences in stocks with a certain liquidity level. Thus, long-term block ownership can be reversely caused by liquidity.

Two studies directly link free float to liquidity: Chan, Chan, and Fong (2004) and Ding, Ni, and Zhong (2016). Chan, Chan, and Fong (2004) exploit the 1998 Hong Kong government purchases of the Hang Seng Index component stocks as a natural experiment. The authors fail to find any cross-sectional relation between reduction in free float and changes in price impact. Ding, Ni, and Zhong (2016) study the relation between free float and liquidity in an international setting. By relating a free float measure that excludes block shareholders (with ownership greater than 5%) from total shares outstanding to daily liquidity measures, the authors find that higher free float is associated with lower liquidity. The inconsistent results of the studies could be driven by the empirical challenges discussed above. In this chapter, I explore the recent large-scale BOJ purchases of equity ETFs as the basis of my empirical strategy to clearly identify the causal link between free float and stock liquidity.

From October 2010, the Bank of Japan (BOJ) started buying a significant amount of equity stocks through index-related exchange traded funds (ETFs) that track the Nikkei 225 Stock Average, the Tokyo Stock Price Index (TOPIX), or the JPX-Nikkei Index 400 as part of its monetary easing policy. To convince the market that this program is only a part of the government's general monetary policy, the central bank has emphasized its neutral and passive role in Japan's equity market and claimed that it does not have any intention to directly influence the management and operation of any firms it invests in through index-related ETFs. Since the initiation of the policy, the central bank has gradually acquired indirect but dominant positions in many of the country's large corporations and does not have any intention of reducing any of its positions in the equity markets. The BOJ's overwhelming investment has made it the top shareholder of many public firms in Japan. According to an estimate by Nikkei, the BOJ has become a top-ten largest shareholder for almost 40% of the listed firms as of June 2018.[11]

This event provides an accurate way to identify exogenous change in the amount of excess reduction in free float. Given the long-term and passive nature of BOJ's investment, the presence of its block ownership immediately reduces a large proportion of free floating shares available for trade to the public. What is more ideal about this event is that a large proportion of the annual BOJ purchase is allocated to the Nikkei 225 index, which is uniquely a price-weighted index. This biased investment scheme results in many Nikkei 225 stocks receiving significant excess capital flow relative to their market capitalization, which creates cross-sectional variation in the amount of reduction in free float across firms. For example, the central bank has the largest percentage holdings of 15.4% in

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[11] As reported in Bloomberg: https://www.bloomberg.com/news/articles/2016-08-14/the-tokyo-whale-s-unstoppable-rise-to-shareholder-no-1-in-japan

Advantest Corporation and 14.03% in Fast Retailing in December 2016. Both firms have top weights in the Nikkei index. According to my estimate using data on free float from the Datastream database, the central bank has taken more than 19.2% of Fast Retailing's free float off the market and about 18.5% of the free float at Advantest Corporation.[12] In contrast, the BOJ only has 1.55% of shares (1.64% of free float) in Toyota Motor Corporation, which is the largest public firm in terms of market capitalization in Japan. Overall, this event provides a natural experiment to tackle endogeneity problems and clearly identify the effect of free float on stock liquidity.

Theoretically, inactive block ownership that takes a large number of free floating shares off the market could influence stock liquidity through two mechanisms. First, when an increasing proportion of a firm's outstanding shares becomes "locked up" due to blockholder purchases, the number of shares available for trade to the public is immediately reduced. The reduction in trading activities will increase trading costs such as order processing costs and inventory costs for the underlying securities as these fixed costs are being spread over fewer trades. Stoll (2000) refers to this mechanism as "the real friction" in the liquidity provision process. Several theoretical studies have addressed this real friction and find that greater investor trading activity decreases transaction costs, which increases liquidity (Demsetz 1968, Merton 1987). Second, inactive trading could affect liquidity through an informational friction effect. As blockholders accumulate their holdings from open market purchases, uninformed investors are more likely to give up their positions in the firm than insiders because they enjoy less benefits from holding the firm's shares. This results in fewer noise traders trading the security and increases the

[12] Datastream defines free float as the percentage of total shares available for trade to ordinary investors excluding strategic block holdings.

probability that a market maker trades with an informed investor. This adverse selection problem results in widening spreads and reduced depths by market makers to recover the potential losses from trading against informed traders (Copeland and Galai 1983, Kyle 1985, and Glosten and Milgrom 1985). Overall, a reduction in a firm's free floating shares can affect the number of and types of investors trading the firm's stocks leading to stock illiquidity through the real friction and informational friction mechanism.

To test the relation between the availability of free floating shares and liquidity, I gather the BOJ's monthly holdings in all Japanese listed stocks during the period from 2010 to 2016. The data I have are the actual amount of ownership held by the BOJ via index ETFs in all firms included in the Nikkei 225 index, the TOPIX index and the JPX-Nikkei Index 400, which covers all the domestic common stocks listed on the Tokyo Stock Exchange First Section. I show that firms that experience greater BOJ purchases do not issue more new shares nor have more block selling in response to BOJ demand, indicating that BOJ ownership can well capture the amount of excess reduction in free float. To accurately measure stock liquidity, I use both high-frequency and low-frequency measures including the effective spreads, relative quoted spreads, Amihud (2002), and stock turnover as the main liquidity measures. These measures aim to capture different aspects of liquidity including transaction cost, adverse selection and trading activity.

The regression results show that firms that experience a larger reduction in free float due to BOJ purchases exhibit a reduction in stock liquidity and stock market trading activity. The empirical specification I adopt makes sure the results are not driven by heterogeneity in firm characteristics and firm-specific information that could affect both free float and liquidity. To further validate the causal link from free float to stock liquidity, I address potential endogeneity concerns relating to time-varying heterogeneity across firms and obtain similar results. The negative effect of free float reduction on stock liquidity is also robust to a series of alternative empirical specifications and proven to be persuasive. The results cannot be fully justified by the large demand shock by the BOJ leading to short-term drying up of liquidity because I not only observe an increase in transaction costs but also a reduction in trading activity measured by stock turnover and number of trades.

Following the above theory, I then identify the underlying channel of the results. I find that BOJ holdings significantly reduce the number of common shareholders and institutional shareholders of a firm. Firms with greater BOJ holdings also experience a reduction in institutional ownership. These results confirm my conjecture that BOJ purchases absorb the ownership of retail and institutional investors and are consistent with both "the real friction" and the informational friction effect of free float on the process of liquidity provision.

Understanding the effect of free float availability contributes to our knowledge about equity market practice. However, few studies have systematically investigated this topic. This study fills the gap and furthers our understanding about the role of free float on liquidity in an event setting. It uses the recent large-scale BOJ purchases of equity ETFs as the basis of my empirical strategy to tackle some of the endogeneity problems in prior studies. The results show how stock liquidity is affected by an exogenous reduction in free floating shares rather than merely linking liquidity to noisy measures of free float at the cross-section.

This study is distinct from Chan, Chan, and Fong (2004) and Ding, Ni, and Zhong (2016) in a few ways. First, I use several high-frequency and daily measures to accurately capture different aspects of stock liquidity at the firm level. Second, the empirical setting I adopted allows a clear identification and measurement of changes in free float. Finally, unlike the event in Chan, Chan, and Fong (2004), the BOJ's purchase program I explore, thanks to the special weighting system of the Nikkei index, creates shocks to free float that are heterogeneous across firms and exogenous to firm fundamentals, which allows clear identification for the causal effect of free float on stock liquidity.

The literature on block ownership provides strong evidence on the negative role block shareholders play in stock liquidity. Many of these studies emphasize the superior information possessed by block owners. Heflin and Shaw (2000) attribute the negative effect of large block ownership on liquidity to the information asymmetry between block shareholders and other investors. Brockman, Chung, and Yan (2009) link block ownership to reduced trading activity. This study takes a distinct perspective and exploit Japan's large-scale purchase program to study the direct impact of free float reduction on stock liquidity. The findings support these studies and show that strategic block shareholders can lift trading costs even they do not trade with their private information.

The findings in this study offer important policy implications and provide evidence that the continuous large-scale purchases by the BOJ create heterogeneous side effects on the liquidity of some securities because of the biased allocation strategy adopted, making some firms experience a larger shock on the level of free float compared to others. This study also adds to the literature that studies the effectiveness of central banks' adoption of unconventional monetary policy, which has emerged during recent years in many countries when conventional monetary policy tools are being constrained by close-to-zero interest rates (Gagnon et al. 2010, Neely 2010, Hamilton and Wu 2012, D'Amico and King 2013). The empirical findings in this study uncover the potential side effects of the quantitative easing policy on the security market and necessitate thorough consideration of an optimal purchase plan.

The remainder of this chapter is organized as follows. Section 3.2 provides details about the data sources, sample construction and variable description. Section 3.3 describes the empirical methodology, reports the primary empirical results and addresses potential endogeneity issues. Section 3.4 presents additional robustness tests. Section 3.5 investigates the underlying channels. Section 3.6 concludes this chapter.

3.2. Data and Sample Description

3.2.1. BOJ Ownership

Firm-level BOJ holdings data are directly obtained from the Quick database and constructed as the percentage of total shares outstanding. This variable reflects the actual amount of indirect ownership held by the BOJ in all constituent firms in the Nikkei 225 index, the TOPIX index and the JPX-Nikkei Index 400 through holdings in ETFs tracking these indices.

3.2.2. Liquidity Measures

I use four measures of stock liquidity: two high frequency measures and two low frequency measures. The liquidity measures I adopted are widely used in prior literature and aim to capture different aspects of stock liquidity. The two high frequency measures, namely the effective spreads and relative quoted spreads, are calculated using high frequency trades and quotes data from Thomson Reuters Tick History (TRTH). TRTH is a comprehensive database which specializes in providing intraday trading data for international public firms. The low frequency measures I employ are Amihud (2002)'s illiquidity measure and stock turnover constructed using daily trading data from Datastream. Before constructing these liquidity measures, I apply the following filters to exclude holidays and abnormal trading days in both datasets. Since Japan's holiday is based on lunar calendar, the dates of public holiday in each year is very different. I identify holidays days as days with greater than 90% of listed stocks having zero return. I have also manually collected historical trading public holidays in Japan. The dates are consistent with my identification. I also discard stock-quarter observations that have more than 80% of zero-return days in a quarter. To address potential errors in the data, I follow Ince and Porter (2006) and exclude observations if $(1 + Return_{i,t})(1 + Return_{i,t-1}) - 1 \leq 0.1$ and at least one of the two days' return is greater than 100%.

The two high frequency spread measures are direct measures of trade-level illiquidity and thus should offer accurate estimates of stock liquidity. Effective spread is defined as two times the difference between trading price and mid-quote relative to trading price for each trade. Quoted spread is defined as the difference between the best ask and bid prices relative to the mid-quote. When calculating these measures, I apply several filtering requirements to intraday spread measures that appeared to be keypunching errors following Chordia, Roll, and Subrahmanyam (2001). I first exclude observations with spread measures greater than 0.4. I also compare the difference between quoted spread and effective spread and delete observations if one of the spread measures is greater than four times the other. Not using these filters does not change the results.

To transform transaction-specific spread measures into quarterly measures, I employ the following algorithm. I first calculate daily spread measures by taking time-weighted average of relative quoted spreads and dollar-volume-weighted average of effective spreads throughout a day. I then average the daily spread measures over each quarter.

The low frequency measures I employ are Amihud (2002) illiquidity measure and stock turnover constructed using daily trading data from Datastream. The Amihud (2002) measure has been proven to be the most accurate measure of price impact among low frequency liquidity measures (Goyenko, Holden, and Trzcinka 2009, Hasbrouck 2009). It is calculated as the absolute value of stock return scaled by dollar trading volume in a day. Stock turnover is a direct measure of trading activity and captures the activeness of stock trading. I calculate stock turnover as the ratio of the number of shares traded to the number of shares outstanding in each day. I then calculate the quarterly measures of the two variables by taking the natural log transformation of the average of daily measures in each quarter.

Table 3.1 Panel A reports the descriptive statistics of these liquidity measures by quarter. I average each of the four quarterly stock liquidity measures across firms over each quarter. The first three measures are inverse measures of liquidity, i.e. measures of the cost of trading or the illiquidity level, while higher turnover indicates higher stock liquidity. Detailed definitions and data sources of these measures are described in the Appendix. On average, the effective spread and quoted spread of Japanese firms over the period is 0.36 and 0.44 respectively. There is a positive trend in the stock liquidity of Japanese listed firms during the period. The average values of all four liquidity measures gradually improve from 2010 Quarter 1.

3.2.3. Sample Description and Summary Statistics

The sample covers all the domestic common stocks listed on the Tokyo Stock Exchange First Section. I match BOJ holdings data during the period 2010 to 2016 with the stock liquidity measures at a quarterly frequency. All sample firms are required to have non-missing financial data from Datastream/Worldscope and available data on firm index weights from Bloomberg. In addition, I require firms to have no less than 30 days of trading data during a quarter. The final sample covers 25 quarters and includes 49,489 firm-quarter observations. All primary analyses are tested using two samples: a sample including all public firms listed on the First Section of the Tokyo Stock Exchange (2,136 firms) and a sample including only firms in the Nikkei index (245 firms). Because I implement a series of different tests throughout this study, any changes to the sample specified above are addressed in the corresponding sections. All control variables and stock liquidity measures are winsorized at 1% and 99%.

Table 3.1 Panel B shows the summary statistics for all liquidity measures and control variables. I present the summary statistics for the full sample and the Nikkei sample. The average firm in the full sample has a BOJ ownership of 0.4%, a quarterly return of 3.1% and a stock volatility of 2.1%. Liquidity measures vary considerably. Firms at the 1st percentile have an effective (quoted) spread of 0% (0.1%), while the effective spread of firms at the 99th percentile is 1.6% (2.1%). This suggests that the full sample covers firms with different levels of stock liquidity. The bias measure at the 99th percentile is 6.65 indicating that more than 1% of the sample firms have a Nikkei index weight six times their market value weight. For the Nikkei sample which includes firms in the Nikkei 225 index, the average BOJ ownership is higher at 1.4% and the 99th percentile of BOJ ownership is 8%. Nikkei firms are also more liquid, have larger size, and greater BOJ investment bias on average. This is as expected because the Nikkei 225 index includes only large firms in Japan.

Panel C of Table 3.1 shows the Pearson correlations across all variables of interest in the sample. All four liquidity proxies have statistically significant but different correlations suggesting that the liquidity measures capture different aspects of stock liquidity. Effective spread and quoted spread have a high correlation of 96%. Amihud has a correlation of about 60% with the high frequency measures. Stock turnover has a relatively low correlation of -25% and -37% with effective spread and quoted spread respectively. These correlations are comparable to prior studies on stock liquidity (e.g. Ng et al. 2016) confirming the validity of the liquidity measures. In addition, BOJ ownership is significantly and negatively correlated with effective spread, quoted spread and Amihud, and positively correlated with turnover with correlation ranging from 18% to 34%. This implies that firms with higher BOJ ownership through index ETFs are more liquid. This positive correlation does not provide any causal implication and is not consistent with the regression results. However, this is not surprising because larger firms with more liquid stocks are the major recipients of BOJ investment as liquid stocks are more likely to be included in the index. It suggests that examining the relation between free float and stock liquidity at the cross-section requires careful analysis to rule out potential endogeneity issues.

Table 3.1: Data Descriptions

This table reports descriptive statistics of the sample. Panel A reports the descriptive statistics of the four liquidity measures by quarter. Panel B shows the summary statistics for all liquidity measures and control variables for the full sample and the Nikkei sample. Panel C reports the correlation matrix. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016.

Panel A: Liquidity Measures by Quarter

Quarter	Effective Spread (%)	Quoted Spread (%)	Amihud	Turnover	N
2010 Q1	0.44	0.56	-1.67	-6.27	1,645
2010 Q2	0.42	0.55	-1.75	-6.07	1,655
2010 Q3	0.45	0.59	-1.35	-6.50	1,657
2010 Q4	0.43	0.52	-1.63	-6.25	1,661
2011 Q1	0.40	0.50	-1.77	-5.96	1,662
2011 Q2	0.43	0.54	-1.56	-6.33	1,669
2011 Q3	0.44	0.56	-1.39	-6.38	1,663
2011 Q4	0.50	0.62	-1.09	-6.56	1,660
2012 Q1	0.40	0.49	-1.74	-6.16	1,668
2012 Q2	0.47	0.59	-1.37	-6.37	1,671
2012 Q3	0.49	0.61	-1.28	-6.54	1,671
2012 Q4	0.45	0.56	-1.57	-6.25	1,679
2013 Q1	0.37	0.43	-2.19	-5.72	1,694
2013 Q2	0.41	0.49	-2.09	-5.57	1,707
2013 Q3	0.37	0.43	-2.06	-5.96	1,745
2013 Q4	0.30	0.34	-2.56	-5.78	1,751
2014 Q1	0.31	0.36	-2.32	-5.73	1,778
2014 Q2	0.31	0.35	-2.33	-6.01	1,806
2014 Q3	0.28	0.31	-2.61	-5.95	1,816
2014 Q4	0.29	0.33	-2.45	-5.79	1,832
2015 Q1	0.27	0.30	-2.67	-5.84	1,858
2015 Q2	0.25	0.28	-2.86	-5.81	1,879
2015 Q3	0.30	0.35	-2.31	-5.79	1,886
2015 Q4	0.27	0.30	-2.51	-5.92	1,903
2016 Q1	0.32	0.39	-1.99	-5.85	1,932
2016 Q2	0.32	0.38	-2.06	-5.97	1,948
2016 Q3	0.30	0.35	-2.07	-6.09	1,967
2016 Q4	0.24	0.26	-2.58	-5.87	1,973
Total	0.36	0.44	-2.02	-6.04	49,436

Panel B: Summary Statistics

Full Sample

Variables	Mean	1st Percentile	Median	99th Percentile	Standard Deviation	N
BOJ Ownership	0.004	0.000	0.003	0.038	0.007	49,040
Effective Spread	0.361	0.043	0.259	1.651	0.318	49,038
Quoted Spread	0.435	0.052	0.305	2.155	0.406	49,040
Amihud (log)	-2.019	-6.853	-1.817	2.537	2.155	49,040
Turnover (log)	-6.044	-9.188	-5.955	-3.652	1.083	49,008
Bias	0.337	0.000	0.000	6.647	1.352	49,040
Size (log)	10.830	8.175	10.613	14.832	1.544	49,040
Volatility	0.021	0.007	0.019	0.052	0.009	49,040
MB	1.100	0.546	0.977	3.551	0.517	48,832
Return	0.030	-0.297	0.013	0.555	0.164	48,988
Price (log)	6.676	4.411	6.728	8.823	0.974	49,040

Nikkei Sample

Variables	Mean	1st Percentile	Median	99th Percentile	Standard Deviation	N
BOJ Ownership	0.014	0.000	0.009	0.080	0.017	6,278
Effective Spread	0.207	0.033	0.136	1.172	0.219	6,278
Quoted Spread	0.221	0.038	0.156	1.188	0.219	6,278
Amihud (log)	-5.259	-7.289	-5.281	-2.379	1.124	6,278
Turnover (log)	-5.217	-6.407	-5.273	-3.657	0.577	6,278
Bias	2.632	0.055	1.579	13.170	2.872	6,278
Size (log)	13.161	10.521	13.202	15.217	1.131	6,278
Volatility	0.021	0.009	0.019	0.041	0.007	6,278
MB	1.140	0.719	1.036	2.719	0.362	6,260
Return	0.027	-0.315	0.019	0.486	0.161	6,270
Price (log)	6.904	4.662	6.945	8.950	0.975	6,278

Panel C: Correlation Matrix

	BOJ Ownership	Effective Spread	Quoted Spread	Amihud	Turnover	Bias	Size	Volatility	MB	Return	Price
BOJ Ownership	1										
Effective Spread	-0.183	1									
	0.000										
Quoted Spread	-0.193	0.957	1								
	0.000	0.000									
Amihud	-0.340	0.602	0.638	1							
	0.000	0.000	0.000								
Turnover	0.228	-0.250	-0.372	-0.624	1						
	0.000	0.000	0.000	0.000							
Bias	0.619	-0.145	-0.147	-0.332	0.215	1					
	0.000	0.000	0.000	0.000	0.000						
Size	0.302	-0.545	-0.517	-0.890	0.265	0.309	1				
	0.000	0.000	0.000	0.000	0.000	0.000					
Volatility	0.021	0.169	0.127	-0.021	0.371	0.013	-0.082	1			
	0.000	0.000	0.000	0.000	0.000	0.004	0.000				
MB	0.103	-0.181	-0.190	-0.256	0.228	0.073	0.209	0.130	1		
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Return	-0.007	-0.070	-0.066	-0.089	0.158	-0.002	0.013	0.111	-0.006	1	
	0.107	0.000	0.000	0.000	0.000	0.721	0.004	0.000	0.209		
Price	0.172	-0.556	-0.466	-0.419	0.029	0.109	0.491	-0.145	0.246	0.026	1
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

3.3. Empirical Methodology and Results

3.3.1. Model Specification

In this section, I describe the empirical framework in more detail.

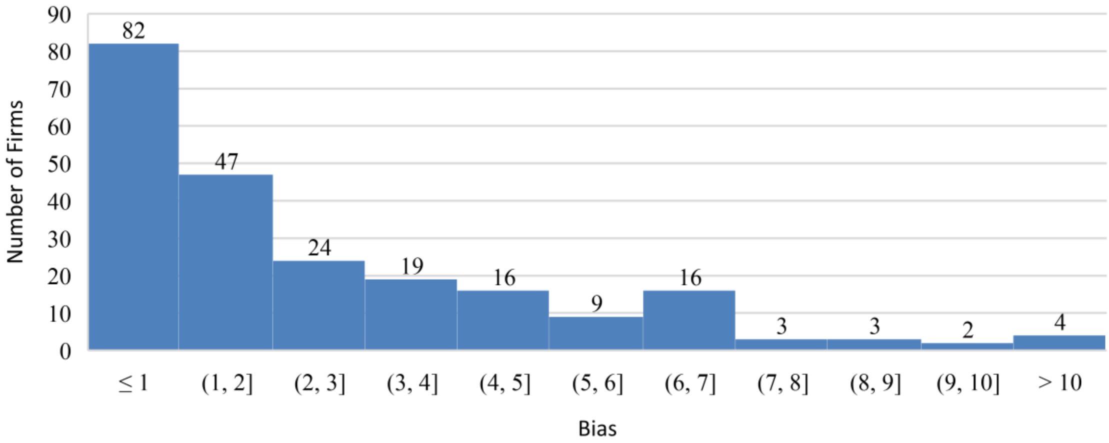
I exploit the unconventional weighting system of the Nikkei index to identify cross-sectional variation in the BOJ demand shocks for index stocks, and relate this variation to changes in stock liquidity. Greenwood (2008) uses over-weighting in the Nikkei index as an identification strategy in a different context to study the relation between index over-weighting and excess stock return comovement. The Nikkei 225 index adopts a price-weighting system, which means the weight of an index constituent is a function of its price at the time it enters the index. As an extreme example, Fast Retailing Co. Ltd, which has the largest weight in the index at 8.63%, is heavily targeted by the BOJ purchase program, while Toyota Motor Corporation, the largest firm in Japan, only receives an index weight of 1.39%. At December 2016, the BOJ held 14.03% of Fast Retailing Co. Ltd's total shares outstanding but only 1.55% of Toyota Motor Corporation.

Figure 3.1 shows the number of Nikkei 225 index firms by the relative difference between the firm's Nikkei index weight and its weight in a value-weighted index, which is calculated as $\frac{Nikkei\ Weight_i}{Nikkei\ Value\ Weight_i}$ as of December 2016. I term this variable as *Bias*. A value greater than one means the firm is subject to more investment from the BOJ through Nikkei index ETFs compared to an investment following its market value weight in the index, and vice versa. Over a third of firms (36%, 82 of 225) have their Nikkei weight less than one, while 43% (96 firms) have a BOJ investment bias of greater than two, i.e.

their Nikkei index weight is two times larger than their market value weight. The bias values of four firms are greater than 10.

Figure 3.1: The Distribution of Nikkei Index Firms with Weight Bias

This figure shows the number of Nikkei 225 index firms in each value interval of the weight bias as of December 2016. Bias is defined as the relative difference between a firm's Nikkei index weight and its weight in a value-weighted index. It is calculated as $\frac{Nikkei\ Weight_{i,t}}{Nikkei\ Value\ Weight_{i,t}}$.



I conduct a series of multivariate regression analyses to investigate the impact of free float on stock liquidity. Specifically, I estimate the model specified as the following:

$$
\begin{aligned}
& Liquidity_{i,t} \\
& = \beta_0 + \beta_1 BOJ\ Ownership_{i,t-1} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} + \beta_4 Volatility_{i,t} + \beta_5 MB_{i,t} \\
& + \beta_6 Return_{i,t} + \beta_7 Price_{i,t} + Firm\ FEs + Industry\ \times\ Time\ FE \\
& + \varepsilon_{i,t} \qquad (3.1)
\end{aligned}
$$

where *i* denotes firms and *t* denotes quarter-years. The dependent variable $Liquidity_{i,t}$ is one of the liquidity measures. The main explanatory variable $BOJ\ Ownership_{i,t-1}$ is the total holdings of the BOJ as a percentage of total number of shares outstanding in quarter *t-1*. $Bias_{i,t-1}$ is defined as the relative difference between a firm's Nikkei index weight and its weight in a value-weighted index (calculated as $\frac{Nikkei\ Weight_{i,t}}{Nikkei\ Value\ Weight_{i,t}}$), which captures the level of bias in BOJ investment due to the Nikkei weighting system relative to the common value-weighting system. The other contemporaneous control variables include the log of market capitalization (*Size*), the standard deviation of stock returns over the previous quarter (*Volatility*), the market to book ratio (*MB*), average daily stock return over the previous quarter, and the log of stock price at the beginning of the quarter (*Price*).

As the BOJ only holds indirect ownership through index ETFs, it strictly allocates funds following index weights. Theoretically, I can express $BOJ\ Ownership_{i,t}$ as follows:

$$BOJ\ Ownership_{i,t} = \frac{BOJ\ Investment_{i,t}}{MV_{i,t}}$$

$$= \frac{BOJ\ Holdings\ via\ Nikkei_{i,t} + BOJ\ Holdings\ via\ Topix_{i,t}}{MV_{i,t}} \tag{3.2}$$

$$= \frac{Total\ BOJ\ Investment\ in\ Nikkei_{t}}{Nikkei\ Market\ Cap_{t}} \times \frac{Nikkei\ Weight_{i,t}}{Nikkei\ Value\ Weight_{i,t}}$$

$$+ \frac{Total\ BOJ\ Investment\ in\ Topix_{t}}{Topix\ Market\ Cap_{t}} \times \frac{TOPIX\ Weight_{i,t}}{TOPIX\ Weight_{i,t}} \tag{3.3}$$

$$= \%\ BOJ\ Holdings\ in\ Nikkei_{t} \times Bias_{i,t} + \%\ BOJ\ Holding\ in\ TOPIX_{t} \tag{3.4}$$

The second part in Equation (3.4) is absorbed by time fixed effects, thus $BOJ\ Ownership_{i,t}$ in the model captures the interaction between BOJ investment over time and bias in BOJ investment across firms. The estimated coefficient of $BOJ\ Ownership_{i,t}$ represents the additional effect of changes in free floating shares due to bias in index weights on a firm’s liquidity compared to similar firms with lower index weights.

3.3.2. Baseline Results

I start by estimating Equation (3.1) using the final pooled sample of firm-quarter panel observations. Table 3.2 reports the regression results for each of the four liquidity measures. Panel A reports the results using data on all firms listed on the First Section of Tokyo Stock Exchange, while Panel B reports results using only firms included in the Nikkei 225 index. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter. For each liquidity measure as the dependent variable, I present the regression results with and without control variables.

Specifically, Columns 1 and 2 of Panel A in Table 3.2 report the regression estimates of the baseline specification using effective spread as the dependent variable. Both columns show a positive and significant association between illiquidity and reduction in free float. The coefficient of BOJ ownership (2.228) in Column 1 is positive and statistically significant with a *t*-statistic of 7.67, suggesting that a larger reduction in free float due to BOJ holdings significantly results in lower stock liquidity. Including multiple firm characteristics reduces the magnitude of the effect (2.055) by a small amount as shown in Column 2, but the coefficient remains significant. In terms of the economic magnitude of the effect, a 1% increase in BOJ ownership leads to a 2.055% decrease in effective spread, which is a 5.81% change relative to the mean of effective spread (0.361). I repeat the regression analysis using other measures of stock liquidity including quoted spread, Amihud as the dependent variable in Columns 3–6. The results are robust to these alternative measures of stock liquidity.

Columns 7 and 8 report the regression results using stock turnover as the dependent variable. BOJ ownership has a negative and significant coefficient of -9.465 (with *t*-

statistic -7.872) in Column 7 and -11.007 (with *t*-statistic -8.26) in Column 8. The results indicate that a greater reduction in free float due to BOJ investment is associated with a larger decrease in stock turnover on average. In Panel B of Table 3.2, I repeat the regression specifications using a subsample of only member firms in the Nikkei 225 index and obtain similar results. As shown in Column 8 of Panel B, a coefficient of -2.624 implies that a 1% rise in BOJ ownership via ETFs is related to a 2.6% reduction in the number of shares traded relative to total shares outstanding. Overall, the baseline regression results show a significantly negative effect of excess reduction in free float on stock liquidity and trading activity.

Table 3.2: Baseline Regression

This table reports the results from the baseline panel regression model specified as the following:

$$Liquidity_{i,t} = \beta_0 + \beta_1 BOJ\ Ownership_{i,t-1} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} + \beta_4 Volatility_{i,t} + \beta_5 MB_{i,t} + \beta_6 Return_{i,t} + \beta_7 Price_{i,t} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t}$$

where *i* denotes firms and *t* denotes quarter-years. The main explanatory variable $BOJ\ Ownership_{i,t-1}$ is the total holdings of the BOJ as a percentage of total number of shares outstanding in quarter *t-1*. $Bias_{i,t-1}$ is defined as the relative difference between a firm's Nikkei index weight and its weight in a value-weighted index (calculated as $\frac{Nikkei\ Weight_{i,t}}{Nikkei\ Value\ Weight_{i,t}}$). Panel A reports the results using all firms listed on the First Section of Tokyo Stock Exchange. Panel B reports results using only firms included in the Nikkei 225 index. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. t-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: Full Sample

	Effective Spread		Quoted Spread		Amihud		Turnover	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BOJ Ownership	2.228***	2.055***	4.316***	4.175***	12.850***	12.609***	-9.465***	-11.007***
	(7.673)	(6.541)	(9.673)	(8.627)	(9.213)	(8.557)	(-7.872)	(-8.260)
Bias		-0.005		-0.013**		-0.030*		0.050***
		(-1.455)		(-2.524)		(-1.730)		(2.812)
Size		-0.116***		-0.113***		-0.711***		-0.237**
		(-3.399)		(-2.701)		(-6.989)		(-2.430)
Volatility		1.837***		1.938***		-9.905***		23.621***
		(5.586)		(4.680)		(-10.878)		(24.934)
MB		0.038***		0.033***		0.013		-0.008
		(4.444)		(2.735)		(0.447)		(-0.290)
Return		-0.090***		-0.101***		-0.625***		0.320***
		(-10.881)		(-10.224)		(-25.413)		(12.149)
Price		-0.041		-0.043		-0.419***		0.441***
		(-1.143)		(-0.956)		(-4.049)		(4.410)
Observations	49,034	48,643	49,036	48,645	49,036	48,645	49,010	48,621
Adj. R^2	76.8%	78.2%	71.2%	72.0%	91.8%	93.9%	72.2%	74.9%

Panel B: Nikkei Sample

	Effective Spread		Quoted Spread		Amihud		Turnover	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
BOJ Ownership	1.864***	1.991***	1.907***	2.023***	0.330	1.579*	-3.142***	-2.624***
	(3.483)	(4.580)	(3.624)	(4.756)	(0.193)	(1.861)	(-3.445)	(-3.275)
Bias		-0.013*		-0.012		-0.003		0.024
		(-1.751)		(-1.633)		(-0.164)		(1.176)
Size		-0.300***		-0.303***		-1.026***		0.088
		(-2.904)		(-2.957)		(-6.536)		(0.567)
Volatility		1.459**		1.481**		0.293		17.080***
		(2.002)		(2.024)		(0.141)		(10.206)
MB		0.091***		0.086***		-0.013		0.022
		(3.492)		(3.318)		(-0.255)		(0.405)
Return		-0.078***		-0.076***		-0.460***		-0.021
		(-5.635)		(-5.459)		(-10.208)		(-0.511)
Price		0.124		0.131		0.207		-0.216
		(1.201)		(1.280)		(1.301)		(-1.362)
Observations	6,120	6,063	6,120	6,063	6,120	6,063	6,120	6,063
Adj. R^2	80.6%	84.4%	80.4%	84.1%	92.8%	95.4%	81.7%	83.2%

3.3.3. Addressing Endogeneity Problems

Although the results shown in Section 3.3.2 are free from fixed firm characteristics that jointly determine both reduction in free floating shares and stock liquidity, the results are still subject to concerns regarding other potential endogeneity problems. In this section, I discuss and address the other potential endogeneity issues that may contaminate the results.

First, certain time-varying firm characteristics may cause changes in both stock liquidity and the amount of BOJ holdings. For example, certain shocks in firm earnings over time may affect both stock liquidity and BOJ holdings. The arrival of firms' earnings information over time can shape stock liquidity, and at the same time affect firms' index weights through changing the stock prices of these firms.

To address this issue, I construct a pseudo measure of BOJ holdings in a firm over time using the firm's index weight in 2010 before the BOJ started its purchase program and actual BOJ capital flow. Specifically, the pseudo holdings measure is calculated as follows:

$$Psudo\ Holdings_{i,t-1} = \%\ BOJ\ Holdings\ in\ Nikkei_{t-1} \times Bias_{i,2010} + \%\ BOJ\ Holding\ in\ TOPIX_{t-1} \quad (3.5)$$

where $Bias_{i,2010}$ is the relative difference between a firm's Nikkei index weight and its weight in a value-weighted index at the first quarter end of 2010, calculated as $\frac{Nikkei\ Weight_{i,2010}}{Nikkei\ Value\ Weight_{i,2010}}$. This equation follows the derivation in Equation (3.4) in Section 3.3.1.

The underlying argument for the use of this pseudo measure is that the index weight in 2010 is determined based on firm characteristics back in 2010. Therefore, it is exogenous to future unexpected shocks that affect liquidity and BOJ holdings. Furthermore, the index weights of most index members are in fact quite stable over time with high correlations over years, thus using index weights in 2010 can capture the fixed component of weights in future years. The calculated pseudo BOJ holdings have a correlation of around 86% with the actual BOJ holdings, which further validates the use of this pseudo measure as an exogeneous measure of BOJ holdings.

Based on the pseudo holdings I calculated, I estimate the following regression specification:

$$\begin{aligned} Liquidity_{i,t} = \beta_0 &+ \beta_1 Pseudo\ Holdings_{i,t-1} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} \\ &+ \beta_4 Volatility_{i,t} + \beta_5 MB_{i,t} + \beta_6 Return_{i,t} + \beta_7 Price_{i,t} + Firm\ FEs \\ &+ Industry \times Time\ FE + \varepsilon_{i,t} \end{aligned} \tag{3.6}$$

I present the regression results of Model (3.6) in Table 3.3. Again, I test this model using both the full sample (Panel A) and the Nikkei sample (Panel B). The coefficients of pseudo holdings on liquidity measures are smaller than those of actual BOJ holdings in Table 3.2. This indicates that some time-varying omitted variables amplify the association between actual BOJ holdings and liquidity and using pseudo holdings effectively controls this issue. The results remain significant and are consistent with the baseline results suggesting that the adverse effect of free float on liquidity is robust to the time-varying omitted variable problem.[13]

Table 3.3: Addressing Time-varying Omitted Variables Problem

The table represents results using the pseudo holdings of BOJ as the main explanatory variable. The regression specification employed is as follows:

$$Liquidity_{i,t} = \beta_0 + \beta_1 Pseudo\ Holdings_{i,t-1} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} + \beta_4 Volatility_{i,t} + \beta_5 MB_{i,t} + \beta_6 Return_{i,t} + \beta_7 Price_{i,t} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t}$$

where the pseudo holdings measure is calculated as follows:
$Pseudo\ Holdings_{i,t-1} = \%\ BOJ\ Holdings\ in\ Nikkei_{t-1} \times Bias_{i,2010} + \%\ BOJ\ Holding\ in\ TOPIX_{t-1}$.

$Bias_{i,2010}$ is the relative difference between a firm's Nikkei index weight and its weight in a value-weighted index at the first quarter end of 2010, calculated as $\frac{Nikkei\ Weight_{i,2010}}{Nikkei\ Value\ Weight_{i,2010}}$. Panel A reports the results using all firms listed on the First Section of Tokyo Stock Exchange. Panel B reports results using firms included in the Nikkei 225 index. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: Full Sample

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
Pseudo Holdings	1.095***	2.467***	6.674***	-5.922***
	(5.096)	(7.154)	(5.546)	(-5.440)
Bias	0.003	0.005	0.020	0.005
	(0.680)	(0.904)	(1.026)	(0.241)
Size	-0.123***	-0.119***	-0.708***	-0.244**
	(-3.442)	(-2.726)	(-6.805)	(-2.455)
Volatility	1.961***	2.104***	-10.058***	24.330***
	(5.319)	(4.540)	(-9.944)	(23.332)
MB	0.051***	0.043***	-0.009	0.021
	(4.478)	(2.627)	(-0.210)	(0.559)
Return	-0.100***	-0.113***	-0.620***	0.293***
	(-10.962)	(-10.390)	(-23.350)	(10.147)
Price	-0.039	-0.034	-0.394***	0.412***
	(-1.045)	(-0.737)	(-3.711)	(4.023)
Observations	44,003	44,005	44,005	43,985
Adj. R^2	78.2%	72.1%	93.9%	74.6%

[13] I obtain similar results from the 2-stage least square (2SLS) regression model using Pseudo Holding as an instrument of BOJ Ownership.

Panel B: Nikkei Sample

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
Pseudo Holdings	1.134***	1.184***	1.534**	-2.292***
	(3.833)	(4.050)	(2.387)	(-3.890)
Bias	-0.010	-0.009	-0.001	0.019
	(-1.265)	(-1.172)	(-0.045)	(0.898)
Size	-0.296***	-0.298***	-1.007***	0.065
	(-2.883)	(-2.930)	(-6.444)	(0.423)
Volatility	1.663**	1.691**	0.358	16.573***
	(2.269)	(2.298)	(0.173)	(9.949)
MB	0.103***	0.099***	0.002	-0.001
	(4.057)	(3.908)	(0.047)	(-0.025)
Return	-0.078***	-0.076***	-0.461***	-0.017
	(-5.549)	(-5.375)	(-10.121)	(-0.412)
Price	0.145	0.152	0.219	-0.239
	(1.405)	(1.489)	(1.391)	(-1.515)
Observations	6,015	6,015	6,015	6,015
Adj. R^2	84.0%	83.8%	95.4%	83.3%

Another endogeneity concern is that, despite controlling for the effect of time-varying aggregate industry shocks on stock liquidity by including Industry × Time fixed effects, changes in market conditions may have heterogeneous impacts on firms. Changes in macroeconomic factors may have a different impact on firms with larger index weight bias compared to firms that receive unbiased capital flow from the BOJ. Including time fixed effects can only control for the aggregate impact of market conditions on all firms but not any differential impact across firms. I try to directly address this concern by including the interaction term of index weight bias and macroeconomic variables to control for the heterogeneous impact of macroeconomic factors on biased firms. I employ the following specification for this test:

$$\begin{aligned} Liquidity_{i,t} = {} & \beta_0 + \beta_1 Pseudo\ Holdings_{i,t-1} + \beta_2 Bias_{i,t-1} \times GDP\ Growth_t \\ & + \beta_3 Bias_{i,t-1} \times Inflation_t + \beta_4 Bias_{i,t-1} + \beta_5 Size_{i,t} + \beta_6 Volatility_{i,t} \\ & + \beta_7 MB_{i,t} + \beta_8 Return_{i,t} + \beta_9 Price_{i,t} + Firm\ FEs \\ & + Industry \times Time\ FE + \varepsilon_{i,t} \end{aligned} \tag{3.7}$$

where $GDP\ Growth_t$ is the annual percentage change in Japan's Gross Domestic Production (GDP). $Inflation_t$ is the annual increase in the general price level in Japan. The separate effects of the two variables on stock liquidity are absorbed by Industry × Time fixed effects. Data on both variables are obtained from the World Bank.

I present the results in Table 3.4. Pseudo holdings significantly increases spreads and Amihud's illiquidity, and decreases stock turnover. Controlling for the interaction of bias and macroeconomic variables does not affect the significantly negative relation between free float reduction and liquidity. The coefficients on the interaction term of GDP and Distortion are zero with no statistical significance indicating that GDP does not have a heterogeneous effect on stock liquidity of firms with different levels of index weight bias. The coefficients of Inflation × Distortion are, however, highly significant at the 1% level.

Table 3.4: Addressing Heterogeneous Effects of Macroeconomic Changes

This table includes the interaction of bias and macroeconomic variables to control for the heterogeneous impact of macroeconomic factors on biased firms. I employ the following specification:

$$\begin{aligned} Liquidity_{i,t} = \beta_0 &+ \beta_1 Pseudo\ Holdings_{i,t-1} + \beta_2 Bias_{i,t-1} \times\ GDP\ Growth_t \\ &+ \beta_3 Bias_{i,t-1}\ \times\ Inflation_t + \beta_4 Bias_{i,t-1} + \beta_5 Size_{i,t} + \beta_6 Volatility_{i,t} + \beta_7 MB_{i,t} \\ &+ \beta_8 Return_{i,t} + \beta_9 Price_{i,t} + Firm\ FEs + Industry\ \times\ Time\ FE + \varepsilon_{i,t} \end{aligned}$$

where $GDP\ Growth_t$ is the annual percentage change in Gross Domestic Product (GDP). $Inflation_t$ is the annual increase in the general price level in Japan's economy. Panel A reports the results using all firms listed on the First Section of Tokyo Stock Exchange. Panel B reports results using only firms included in the Nikkei 225 index. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: Full Sample

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
Pseudo Holdings	1.034***	1.078***	1.071*	-1.956***
	(3.619)	(3.805)	(1.760)	(-3.382)
GDP × Distortion	0.000	0.000	0.001	-0.000
	(0.998)	(1.464)	(0.881)	(-0.320)
Inflation × Distortion	0.002***	0.003***	0.011***	-0.007***
	(2.811)	(3.238)	(3.751)	(-3.199)
Bias	-0.008	-0.007	0.009	0.012
	(-1.055)	(-0.928)	(0.471)	(0.654)
Size	-0.301***	-0.304***	-1.031***	0.081
	(-2.933)	(-2.986)	(-6.642)	(0.529)
Volatility	1.567**	1.586**	-0.083	16.876***
	(2.126)	(2.144)	(-0.041)	(10.178)
MB	0.106***	0.102***	0.014	-0.008
	(4.098)	(3.964)	(0.266)	(-0.154)
Return	-0.077***	-0.075***	-0.453***	-0.022
	(-5.465)	(-5.283)	(-10.025)	(-0.537)
Price	0.146	0.153	0.225	-0.242
	(1.421)	(1.507)	(1.438)	(-1.544)
Observations	6,015	6,015	6,015	6,015
Adj. R^2	84.1%	83.9%	95.5%	83.4%

Panel B: Nikkei Sample

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
Pseudo Holdings	0.980***	2.215***	5.681***	-5.029***
	(4.647)	(6.594)	(4.796)	(-4.712)
GDP × Distortion	0.000	0.000	0.006***	-0.006***
	(0.210)	(0.174)	(4.143)	(-4.170)
Inflation × Distortion	0.003***	0.006***	0.032***	-0.029***
	(5.025)	(6.492)	(6.958)	(-6.694)
Bias	0.004	0.008	0.033	-0.006
	(1.017)	(1.442)	(1.621)	(-0.287)
Size	-0.124***	-0.121***	-0.716***	-0.236**
	(-3.455)	(-2.754)	(-6.899)	(-2.381)
Volatility	1.955***	2.092***	-10.168***	24.431***
	(5.295)	(4.510)	(-10.111)	(23.555)
MB	0.051***	0.043***	-0.008	0.021
	(4.456)	(2.599)	(-0.200)	(0.548)
Return	-0.100***	-0.113***	-0.621***	0.293***
	(-10.990)	(-10.452)	(-23.642)	(10.228)
Price	-0.039	-0.033	-0.390***	0.409***
	(-1.032)	(-0.715)	(-3.680)	(3.991)
Observations	44,003	44,005	44,005	43,985
Adj. R^2	78.3%	72.1%	94.0%	74.7%

3.4. Further Robustness Tests

In this section, I show that the results are robust to a variety of alternative samples and empirical specifications. These robustness tests further corroborate the findings.

3.4.1. Validity of BOJ Ownership as a Measure of Reduction in Free Float

BOJ ownership may not accurately measure the amount of reduction in free float under two circumstances: 1) Firms issue additional new shares to meet the BOJ's demand; or 2) Strategic blockholders directly sell their holdings to the BOJ. In either of these two cases, the level of free float in a firm remains the same if the amount of the new issue or block selling can completely offset the amount of BOJ investment in the firm. In this section, I test the validity of using BOJ ownership as a measure of excess reduction in free floating shares by directly examining whether firms that experience higher BOJ purchases issue more shares and whether strategic blockholders sell additional ownership in response to BOJ demand.

I collect issuance data including issue date, issue type and issue amount from the SDC Platinum database. SDC New Issues Database contains information about both primary issue (where firms directly issue new shares) and secondary issue (where shareholders sell blocks of shares). All share issue variables are split-adjusted. To test the effect of BOJ purchases on share issuance, I regress the total number of shares issued in primary equity offering scaled by total shares outstanding on lagged BOJ holdings. I also construct a cumulative measure of share issuance as the sum of all new shares issued since 2010 to date to better match with aggregate BOJ holdings since the start of the BOJ purchase program. The SDC database may not contain all incidences of new issues due to missing information. To address this concern, I also calculate changes in shares outstanding at the end of each quarter relative to the number of shares outstanding at the beginning of 2010 as an indirect measure of new share issues. The results are presented in Table 3.5 Panel A. Columns 1–3 of Panel A report the results using these three measures of primary issue as dependent variables. The coefficient estimates of BOJ ownership in all three columns are not statistically significant suggesting that the amount of BOJ purchases does not lead to more new equity issuance during the next year nor does it increase the aggregate amount of equity issuance. There is also no significant association between BOJ ownership and changes in shares outstanding.

I then examine the effect of BOJ investment on block selling by large shareholders. I first measure the amount of block selling based on secondary issue. I construct similar quarterly and cumulative measures of secondary issue and regress these variables on lagged BOJ ownership in Columns 4 and 5 of Panel A. I further use changes in the total ownership of block shareholders relative to the amount in 2010 excluding the amount of BOJ ownership as an alternative measure of blockholder selling and report the results in Column 6. Block shareholders are defined as strategic owners of a firm including insiders, government entities, and corporations who own more than 5% of ownership in the firm. Block ownership data are from Worldscope. As shown in Columns 4–6, greater BOJ ownership is not significantly associated with all three measures of block selling. Firms that receive greater BOJ ownership do not issue additional new shares to meet this demand shock. Blockholders of these firms also do not sell more shares. This means at least a majority of BOJ holdings in these firms are acquired from retail investors or institutional investors, hence BOJ investment indeed reduces the level of free float.

In addition, I also include measures of new issue and block selling as additional control variables in the baseline model. The results are shown in Panel B. The coefficients of BOJ ownership remain significant and consistent. It is worth noting that the amount of new issue and block selling is positively associated with stock liquidity, the opposite of the effect of BOJ ownership. A plausible justification for this positive relation is that new issue and block selling increase the number of free floating shares in the market which in turn increases stock liquidity. Overall, these results validate the use of BOJ ownership as a measure of excess reduction in free float.

Table 3.5: Validity of BOJ Ownership as a Measure of Reduction in Free Float

This table presents the results on the effect of BOJ ownership on firm share issuance and block selling. Panel A reports the results of regressing share issuance and block selling variables on BOJ Ownership, while Panel B reports the results of including issuance and block selling variables as additional controls in the baseline specification. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: BOJ Ownership and Corporate Share Issuance and Block Selling

	New Share Issuance			Block Selling		
	Primary Issue	Primary Issue Cum	Changes in Shares Outstanding	Secondary Issue	Secondary Issue Cum	Changes in Block Holdings
	(1)	(2)	(3)	(4)	(5)	(6)
BOJ Ownership	-0.898	-0.590	-0.015	-14.181	-0.049	-0.006
	(-1.499)	(-1.414)	(-0.847)	(-1.447)	(-0.961)	(-1.574)
Bias	-0.005	-0.005	0.001	-0.129	0.000	0.000
	(-0.623)	(-1.540)	(1.583)	(-0.766)	(0.553)	(0.600)
Size	1.945***	0.548**	-0.031***	2.964	0.033	-0.001
	(4.250)	(2.448)	(-3.522)	(1.343)	(1.062)	(-0.896)
Volatility	0.325	0.421	0.067	5.403	-0.025	0.004
	(0.545)	(1.316)	(1.549)	(0.623)	(-0.734)	(0.985)
MB	0.033	0.048	0.000	-0.958**	0.004**	-0.000*
	(0.930)	(1.504)	(0.301)	(-2.468)	(2.125)	(-1.656)
Return	0.013	0.015	-0.001	0.026	0.000	0.000**
	(1.106)	(1.385)	(-0.475)	(0.123)	(0.204)	(2.037)
Price	-1.936***	-0.578**	0.029***	-2.997	-0.030	0.001
	(-4.241)	(-2.448)	(3.438)	(-1.350)	(-1.044)	(1.328)
Observations	47,268	48,672	48,672	48,621	48,672	48,672
Adj. R^2	83.4%	70.5%	1.6%	94.3%	93.2%	2.3%

Panel B: Controlling for Share Issuance and Block Selling

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
BOJ Ownership	2.110***	4.265***	12.869***	-11.281***
	(16.146)	(20.255)	(16.285)	(-15.579)
Primary Issue	-0.016	0.009	-0.466***	0.939***
	(-0.593)	(0.245)	(-4.553)	(3.999)
Secondary Issue	-0.297	-0.334	-1.426***	3.136***
	(-1.515)	(-1.638)	(-2.925)	(3.734)
Bias	-0.007***	-0.014***	-0.048***	0.055***
	(-2.996)	(-4.337)	(-3.968)	(4.751)
Size	-0.128***	-0.121***	-0.720***	-0.242***
	(-9.599)	(-7.931)	(-16.364)	(-5.411)
Volatility	1.717***	1.874***	-9.740***	23.586***
	(8.272)	(7.259)	(-15.689)	(35.019)
MB	0.063***	0.049***	-0.049***	0.105***
	(13.626)	(8.818)	(-2.767)	(6.189)
Return	-0.094***	-0.105***	-0.624***	0.304***
	(-11.891)	(-10.586)	(-23.922)	(11.324)
Price	-0.047***	-0.048***	-0.391***	0.398***
	(-3.484)	(-2.995)	(-9.409)	(9.145)
Observations	48,450	48,452	48,452	48,422
Adj. R^2	78.3%	72.1%	93.9%	75.2%

3.4.2. Matched Sample Tests

To address possible sample imbalance concern, I match firms with high BOJ ownership and stable relative weight bias ("treated" firms) with a similar control firm. A firm is classified as a "treated firm" if: 1) BOJ ownership in the firm is greater than 3% of total shares outstanding in 2016; and 2) its Nikkei weight and market value weight do not change more than 50% from 2010 to 2016. For each "treated firm", I identify the best control firm with replacement in three different ways. First, I use a propensity score matching (PSM) procedure, where matching is based on all control variables included in Model (3.1). Specifically, I match each treated firm with a control firm that falls in the same Fama French 48 (FF48) industry and has the smallest difference in propensity scores. Second, I match each treated firm with a control firm that has the closest market capitalization and is within the same FF48 industry. Third, I also match the sample by stock prices at the beginning of 2010. A control firm is required to have the closest stock prices with a treated firm in 2010 and operate in the same FF48 industry.

Table 3.6 reports the results of the baseline model using the three matched samples. Panel A shows the results based on propensity score matching. Panel B reports the results using the sample matched by industry and market capitalization, while Panel C uses the sample matched by industry and stock price. The results show a significant and negative impact of excess reduction in free float on stock liquidity which is consistent with the prior findings.

Table 3.6: Matched Samples

This table reports the results of the baseline model using matched samples. I match firms with high BOJ ownership and stable relative weight bias ("treated" firms) with similar control firms. A firm is considered as a treated firm if 1) BOJ ownership in the firm is greater than 3% of total share outstanding in 2016; and 2) its Nikkei weight and market value weight do not change more than 50% from 2010 to 2016. For each "treated firm", I find the best five matches with replacement by different matching criteria. Panel A shows the results using propensity score matching based on all control variables. Panel B (C) matches the sample by Fama French 48 industry codes and the closest market capitalization (stock price). The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: Propensity Score Matching

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
BOJ Ownership	0.334	0.901**	11.143***	-10.048***
	(1.343)	(2.594)	(3.728)	(-3.705)
Bias	0.004	0.004	0.036	-0.019
	(0.734)	(0.683)	(0.710)	(-0.425)
Size	-0.028	0.038	0.202	-0.806*
	(-0.464)	(0.459)	(0.391)	(-1.931)
Volatility	0.963*	0.815	-3.671	20.352***
	(1.927)	(1.414)	(-0.962)	(5.715)
MB	0.011	-0.007	-0.512***	0.468***
	(0.766)	(-0.470)	(-2.732)	(2.660)
Return	-0.036***	-0.030**	-0.425***	-0.013
	(-2.795)	(-2.032)	(-5.305)	(-0.163)
Price	-0.040	-0.110	-1.158**	0.872*
	(-0.693)	(-1.338)	(-2.084)	(1.898)
Observations	4,368	4,368	4,368	4,368
Adj. R^2	74.5%	73.5%	91.0%	78.3%

Panel B: Match by Industry and Size

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
BOJ Ownership	0.663**	1.201***	7.269***	-8.331***
	(2.448)	(2.882)	(2.946)	(-3.612)
Bias	-0.000	0.001	0.026	-0.010
	(-0.060)	(0.133)	(0.719)	(-0.304)
Size	0.001	0.034	0.423	-1.274***
	(0.053)	(1.021)	(1.381)	(-4.444)
Volatility	0.915	1.508*	0.369	15.267***
	(1.581)	(1.833)	(0.114)	(4.996)
MB	-0.003	-0.023	-0.289*	0.207
	(-0.274)	(-1.203)	(-1.815)	(1.577)
Return	-0.022**	-0.019	-0.365***	-0.058
	(-2.003)	(-1.397)	(-5.720)	(-0.970)
Price	-0.045*	-0.066**	-1.199***	1.198***
	(-1.707)	(-2.077)	(-3.412)	(3.616)
Observations	4,704	4,704	4,704	4,704
Adj. R^2	82.6%	80.1%	92.6%	80.9%

Panel C: Match by Industry and Price

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
BOJ Ownership	2.189***	3.696***	12.297***	-12.209***
	(4.182)	(4.368)	(5.166)	(-5.551)
Bias	0.001	-0.005	-0.077*	0.090**
	(0.086)	(-0.312)	(-1.727)	(2.185)
Size	-0.183***	-0.178***	-0.547***	-0.443***
	(-3.852)	(-3.124)	(-3.737)	(-2.609)
Volatility	1.670**	2.091*	-3.216	18.475***
	(1.988)	(1.914)	(-1.111)	(7.204)
MB	0.025	0.036	0.032	-0.078
	(1.038)	(1.175)	(0.371)	(-0.939)
Return	-0.040***	-0.041*	-0.389***	0.051
	(-2.838)	(-1.972)	(-5.926)	(0.790)
Price	0.071	0.054	-0.498***	0.638***
	(1.620)	(1.063)	(-3.906)	(4.277)
Observations	4,704	4,704	4,704	4,704
Adj. R^2	76.3%	68.3%	95.5%	80.9%

3.4.3. Changes in BOJ holdings and Liquidity

I further robust test the findings to the first difference model and regress changes in stock liquidity on changes in BOJ ownership over a quarter. Specifically, I analyze the following regression specification:

$$
\begin{aligned}
\Delta Liquidity_{i,t} = {} & \beta_0 + \beta_1 \Delta BOJ\ Ownership_{i,t-1} + \beta_2 \Delta Bias_{i,t-1} + \beta_3 \Delta Size_{i,t} \\
& + \beta_4 \Delta Volatility_{i,t} + \beta_5 \Delta MB_{i,t} + \beta_6 \Delta Return_{i,t} + \beta_7 \Delta Price_{i,t} \\
& + Industry \times Time\ FE + \varepsilon_{i,t} \qquad (3.8)
\end{aligned}
$$

where Δ indicates change in the value of a variable in quarter *t* relative to the same quarter one year prior, i.e. *t-4*.

Table 3.7 presents the regression results of the above specification. A larger change in BOJ ownership is significantly associated with a greater reduction in stock liquidity and trading activity, suggesting that the prior findings are robust to using the first difference model.

3.4.4. Reverse Granger Tests

I then employ the reverse Granger test and test whether excess reduction in free float due to BOJ investment Granger causes stock liquidity. Specifically, I include the lagged values of the liquidity measure in the baseline model. As shown in Table 3.8, the results remain consistent with the prior findings after the inclusion of the lagged liquidity measures.

Table 3.7: Change Regression

This table reports the results using the first difference model and regresses changes in stock liquidity on changes in BOJ ownership over a quarter following the model below:

$$\Delta Liquidity_{i,t} = \beta_0 + \beta_1 \Delta BOJ\ Ownership_{i,t-1} + \beta_2 \Delta Bias_{i,t-1} + \beta_3 \Delta Size_{i,t} + \beta_4 \Delta Volatility_{i,t} + \beta_5 \Delta MB_{i,t} + \beta_6 \Delta Return_{i,t} + \beta_7 \Delta Price_{i,t} + Industry \times Time\ FE + \varepsilon_{i,t}$$

where Δ indicates change in the value of a variable in quarter *t* relative to *t-4*. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	ΔEffective Spread	ΔQuoted Spread	ΔAmihud	ΔTurnover
	(1)	(2)	(3)	(4)
ΔBOJ Ownership	0.631***	1.383***	4.296***	-3.200***
	(3.487)	(6.022)	(4.473)	(-3.774)
ΔBias	-0.006***	-0.008***	-0.013	0.031**
	(-2.771)	(-2.994)	(-0.903)	(2.585)
ΔSize	-0.097***	-0.130***	-0.629***	-0.337***
	(-6.228)	(-4.851)	(-7.964)	(-5.020)
ΔVolatility	-0.001	-0.163	-10.304***	21.649***
	(-0.003)	(-0.585)	(-14.054)	(32.020)
ΔMB	-0.004	-0.004	-0.012	-0.052***
	(-0.793)	(-0.574)	(-0.646)	(-2.896)
ΔReturn	-0.076***	-0.083***	-0.579***	0.309***
	(-7.746)	(-7.499)	(-24.049)	(9.300)
ΔPrice	-0.066***	-0.036	-0.480***	0.516***
	(-3.859)	(-1.294)	(-5.528)	(6.341)
Observations	40,401	40,405	40,405	40,375
Adj. R^2	20.9%	18.2%	49.5%	26.1%

Table 3.8: Reverse Granger Tests

This table reports the results of the reverse Granger test by including the lagged values of the liquidity measures in the baseline model. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
BOJ Ownership	0.659***	1.193***	3.871***	-3.573***
	(6.332)	(7.580)	(8.044)	(-6.461)
Bias	-0.002	-0.004***	-0.017**	0.032***
	(-1.458)	(-2.688)	(-2.006)	(3.347)
Size	-0.019**	-0.024*	-0.042	-0.196***
	(-2.065)	(-1.913)	(-1.125)	(-4.079)
Volatility	-0.225	-0.096	-5.173***	-7.712***
	(-1.471)	(-0.490)	(-8.883)	(-8.515)
MB	0.001	-0.000	-0.039***	0.028*
	(0.394)	(-0.128)	(-3.534)	(1.951)
Return	-0.098***	-0.098***	-0.651***	0.226***
	(-15.999)	(-12.840)	(-30.356)	(9.527)
Price	-0.001	0.001	-0.102***	0.168***
	(-0.108)	(0.078)	(-2.870)	(3.429)
Lag Effective Spread	0.738***			
	(54.418)			
Lag Quoted Spread		0.709***		
		(41.839)		
Lag Amihud			0.728***	
			(57.019)	
Lag Turnover				0.669***
				(47.922)
Observations	48,600	48,604	48,642	48,502
Adj. R^2	90.4%	87.7%	97.0%	83.7%

3.4.5. Addressing Time Trend in Liquidity

The reverse relation between the availability of free float and liquidity I find may be driven by the possibility that the stock liquidity of firms with a large index weight bias may have a different time trend compared to other firms. I address this concern in two ways. First, I directly test whether there is a time trend in stock liquidity for "treated firms" during the six-year period before BOJ started its purchase program. To do so, I regress stock liquidity during the period 2004–2010 on the interaction of "treated firm" dummy (defined based on BOJ holding information in 2016) and year indicator variable (2004–2010). The coefficient of this interaction term captures the difference in the time patterns of liquidity between "treated" firms and other firms. Specifically, I run the following model specification:

$$\begin{aligned} Liquidity_{i,t} = {} & \beta_0 Treated\ Dummy \times t + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} + \beta_4 Volatility_{i,t} \\ & + \beta_5 MB_{i,t} + \beta_6 Return_{i,t} + \beta_7 Price_{i,t} + Firm\ FEs \\ & + Industry \times Time\ FE + \varepsilon_{i,t} \qquad (3.9) \end{aligned}$$

where t denotes the period from 2004 to 2010. $Treated\ Dummy$ is as defined in Section 3.4.2.

Second, I examine whether BOJ ownership during the recent six years from 2010 to 2016 is related to stock liquidity six years before the event from 2004 to 2009. If the results are solely driven by a persistent time trend in stock liquidity, then BOJ ownership should be related to not just contemporaneous stock liquidity, but stock liquidity during other periods. I test this following the specification below:

$$
\begin{aligned}
Liquidity_{i,t} = \beta_0 &+ \beta_1 BOJ\ Ownership_{i,t+6} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} \\
&+ \beta_4 Volatility_{i,t} + \beta_5 MB_{i,t} + \beta_6 Return_{i,t} + \beta_7 Price_{i,t} + Firm\ FEs \\
&+ Industry\ \times\ Time\ FE \\
&+ \varepsilon_{i,t} \qquad (3.10)
\end{aligned}
$$

where t denotes the period from 2004 to 2010. $BOJ\ Ownership_{i,t+6}$ is the amount of quarterly BOJ holdings during 2010 to 2016, i.e. six years leading all the other variables.

The results of Models (3.9) and (3.10) are shown in Table 3.9. Due to the limited availability of the high frequency trade data, I only report the results using Amihud and Turnover. Columns 1 and 2 show results using Amihud as the dependent variable and Columns 3 and 4 show results for Turnover. I find that BOJ ownership during the six years of the purchase program is not significantly related to both liquidity measures six years prior to the purchase program. Moreover, the interaction of the treated dummy and time is also not significantly associated with liquidity. These results suggest that the time patterns of liquidity for firms with greater BOJ holdings are not significantly different from that of other firms. Therefore, the adverse relation between free float reduction and stock liquidity is not driven by a linear time trend in liquidity.

Table 3.9: Addressing Time Trend in Liquidity

This table reports the results of the following two models to test whether a linear time trend in stock liquidity affects the main results:

$$Liquidity_{i,t} = \beta_0 Treated\ Dummy \times t + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} + \beta_4 Volatility_{i,t} + \beta_5 MB_{i,t} + \beta_6 Return_{i,t} + \beta_7 Price_{i,t} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t}$$

$$Liquidity_{i,t} = \beta_0 + \beta_1 BOJ\ Ownership_{i,t+6} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} + \beta_4 Volatility_{i,t} + \beta_5 MB_{i,t} + \beta_6 Return_{i,t} + \beta_7 Price_{i,t} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t}$$

where t denotes the period from 2004 to 2010. $BOJ\ Ownership_{i,t+6}$ is the amount of BOJ holdings during 2010 to 2016, i.e. six years leading all the other variables. $Treated\ Dummy$ is defined as 1) BOJ ownership in the firm is greater than 3% of total shares outstanding in 2016; and 2) its Nikkei weight and market value weight do not change more than 50% from 2010 to 2016. The definitions and data sources of all variables are described in detail in the Appendix. t-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	Amihud		Turnover	
	(1)	(2)	(3)	(4)
BOJ Ownership$_{t+6}$	-0.689		0.621	
	(-0.560)		(0.513)	
Treated Dummy*t		0.009		-0.006
		(0.860)		(-0.535)
Bias	0.017	0.024	-0.036	-0.045*
	(0.697)	(1.048)	(-1.490)	(-1.965)
Size	-0.619***	-0.550***	-0.335***	-0.438***
	(-6.355)	(-4.981)	(-2.605)	(-3.042)
Volatility	-4.395**	-5.758**	18.132***	18.476***
	(-2.009)	(-2.583)	(7.161)	(7.807)
MB	0.001	-0.011	-0.022	-0.010
	(0.018)	(-0.338)	(-0.564)	(-0.242)
Return	-0.370***	-0.367***	-0.018	-0.021
	(-7.173)	(-7.292)	(-0.407)	(-0.460)
Price	-0.390***	-0.429***	0.362***	0.429***
	(-4.008)	(-3.949)	(2.831)	(3.050)
Observations	5,478	5,671	5,478	5,671
Adj. R^2	95.2%	95.0%	78.0%	76.8%

3.4.6. Other Liquidity Measures

Precisely measuring stock liquidity is a challenging task. To ensure that the results are not driven by measurement issues, I construct several alternative measures of stock liquidity commonly used in the literature, including average quoted depth, the number of trades, price impact, Amivest and stock turnover adjusted for free float. Detailed definitions of these variables are listed in the Appendix. As shown in Table 3.10, the results are robust to the use of these alternative measures of stock liquidity.

3.4.7. BOJ Holdings as a Percentage of Free Floating Shares

Firms vary in terms of ownership structure, and using BOJ holdings as a proportion of total shares outstanding may not capture such difference. Thus, I also construct BOJ holdings as a percentage of the free floating shares and re-run all models using this measure. I obtain similar results. For brevity purposes, I only present the results of the baseline model in Table 3.11.

Table 3.10: Alternative Liquidity Measures

This table reports the results using alternative measures of liquidity in the baseline model. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	Depth	No. of Trades	Price Impact	Amivest	Turnover Float
	(1)	(2)	(3)	(4)	(5)
BOJ Ownership	-12.002***	-4.189***	1.250***	-12.206***	-11.536***
	(-5.539)	(-3.588)	(6.493)	(-5.893)	(-8.207)
Bias	0.063**	0.038**	-0.003	0.045	0.044***
	(2.171)	(2.008)	(-1.160)	(1.025)	(2.611)
Size	0.083	0.333***	-0.071***	0.509***	-0.046
	(0.766)	(4.124)	(-3.908)	(2.677)	(-0.538)
Volatility	1.343	22.437***	2.683***	11.732***	24.235***
	(1.492)	(25.220)	(13.743)	(5.739)	(24.905)
MB	0.094***	0.023	0.020***	0.060	-0.032
	(3.265)	(0.772)	(4.044)	(1.001)	(-1.128)
Return	0.222***	0.407***	-0.033***	0.773***	0.353***
	(9.217)	(15.555)	(-6.007)	(9.586)	(12.687)
Price	0.237**	0.270***	-0.027	0.509***	0.226***
	(2.115)	(3.178)	(-1.367)	(2.670)	(2.593)
Observations	48,645	48,645	48,643	26,620	48,621
Adj. R^2	86.3%	87.7%	76.1%	63.3%	72.1%

Table 3.11: Percentage BOJ holdings Adjusted for Free Float

This table presents the results of the baseline model using *BOJ Owership Float*, which is defined as BOJ holdings as a percentage of free floating shares, as the main explanatory variable. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	Effective Spread	Quoted Spread	Amihud	Turnover
	(1)	(2)	(3)	(4)
BOJ Ownership Float	1.779***	3.198***	10.088***	-8.965***
	(6.860)	(8.396)	(8.908)	(-8.434)
Bias	-0.008*	-0.016***	-0.043**	0.062***
	(-1.917)	(-2.813)	(-2.282)	(3.134)
Size	-0.133***	-0.135***	-0.801***	-0.169*
	(-3.667)	(-3.015)	(-8.285)	(-1.851)
Volatility	1.855***	1.982***	-9.826***	23.617***
	(5.625)	(4.761)	(-10.767)	(24.981)
MB	0.037***	0.031***	0.008	-0.004
	(4.351)	(2.618)	(0.253)	(-0.148)
Return	-0.090***	-0.101***	-0.631***	0.329***
	(-10.913)	(-10.264)	(-25.689)	(12.567)
Price	-0.024	-0.019	-0.326***	0.373***
	(-0.624)	(-0.399)	(-3.322)	(3.970)
Observations	48,538	48,540	48,540	48,540
Adj. R^2	78.3%	72.1%	94.0%	75.1%

3.5. Underlying Channels

In this section, I identify possible channels through which reduction in free float negatively impacts stock liquidity. As discussed in Section 3.1, free float affects stock liquidity through shaping the number and types of investors trading the security. The long-term holding strategy of BOJ decreases the number of investors trading a security leading to increased transaction costs of trades among market participants and ultimately decreased liquidity. Moreover, the large demand shock on free floating shares makes many retail and uninformed investors sell their shares to the BOJ. As a result, market makers would face a higher chance of trading with remaining informed investors and consequently widen spreads and reduce depths to recover the potential adverse selection losses. Therefore, I conjecture that the negative effect of free float on liquidity would be through a reduced number of shareholders and institutional investors.

Several studies have provided evidence on a direct link between the number of shareholders and stock liquidity. Benston and Hagerman (1974) document that the number of shareholders is negatively correlated with stocks' bid-ask spreads. Amihud, Mendelson, and Uno (1999) provide empirical evidence that an increase in the number of investors holding a stock leads to improved stock liquidity. In terms of institutional investors, many studies including Gompers and Metrick (2001) and Bennett et al. (2003) find that stock liquidity is positively related to institutional ownership.

To identify the effect of free float reduction on the number of investors, I directly test whether BOJ purchases decrease the number of shareholders and institutional investors in a firm. I regress the number of common shareholders and institutional investors as well as the amount of institutional ownership on BOJ holdings. The number of common (institutional) shareholders is defined as the log of the actual number of the common (institutional) shareholders in thousands as reported by the firm. Institutional ownership is defined as the fraction of shares held by institutional shareholders excluding those held by the BOJ via trust banks. Data on the number of common shareholders are obtained from Compustat Global, while data on the number of institutional shareholders and institutional ownership are extracted from Factset.

Table 3.12 presents the results using the total number of common shareholders, the number of institutional shareholders, and institutional ownership as the dependent variable. I report the results using both the full sample in Panel A and the Nikkei sample in Panel B. Consistent with the conjecture, BOJ ownership significantly reduces the number of common shareholders, the number of institutional shareholders and their ownership. A 1% increase in BOJ ownership leads to 3% fewer shareholders in a firm, 1.8% fewer institutional shareholders, and 0.4% decrease in institutional ownership. These results are consistent with "the real friction" and the informational friction effect of free float on the process of liquidity provision.

Table 3.12: Underlying Channels

This table presents the results of regressing the number of common shareholders and institutional investors as well as the amount of institutional ownership on BOJ holdings. Panel A reports the results using all firms listed on the First Section of Tokyo Stock Exchange. Panel B reports results using only firms included in the Nikkei 225 index. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: Full Sample

	No. of Shareholders (Log)	No. of Institutional Shareholders (Log)	Institutional Ownership
	(1)	(2)	(3)
BOJ Ownership	-3.107***	-1.774***	-0.418***
	(-2.909)	(-4.241)	(-3.806)
Bias	-0.005	0.005	-0.004
	(-0.230)	(0.558)	(-1.368)
Size	0.184***	0.340***	-0.007
	(4.109)	(6.030)	(-0.662)
Volatility	0.872	-2.215***	-0.185***
	(1.442)	(-5.876)	(-3.467)
MB	0.110***	0.026***	-0.003**
	(5.166)	(4.638)	(-2.422)
Return	-0.169***	0.007	0.005**
	(-7.148)	(0.516)	(2.372)
Price	-0.204***	0.022	0.036***
	(-4.363)	(0.383)	(3.182)
Observations	10,000	12,101	12,101
Adj. R^2	96.3%	98.0%	88.8%

Panel B: Nikkei Sample

	No. of Shareholders (Log)	No. of Institutional Shareholders(Log)	Institutional Ownership
	(1)	(2)	(3)
BOJ Ownership	-2.184*	-0.661*	-0.513***
	(-1.742)	(-1.914)	(-6.915)
Bias	-0.117**	-0.026***	-0.008***
	(-2.428)	(-2.594)	(-3.854)
Size	0.026	0.505***	0.037***
	(0.182)	(9.317)	(3.164)
Volatility	-3.724**	1.105	-0.091
	(-2.067)	(1.460)	(-0.561)
MB	0.077	-0.003	-0.008*
	(1.085)	(-0.153)	(-1.926)
Return	-0.147***	-0.006	0.006
	(-2.982)	(-0.212)	(0.964)
Price	-0.122	-0.140***	-0.017
	(-0.881)	(-2.636)	(-1.521)
Observations	1,247	1,498	1,498
Adj. R^2	97.5%	97.3%	90.8%

3.6. Conclusion

In this study, I investigate how stock liquidity is affected by exogenous reduction in free floating shares by exploiting the large-scale asset purchase program adopted by the Japanese central bank during 2010 to 2016 as the basis of the empirical strategy to tackle potential endogeneity problems.

I find a heterogeneous effect of free float reduction on stock liquidity due to the biased capital allocation based on the Nikkei index weight. Firms that experience a large reduction in free float due to BOJ purchases exhibit reduced stock liquidity and stock market trading activity. The empirical specifications I adopt allow me to rule out endogeneity concerns relating to heterogeneity in firm-specific information and time-varying heterogeneity across firms. The adverse effect of free float reduction on stock liquidity I find is robust to a battery of robustness tests and is proven to be persuasive. After establishing a negative causal link between free floating shares and stock liquidity, I then identify the underlying channel of this relation. I find that BOJ holdings significantly reduce the number of common shareholders and institutional shareholders of a firm. These results are consistent with "the real friction" and the informational friction effect of free float on the process of liquidity provision.

The empirical findings have significant implications for both academic researchers and industry practice. I uncover the potential side effects of large-scale government purchases on the security market which require thorough consideration of an optimal purchase plan.

Appendix: Variable Definitions

VARIABLE NAME	DEFINITION	DATA SOURCE
Stock Liquidity Measure		
Quoted Spread	Average of daily relative quoted spread over a quarter. The relative quoted spread is defined as the difference between the best ask and bid prices relative to the midpoint of the quote: $Relative\ Quoted\ Spread\ = \frac{Ask-Bid}{(Ask+Bid)/2}$	Thomson Reuters Tick History database (TRTH)
Effective Spread	Average of daily effective spread over a quarter. The effective spread for a trade is defined as $Effective\ Spread = 2 \times Sign \times (Price - \frac{Ask+Bid}{2})/$Price, where Sign is a trade direction indicator identified following Lee and Ready (1991).	TRTH
Amihud	Log of the average of the Amihud (2002) illiquidity ratio over a quarter calculated as $Amihud_{\ i,t} = 1{,}000{,}000\ \times \frac{1}{D_{i,t}} \times \sum_{d=1}^{D} \lvert Return_{i,t} \rvert / Volume_{i,t}$.	Datastream
Turnover	Log of the average of daily stock turnover over a quarter calculated as the ratio of the number of shares traded to the number of shares outstanding.	Datastream
Depth	Log of the average of daily quoted depth posted at the best bid and best ask prices quoted over a quarter.	TRTH
Price Impact	Average of daily 5-minutes price impact over a quarter calculated as 2 × Sign × $(M_{5\ mins} -$ M)/M, where $M_{5\ mins}$ is the mid-point 5 minutes after a trade, and M is the prevailing midpoint of a trade which equals to $\frac{Ask+Bid}{2}$.	TRTH
Turnover Float	Average of daily stock turnover over a quarter calculated as the ratio of the number of shares traded to the number of free floating shares outstanding.	Datastream
No. of trades	Average of daily number of trades over a quarter.	TRTH
Amivest	The average of the ratio of daily volume on the absolute value of daily returns over a quarter.	Datastream
BOJ Ownership Measures		
BOJ Ownership	The total holdings of the BOJ as a percentage of total number of shares outstanding in a quarter.	BOJ

BOJ Ownership Float	BOJ holdings as a percentage of the free floating shares.	BOJ Bloomberg
Firm Characteristics		
Bias	The relative difference between a firm's Nikkei index weight and its weight in a value-weighted index (calculated as $\frac{Nikkei\ Weight_{i,t}}{Nikkei\ Value\ Weight_{i,t}}$), which captures the level of bias in BOJ investment due to the Nikkei weighting system relative to the common value-weighting system.	Bloomberg
Size	Log of market capitalization	Worldscope
Volatility	The standard deviation of stock returns over previous quarter	Datastream
MB	Market to book ratio	Worldscope
Return	Average daily stock return over previous quarter	Datastream
Price	Log of stock price at the beginning of the quarter	Datastream
Primary Issue	Number of new shares issued as a percentage of total shares outstanding adjusted for share split during a quarter.	SDC
Primary Issue Cum	The sum of all new shares issued since 2010 to date	SDC
Δ Shares Outstanding	Changes in shares outstanding in a year relative to the number of shares outstanding at 2010	Datastream
Secondary Issue	Number of shares sold by shareholders through secondary issue as a percentage of total shares outstanding adjusted for share split during a quarter	SDC
Secondary Issue Cum	The sum of all shares sold through secondary issue since 2010 to date as a percentage of total shares outstanding in 2010	SDC
Δ Block Holdings	Changes in the total ownership of block shareholders, defined as insiders, government entities, and corporations who own more than 5% of ownership in the firm, relative to the amount in 2010 as an alternative measure of blockholder selling.	Datastream
No. of Shareholders	Log of the number of common shareholders	Factset
No. of Institutional Shareholders	Log of the number of institutional shareholders	Factset
Institutional Ownership	The total ownership held by institutional shareholders as a percentage of total number of shares outstanding excluding shares held by the BOJ via trust banks	Factset

Chapter 4: Exchange Traded Fund Ownership and Stock Price Efficiency

4.1. Introduction

We have witnessed a strikingly rapid expansion of the exchange traded funds (ETFs) industry around the world during recent decades. According to the EY Global ETF Survey 2017, the amount of assets under management by global ETFs had reached US$4.4 trillion by 2017 compared to just US$417 billion in 2005, an average annual growth rate of about 21%. The survey also predicts that global ETF assets will approach US$7.6 trillion by the end of 2020 (Kealy et al. 2017). ETFs have attracted popularity among investors for their low management costs and high diversification. Most ETFs track broad benchmarks without active selection of stocks.[14] This investment style effectively reduces the costs of managing ETFs and consequently the fees charged to investors. The passive investment style of ETFs also reduces active management risk given that most active mutual funds failed to outperform the returns of major indices.

However, how this broadened scope of ETF ownership in the underlying stocks affects the equity markets is still an open question. In this study, I investigate whether an increase in ETF ownership, particularly passively managed ETFs that track an equity index, leads to a decline in the informational efficiency of stock prices. In a frictionless market, the ownership structure of a firm should not have an impact on the pricing efficiency of its stock. However, impediments related to information gathering costs and transaction costs can cause ETF ownership to have a real impact on the economy. One of the direct

[14] A very small number of ETFs are actively managed. The first active ETFs were introduced in 2008 in the US. According to an estimate by the ETF.com, as of 2015, less than 1% of ETF assets were managed by active ETFs in the US.

influences is on how quickly and efficiently information is reflected in the stock prices of underlying securities.

On the one hand, ETF investment generally involves holding a basket of stocks in certain indices passively, without active information acquisition and price discovery. This raises concerns regarding a possible negative impact on price efficiency. As suggested by Grossman and Stiglitz (1980), price discovery relies on informed traders who actively acquire information and incorporate that information into stock prices by trading. The reward from trading with the uninformed provides the incentive for active traders to spend costly effort on price discovery. Passive investment, however, siphons off shares available to traders who wish to transact on firm-specific information and consequently results in reduced incentive for active traders to expend resources to acquire information in the firm, leading to price inefficiency. On the other hand, since institutions that manage ETFs hold the underlying stocks for a fairly long period of time, they typically engage in share lending to short-sellers in order to earn fees at low turnover risk. Thus, the number of shares available for shorting goes up, possibly reducing the cost of short selling shares. This is useful in reducing the cost of a negative bet for speculators. Since investors looking for information will encounter bad news roughly half the time, the increase in the return to investing in information will increase the incentive for information gathering and stock price efficiency.

Investigating the effect of ETF ownership on price efficiency is challenging because of endogeneity issues. Stocks differ in ETF ownership mainly due to their inclusion in different indices that are tracked by ETFs. If ETF ownership is directly related to price efficiency, it is essentially comparing the price efficiency of stocks in and out of certain equity indices. Several studies have examined index inclusions and fundamental stock characteristics. These studies find that index inclusions are related to certification of firm quality (Jain 1987, Dhillon and Johnson 1991), increased investor awareness (Chen, Noronha, and Singal 2004), or improved analyst earnings forecasts (Denis et al. 2003), all of which are associated with price efficiency. Thus, it is not clear whether it is ETF ownership that affects the efficiency of stock prices or it is just an index inclusion effect. A few recent studies that examine ETFs look at changes in firm-level ETF ownership (Hamm 2011, Glosten and Zou 2016, Israeli, Lee, and Sridharan 2017). However, inflow and outflow of funds should not generate cross-sectional variation in terms of ETF ownership in index constituent firms because most indices determine underlying stocks' weights based on float-adjusted market capitalization. The fraction of ETF ownership across firms remains the same as long as these funds buy and sell underlying stocks following the index weights precisely, which is roughly true in practice as one of the major objectives of index ETF funds is to minimize tracking error. Therefore, analyzing changes in ETF ownership driven by fund inflow and outflow does not create cross-sectional variation across firms within an index, and is still subject to endogeneity issues.

This study examines the effect of ETF ownership on stock price efficiency by using the large-scale ETF purchase program of the Bank of Japan (BOJ) as the identification strategy. Designed to combat Japan's two decades of deflation and to stimulate consumption and business spending, the BOJ started buying equity stocks through index-related ETFs as part of its monetary easing policy from 2010. Since then, the policy has been expanded on several occasions and the level of intervention became economically significant after 2014. The purchase program is implemented following a strict scheme and only invests through index ETFs that track the Nikkei 225 Stock Average, the Tokyo

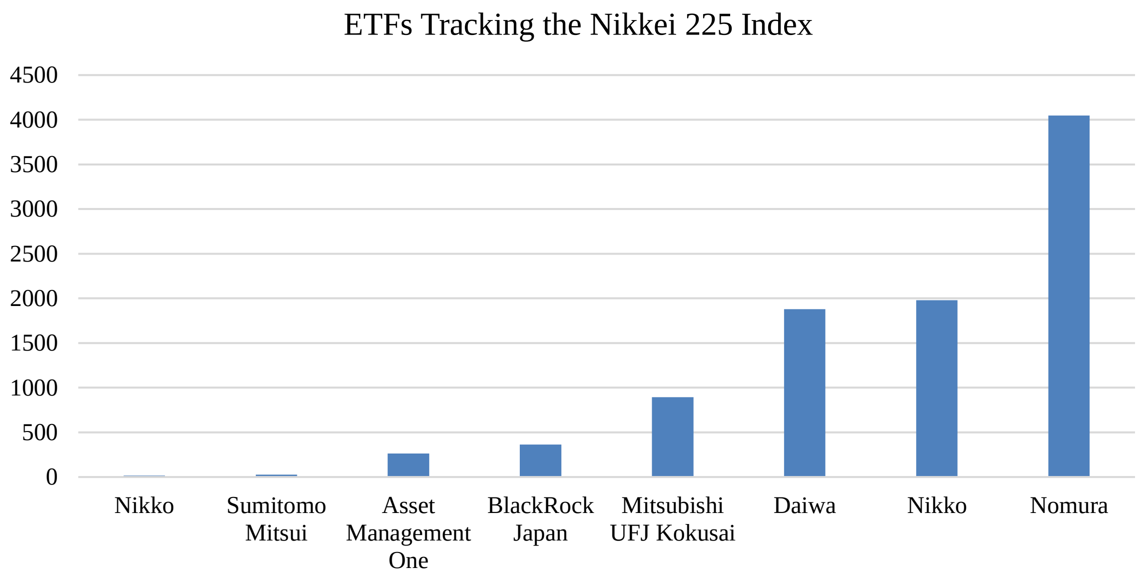
Stock Price Index (TOPIX), and the JPX-Nikkei Index 400. Through holdings in the ETFs, the BOJ has become the top shareholder of many public firms in Japan.

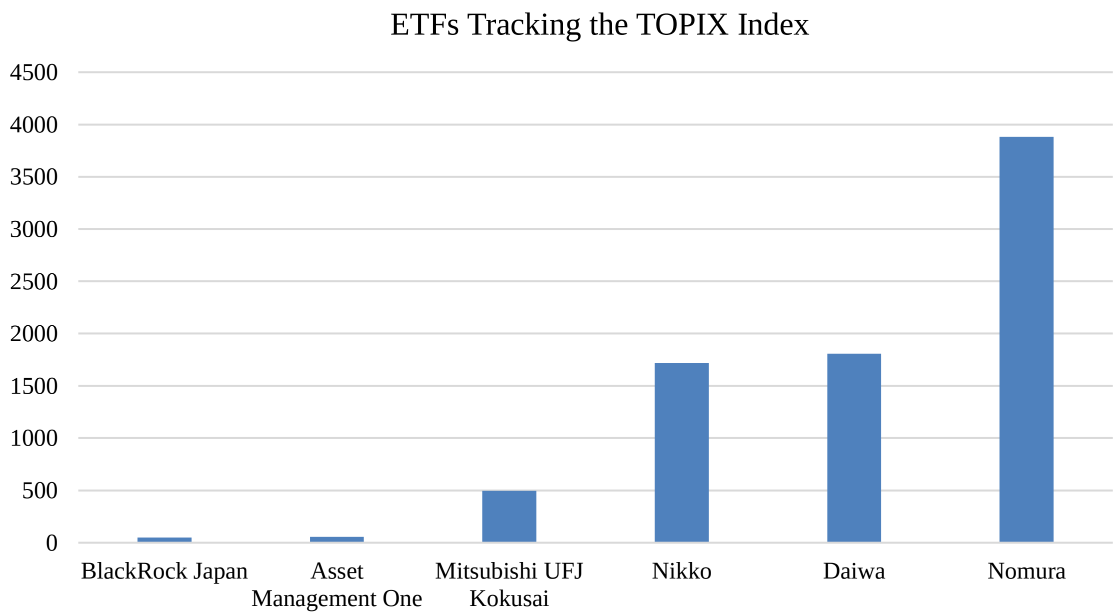
To purchase ETFs from the market, the BOJ establishes a trust arrangement with a trust bank which places orders and safekeeps the ETFs on behalf of the BOJ. The trust bank places orders to brokerage firms, whose role is to purchase the constituent shares from the market and deliver to the ETF sponsors in exchange for the ETFs. The major brokerage houses act as participation dealers in Japan. The participation dealers can also trade the ETFs and play the role of arbitrageurs between ETFs and their underlying assets. The ETF sponsors are the primary issuers of the ETFs who calculate and publish the net asset value of their ETFs in the secondary market.[15] Figure 4.1 shows the amount of assets under management of these ETF sponsors. The ETFs of Nomura manages the largest amount of assets tracking both the Nikkei index and the TOPIX index.

[15] There are six ETFs listed on the Tokyo Stock Exchange that follow the TOPIX index (Exchange code 1305, 1306, 1308, 1348, 1473, 1475) and eight that follow the Nikkei 225 index (1320, 1321, 1330, 1329, 1346, 1578, 1369, 1397). The sponsors include Daiwa Asset Management (AM), Nomura AM, Nikko AM, Mitsubishi UFJ Kokusai AM, Asset Management One, BlackRock Japan, and Sumitomo Mitsui AM.

Figure 4.1: Assets Under Management of ETFs by Provider

This figure shows the amount of assets under management (in billions of yen) of ETFs by ETF providers in Japan. The values are as of December 2016 based on data from Datastream.





Since the initiation of its ETF purchase program, the BOJ has gradually acquired dominant positions in the country's ETF market. Figure 4.2 shows the amount of assets under management of all ETFs tracking the Nikkei index and the TOPIX index (blue line) and those held by the BOJ (orange line) over the period from the end of 2010 to 2017. The two lines slope up rapidly with parallel growth patterns over the period. Due to the BOJ's ETF purchases, the combined market value of the Nikkei 225 index and the TOPIX ETFs increased by more than eight fold from 2.2 trillion yen at the end of 2010 to 18 trillion yen at the end of 2016. As of December 2016, the central bank has invested more than US$124 billion (13.8 trillion yen) in ETFs, which is close to 78% of the total ETFs tracking the two indices.

Figure 4.3 further illustrates the significant impact of BOJ purchases on Japan's ETF market. The assets under management of ETFs tracking both indices were very similar with only a slight difference before the BOJ starts to aggressively intervene in the market and starts to diverge largely with the assets under management of Nikkei ETFs exceeding that of TOPIX ETFs after the BOJ's announcement to triple its investment on October 31, 2014. The amount of assets under management of Nikkei ETFs then fall below that of TOPIX ETFs soon after the BOJ announced revising its investment schedule to invest more in TOPIX ETFs and a smaller fraction in Nikkei 225 index ETFs.

Figure 4.2: Assets Under Management of ETFs Held by the BOJ

This figure shows the monthly amount of assets under management (in billions of yen) of all ETFs tracking the Nikkei and the TOPIX index and those held by the BOJ from the end of 2010 to 2017.

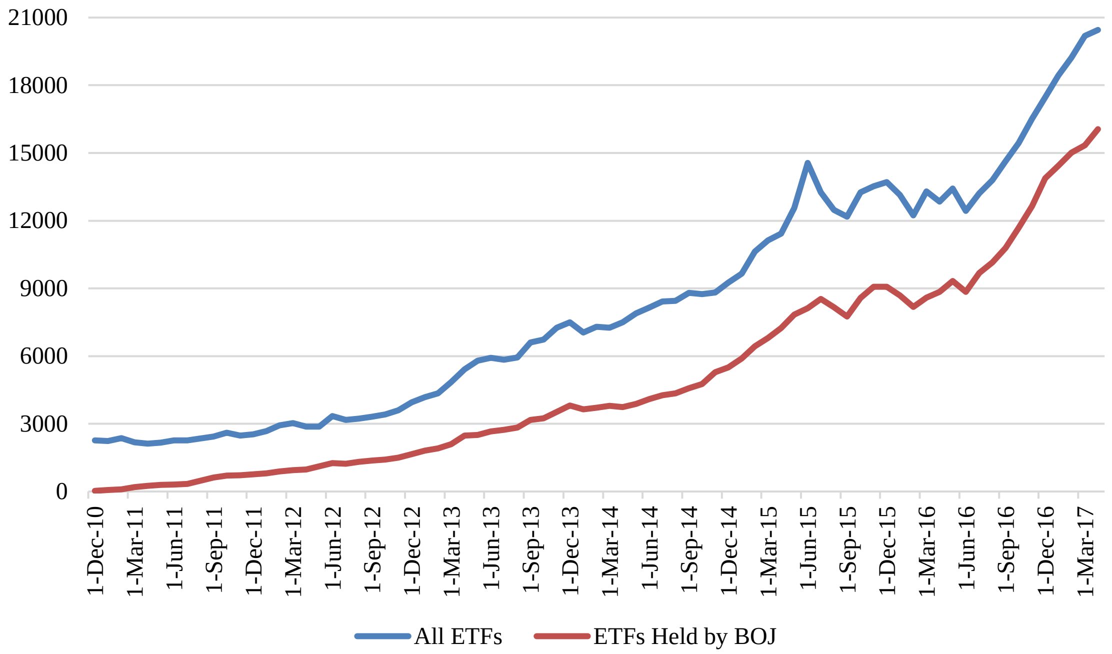
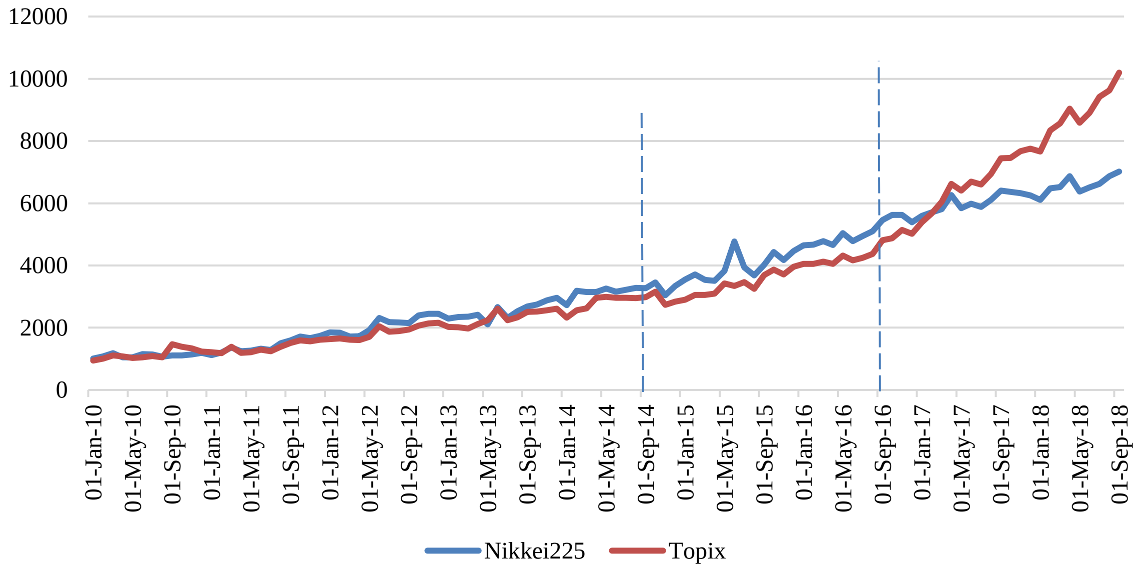


Figure 4.3: Adjusted Assets Under Management of all ETFs tracking the TOPIX or Nikkei Index

The figure shows the monthly amount of assets under management (in billions of yen) of all ETFs tracking the TOPIX index or the Nikkei 225 index adjusted for changes in index values at the beginning of 2010. The data are from Datastream. The two vertical dash lines mark the time of two announcements made by the BOJ adjusting its purchase program: on October 31, 2014 when the BOJ tripled the annual mark to about 3 trillion yen, and on September 21, 2016 when the BOJ announced revising its investment schedule to invest more in TOPIX ETFs and a smaller fraction in Nikkei 225 index ETFs.



It is worth noting that according to Japan's ETF market data on the Datastream database, ETFs tracking the Nikkei and TOPIX index have dominated the majority of Japan's ETF market, accounting for 95% of total assets under management in the market as of 2017. Therefore, BOJ purchases are entirely driving the changes in the ETF market over this period.

The BOJ's aggressive purchase schedule has significantly increased the level of index ETF ownership in affected firms and the increase is exogenous to firm-specific characteristics. Furthermore, one of the indices the BOJ invests in, the Nikkei 225 index, adopts a special weighting system not based on the conventional value-weighting system. The weight of a constituent firm in the Nikkei 225 index is a function of its stock price at the time it enters the index, which could largely deviate from its relative market capitalization in the index. This means many stocks in the Nikkei index are receiving excess capital flow from the BOJ relative to their market capitalization. For example, Fast Retailing Co. Ltd, which has the largest weight in the index at 8.63%, has 14.03% of its shares held by the BOJ through index ETFs as of December 2016, while Toyota Motor Corporation, the largest firm in terms of market capitalization in the index, only receives an index weight of 1.39% and has 1.55% of its shares held by the BOJ. The cross-sectional variation in BOJ purchases across firms is also exogenous since the weighting system of the Nikkei was determined long before the BOJ policy was enacted and implemented. Therefore, the policy provides a natural experiment to tackle endogeneity problems in previous studies and clearly identify the effect of ETF ownership on stock price efficiency.

I conduct a series of empirical tests using a sample of all the Japanese common stocks listed on the Tokyo Stock Exchange First Section. I gather actual monthly holdings in

Japanese listed stocks held by the BOJ via index ETFs that track the Nikkei 225 index, the TOPIX index and the JPX-Nikkei Index 400 during the period from 2010 to 2016. Following prior literature, I measure price efficiency in various ways: 1) two measures, the variance ratio and daily return autocorrelation, that both capture the deviation of stock prices from random walk (under the assumption that efficient prices follow a random walk process); and 2) the price delay measures proposed by Hou and Moskowitz (2005), which capture how quickly prices incorporate public information (without an assumption of random walk).

The results show that a greater increase in ETF ownership driven by BOJ investment leads to a decline in the price efficiency of the underlying stocks. ETF ownership is significantly related to larger deviations of stock prices from a random walk and longer delay of stock prices in responding to market information. Specifically, a 1% increase in ETF ownership is associated with an approximately 5.24% change in variance ratio relative to its median and 4.22% change in return autocorrelation relative to its median. The empirical specification I adopt makes sure the results are not driven by heterogeneity in firm characteristics and firm-specific information that drive changes in both ETF ownership and price efficiency. To further validate a causal link from ETF ownership to stock price efficiency, I address potential endogeneity concerns relating to time-varying heterogeneity across firms and obtain consistent results.

To further examine the impact of ETF ownership on the informational efficiency of stock prices, I use another common measure of price efficiency, the post-earnings announcement drift (PEAD), which is a well-established market anomaly that indicates some degree of informational inefficiency in stock prices; I find that the PEAD of firms that experience a greater increase in ETF ownership due to BOJ purchases are larger in magnitude. This suggests that information contained in earnings surprise is not immediately incorporated into the prices of these firms.

I then turn to identifying the underlying channel of the results. I first argue that excess ETF ownership reduces the fraction of firms' institutional ownership and the number of institutional investors who have greater incentive to acquire information, hence results in less information production and inefficient prices. Second, given the negative impact of ETF ownership on stock liquidity, which generally reflects the transaction costs of trade, ETF ownership can reduce price efficiency through increasing the cost of informed arbitrage. I directly show that stock illiquidity adversely affects price efficiency. The stock illiquidity measure also absorbs the magnitude of the relation between ETF ownership and price efficiency, suggesting that part of the negative impact of ETF ownership on price efficiency is explained by stock liquidity.

Finally, I specifically examine the impact of ETF ownership on firm-specific information production and the information content of stock prices. I find that greater increase in ETF ownership is associated with a reduction in analyst following. The average number of unique analysts following a firm decreases by approximately 1% for a 1% increase in ETF ownership. Increase in ETF ownership driven by the BOJ investment also adversely affects the informativeness of stock prices. If the level of information arbitrage activity is reduced, stock prices can reflect less information about future earnings. Firms with higher ETF ownership experience a weaker current return to future earnings relation, i.e. stock returns reflect less information about future firm earnings. After decomposing earnings into "macro" and "firm-specific" components, I find a strong negative effect of ETF ownership on the extent to which stock returns incorporate firm-specific information.

Understanding the effect of ETF ownership on price efficiency is of critical importance to equity market practice. More efficient prices facilitate better-informed financing and investment decisions. Using the recent large-scale BOJ purchases of equity ETFs as the basis of the empirical strategy to tackle the endogeneity problems, the findings reflect that ETF ownership exerts a negative externality by making it more difficult for stock prices to reflect information efficiently. Given the expected rapid growth of ETF investment in the future, it is reasonable to be cautious about its negative influence on market efficiency.

This study contributes to the literature that examines the determinants and ramifications of price efficiency. Chordia, Roll, and Subrahmanyam (2008) show that smaller tick sizes and narrower bid-ask spreads prompt more arbitrage trading, which in turn increases the informational efficiency of stock prices. Boehmer and Kelley (2009) show that stocks with higher institutional ownership are priced more efficiently. Chang and Yu (2010)analyze how the firm's capital structure choice affects price efficiency and suggest that the firm's capital structure can be designed to improve price efficiency. I provide thorough empirical evidence that ETF investment reduces informational efficiency of transaction prices.

This study is also closely related to papers that study the effect of ETF ownership. A few recent papers study the adverse effect of ETF ownership on the underlying stocks. Ben-David, Franzoni, and Moussawi (2018) find that ETFs increase underlying securities' volatility. Hamm (2011) shows that introduction of ETFs decreases the liquidity of individual component stocks. Israeli, Lee and Sridharan (2017) show that an increase in ETF ownership is associated with a reduction in pricing efficiency for the underlying stocks. In contrast, Glosten and Zou (2016) examine the effect of ETF trading on price efficiency and find that an increase in ETF trading is associated with improved informational efficiency of underlying stocks. Agarwal et al. (2018) document that ETF ownership significantly increases the liquidity commonality because of the arbitrage activities undertaken by the authorized participants of ETFs. This study complements this literature and provides robust evidence that an exogenous increase in ETF ownership adversely affects stock price efficiency.

The remainder of this chapter is organized as follows. In Section 4.2, I develop the main hypotheses and outline the research design. In Section 4.3, I describe the data collection procedure and provide summary statistics for the sample. In Section 4.4, I show the baseline findings about the effect of ETF ownership on price efficiency and provide more robustness tests. In Section 4.5, I examine the effect of ETF ownership on post-earnings announcement drift. In Section 4.6, I conduct tests to identify the channels of the results. Section 4.7 investigates the effect of ETF ownership on analyst coverage and Section 4.8 the degree to which current stock returns incorporate firm future earnings. Section 4.9 concludes.

4.2. Hypothesis Development and Research Design

There are competing hypotheses about the role of ETF ownership on price efficiency. On the one hand, passive ETF investment can have a negative impact on stock price efficiency. The noisy rational expectations models with costly information feature investors who expend resources to become informed and describe an equilibrium that requires trading by these active investors for the efficient transmission of costly information to stock prices (for example, Admati 1985, Diamond and Verrecchia 1981, Grossman and Stiglitz 1980, Kyle 1989, and Verrecchia 1982). Active traders contribute to market efficiency through acquiring and disseminating information. They earn a return on their information acquisition efforts from trading against uninformed investors. In the equilibrium, the benefit of trading information should be just enough to provide active traders the incentive to spend costly effort in information acquisition and processing. In this way, the information procured by active traders is incorporated into stock prices. The relative cost of information acquisition faced by active traders above or below the gains from trading with uninformed investors determines the level of informational efficiency of stock prices in the equilibrium.

Passive investors, in contrast, do not directly contribute to making efficient prices. As the investment style of passive ETFs often involves tracking a basket of stocks in an index and holding these stocks for a substantial period of time, their trades barely contain firm-specific or industry-specific information. Greater passive ETF ownership in a firm also implies a reduced number of shares available for trading by active traders, which decreases the potential benefit from information arbitrage. Moreover, as shown in Chapter 3, inactive block ownership can adversely affect stock liquidity, which also raises the transaction cost faced by active traders. The reduced benefit and increased cost of information arbitrage will then reduce the incentive of active traders to engage in firm-specific information acquisition activities and move the market equilibrium towards a less efficient level. Therefore, I hypothesize that an "excessive" fraction of ETF ownership reduces the production of information and results in inefficient stock prices.

On the other hand, it may be argued that ETF ownership can reduce the cost of short selling which leads to improved informational efficiency of stock prices. Institutions that manage ETFs often engage in share lending, which increases the supply of lendable shares and reduces short selling constraints. Increased lending supply is useful in reducing the cost of a negative bet for speculators and leads to more efficient stock prices. Bris, Goetzmann and Zhu (2007) find that short selling facilitates faster incorporation of negative information into stock prices. Boehmer and Wu (2013) examine short selling activities and show that active short-selling flow promotes more accurate stock prices. Saffi and Sigurdsson (2011) use equity lending supply data in 26 countries and find that lending supply has a significantly positive impact on price efficiency. If the benefit from reduced short selling constraints outweighs the negative impact discussed above, information gathering and stock price efficiency would expect to increase. Hence, I propose an opposite hypothesis that ETF ownership can enhance price efficiency.

To test these competing hypotheses, I exploit the unconventional weighting system of the Nikkei index to identify cross-sectional variation in ETF ownership driven by BOJ demand shocks and relate this variation to changes in price efficiency by conducting a series of multivariate regression analyses. The baseline regression model is specified as follows:

$$Efficiency_{i,t} = \beta_0 + \beta_1 ETF\ \widehat{Ownership}_{i,t-1} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t-1} + \beta_4 Volatility_{i,t-1} + \beta_5 Price_{i,t-1} + \beta_6 Turnover_{i,t-1} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t} \quad (4.1)$$

where *i* denotes firms and *t* denotes quarter-years. The dependent variable $Efficiency_{i,t}$ is one of the price efficiency measures. The main explanatory variable $ETF\ \widehat{Ownership}_{i,t-1}$ is the amount of ETF holdings in a firm as a percentage of total number of shares outstanding held by the BOJ. Statistically, this variable could be considered as an instrumental variable for the time-series variation in ETF ownership. As the BOJ's ETF investment has a one-to-one relationship with firm-level changes in ETF ownership, $ETF\ \widehat{Ownership}_{i}$ captures exogenous variation in ETF ownership across firms over time. $Bias_{i,t-1}$ is the level of bias in BOJ investment due to the Nikkei weighting system relative to the common value-weighting system. $Size_{i,t-1}$ is the log of market capitalization. $Volatility_{i,t-1}$ is the standard deviation of stock returns over previous quarter. $Price_{i,t-1}$ is the log of stock price at the end of the previous quarter. $Turnover_{i,t-1}$ is the log of total number of shares traded scaled by the number of shares outstanding. Firm fixed effects control for time-invariant differences between firms. Industry × Time fixed effects control for time-varying industry-level differences.

4.3. Data and Sample Description

4.3.1. Measures of Stock Price Efficiency

The literature has proposed several approaches to measure informational efficiency of stock prices. First, under the assumption that efficient prices follow a random walk, informational efficiency can be measured as how closely transaction prices resemble this benchmark. This view allows continuous arrival of information and order flow, as well as market frictions that drive a temporary wedge between transaction prices and the efficient price. I employ two measures under this approach, the variance ratio and return autocorrelations. For stock prices that follow a random walk, the variance of returns is a linear function of the return measurement frequency. The variance ratio makes use of this property to measure inefficiency as a price series' deviation from the characteristics that would be expected under a random walk (Lo and MacKinlay 1988). Specifically, it is calculated as the absolute value of one minus the variance of weekly returns divided by five times the variance of daily returns. The closer the number is to zero, the more prices behave like a random walk, and the more efficient the market. Return autocorrelation is associated with the magnitude of deviation of stock price from a random walk. It is calculated as the absolute value of first-order daily return autocorrelation estimated for each stock over each quarter by regressing daily returns on one-day lagged returns. A higher value of both the variance ratio and return autocorrelations represents a greater degree of price inefficiency.

Second, without an assumption of random walk, relative price efficiency can be measured by the delay of stock prices in response to the market prices (Hou and Moskowitz 2005). If investors cannot fully incorporate market-wide information into today's stock prices, they will defer their actions such that this information is fed only gradually into prices. Following Hou and Moskowitz (2005), I measure price-response delay from a market-model regression that is extended using the lagged returns of a local market index. The greater the explanatory power of these lags, the longer the delay in responding to information. For each stock and quarter, I estimate a regression of daily returns on the value-weighted local index return and its lagged values up to the previous four weeks. Specifically, I run the following model:

$$R_{i,t} = a_i + b_i R_{m,t} + \sum_{n=1}^{4} c_i^n R_{m,t-n} + \varepsilon_{i,t}$$

where $R_{i,t}$ is the return on stock i on day t and $R_{m,t}$ is the value-weighted TOPIX index return. I then estimate a second regression that restricts the coefficients on lagged market returns to zero.

The first delay measure (D1) captures the fraction of variability in stock returns that is explained by lagged market returns. It compares the value of R^2 from the regression above with that of the second regression when the coefficients on lagged market returns are restricted to zero and is calculated as:

$$D1_i = 1 - \frac{R^2_{i,Restricted\ model}}{R^2_{i,unRestricted\ model}}$$

The larger the delay, the less efficient the stock price is, in the sense that it takes longer for the stock to incorporate market-wide information. However, D1 does not take the magnitude of the coefficients of lagged market returns into account. Another delay measure, D2, captures the magnitude of the lagged coefficients relative to the magnitude of all market-return coefficients:

$$D2_i = \frac{\sum_{n=1}^{4} |c_i^n|}{|b_i| + \sum_{n=1}^{4} |c_i^n|}$$

I use the absolute values of each coefficient regardless of their estimated signs because price efficiency is smaller as these measures deviate from zero.

The third delay measure I employ adjusts D2 with the standard errors of the coefficient estimates. Specifically, it is estimated as

$$D3_i = \frac{\sum_{n=1}^{4} \frac{|c_i^n|}{se_{c_i^n}}}{\frac{|b_i|}{se_{b_i}} + \sum_{n=1}^{4} \frac{|c_i^n|}{se_{c_i^n}}}$$

where se_* is the standard error of each of the corresponding coefficient estimates.

To construct these variables, I obtain data on stock prices and market returns from the Datastream database. To make sure there are adequate stock price information, I require firms to have no less than 30 days of trading data during a quarter. Table 4.1 Panel A shows the descriptive statistics of the efficiency measures by quarter. The values are comparable with those in the other studies.

4.3.2. Data and Sample

Firm-level BOJ holdings data are from the Quick database. Financial variables are obtained from the Datastream/Worldscope database. To begin with, I collect data for all public firms listed on the First Section of the Tokyo Stock Exchange during the period 2010–2016 from the Datastream/Worldscope database. I exclude firms with missing financial data. The final sample covers 25 quarters and includes 49,489 firm-quarter observations. Because I implement a range of different tests in this study, any changes to the sample are addressed in the corresponding sections.

4.3.3. Summary Statistics

Table 4.1 Panel B shows the summary statistics for all efficiency measures and control variables. There are large cross-sectional dispersions in the efficiency measures of Japanese firms. Table 4.1 Panel C shows the correlations across all variables of interest in the sample. The correlations between the efficiency measures are relatively low ranging from -0.016 to 0.215, suggesting that they capture different aspects of price efficiency but also share a common component. The correlations between $ETF\ \widehat{Ownership}$ and the efficiency measures are not consistent. The result indicates that examining the relation between ETF ownership and price efficiency at the cross-section without properly addressing endogeneity can generate misleading results.

Table 4.1: Data Descriptions

This table reports descriptive statistics of all main variables and control variable. Panel A reports the descriptive statistics of the price inefficiency measures by quarter. Panel B shows the summary statistics for all price efficiency measures and control variables. Panel C reports the correlation matrix. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016.

Panel A: Measures of Price Inefficiency by Quarter

Quarter	Variance Ratio	Autocorrelation	D1	D2	D3	N
2010 Q1	0.29	0.128	0.271	0.478	0.478	1,644
2010 Q2	0.283	0.103	0.173	0.405	0.41	1,647
2010 Q3	0.367	0.123	0.17	0.397	0.394	1,657
2010 Q4	0.315	0.119	0.288	0.474	0.484	1,659
2011 Q1	0.737	0.171	0.149	0.368	0.374	1,662
2011 Q2	0.301	0.119	0.24	0.464	0.465	1,662
2011 Q3	0.295	0.111	0.196	0.417	0.419	1,669
2011 Q4	0.378	0.135	0.224	0.435	0.44	1,660
2012 Q1	0.338	0.145	0.382	0.551	0.545	1,659
2012 Q2	0.328	0.13	0.213	0.426	0.417	1,664
2012 Q3	0.326	0.118	0.292	0.489	0.491	1,673
2012 Q4	0.33	0.127	0.342	0.54	0.543	1,665
2013 Q1	0.366	0.13	0.296	0.501	0.488	1,677
2013 Q2	0.286	0.103	0.121	0.354	0.348	1,694
2013 Q3	0.324	0.117	0.17	0.386	0.401	1,707
2013 Q4	0.306	0.117	0.238	0.444	0.45	1,739
2014 Q1	0.431	0.1	0.104	0.327	0.329	1,753
2014 Q2	0.323	0.116	0.2	0.426	0.426	1,776
2014 Q3	0.334	0.137	0.287	0.486	0.483	1,806
2014 Q4	0.331	0.12	0.138	0.359	0.359	1,807
2015 Q1	0.298	0.123	0.269	0.477	0.479	1,830
2015 Q2	0.3	0.116	0.313	0.527	0.517	1,855
2015 Q3	0.311	0.103	0.087	0.316	0.308	1,879
2015 Q4	0.298	0.111	0.227	0.422	0.443	1,881
2016 Q1	0.295	0.106	0.081	0.302	0.301	1,902
2016 Q2	0.253	0.105	0.113	0.333	0.335	1,927
2016 Q3	0.348	0.124	0.248	0.454	0.459	1,949
2016 Q4	0.357	0.171	0.22	0.449	0.445	1,966
Total	0.337	0.122	0.215	0.428	0.429	49,069

Panel B: Summary Statistics

Variables	Mean	1st Percentile	Median	99th Percentile	Standard Deviation	N
ETF $\widehat{\text{Ownership}}$	0.004	0	0.003	0.038	0.007	49,072
Variance Ratio	0.337	0.007	0.291	1.133	0.251	49,069
Autocorrelation	0.122	0.002	0.103	0.394	0.092	49,069
D1	0.215	0.009	0.136	0.958	0.218	49,069
D2	0.428	0.136	0.407	0.902	0.169	49,069
D3	0.429	0.136	0.408	0.903	0.169	49,069
Bias	0.337	0	0	6.647	1.352	49,072
Size	10.828	8.175	10.612	14.832	1.544	49,072
Volatility	0.021	0.007	0.019	0.052	0.009	49,072
Price	6.674	4.384	6.727	8.823	0.976	49,072
Turnover	-6.05	-9.267	-5.963	-3.481	1.109	49,020

Panel C: Correlation Matrix

	ETF $\widehat{Ownership}$	Variance Ratio	D1	D2	D3	Autocorrelation	Bias	Size	Volatility	Price	Turnover
ETF $\widehat{Ownership}$	1										
Variance Ratio	0.215	1									
	0.000										
D1	-0.122	-0.061	1								
	0.000	0.000									
D2	-0.137	-0.080	0.934	1							
	0.000	0.000	0.000								
D3	-0.137	-0.080	0.934	0.999	1						
	0.000	0.000	0.000	0.000							
Autocorrelation	-0.016	-0.042	0.104	0.124	0.123	1					
	0.000	0.000	0.000	0.000	0.000						
Bias	0.616	0.255	-0.110	-0.121	-0.121	-0.030	1				
	0.000	0.000	0.000	0.000	0.000	0.000					
Size	0.300	0.325	-0.233	-0.261	-0.261	-0.123	0.308	1			
	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
Volatility	0.023	0.150	0.053	0.045	0.054	-0.046	0.016	-0.079	1		
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
Price	0.171	0.019	-0.067	-0.076	-0.076	-0.072	0.108	0.493	-0.149	1	
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
Turnover	0.227	0.247	-0.064	-0.085	-0.084	-0.111	0.215	0.282	0.502	0.052	1
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	

4.4. The Effect on Price Efficiency

4.4.1. The Baseline Results

Table 4.2 reports the regression results of the baseline model using two proxies of stock price efficiency. Panel A reports the results for variance ratio and return autocorrelation as the proxies for price efficiency, while Panel B reports the results for price delay measures. I report all results using two different samples, a full sample of all firms listed on the First Section of the Tokyo Stock Exchange and a sample containing only firms in the Nikkei 225 index. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Results in Panel A of Table 4.2 reveal that $ETF\ \widehat{Ownership}$ is significantly positively associated with variation of stock prices from a random walk as measured by variance ratio and return autocorrelation. The coefficient of $ETF\ \widehat{Ownership}$ is 1.525 (Panel A Model 1) and 0.435 (Panel A Model 3) respectively. The two coefficients imply that a 1% increase in $ETF\ \widehat{Ownership}$ leads to an approximately 5.24% change in variance ratio relative to its median (0.291) and 4.22% change in return autocorrelation relative to its median (0.103). The results indicate that greater ETF ownership is associated with larger deviations of stock prices from a random walk and hence lower informational efficiency. Panel B shows that $ETF\ \widehat{Ownership}$ is significantly and positively related to price delays, suggesting that ETF ownership results in longer delay of stock prices in responding to market information. All the results are not affected by controlling for Nikkei index weight bias, various other firm characteristics and fixed effects. They are also consistent across the full sample and the Nikkei sample. Taken together, the results in Table 4.2 provide strong evidence supporting a negative impact of ETF ownership on the informational efficiency of stock prices.

It is worth noting that the regression results are inconsistent with the correlation results as shown in Table 4.1 Panel C. However, the significant correlations between $ETF\ \widehat{Ownership}$ and stock efficiency measures do not provide any causal implication because large Nikkei firms, which are the major recipients of BOJ investment, on average have greater stock efficiency. These contradicting results suggest that extra care needs to be taken to rule out potential endogeneity issues when we examine the relation between ETF ownership and stock efficiency at the cross-section.

Table 4.2: The Effect on Price Efficiency

This table reports the results from the baseline panel regression model specified as the following:

$$Efficiency_{i,t} = \beta_0 + \beta_1 ETF\ \widehat{Ownership}_{i,t-1} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} + \beta_4 Volatility_{i,t} + \beta_5 Price_{i,t} + \beta_6 Turnover_{i,t} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t}$$

where i denotes firms and t denotes quarter-years. $Efficiency_{i,t}$ is one of the price efficiency measures. The main explanatory variable $ETF\ \widehat{Ownership}_{i,t-1}$ is the amount of ETF holdings in a firm as a percentage of the total number of shares outstanding held by the BOJ in quarter *t-1*. $Bias_{i,t-1}$ is defined as the relative difference between a firm's Nikkei index weight and its weight in a value-weighted index (calculated as $\frac{Nikkei\ Weight_{i,t}}{Nikkei\ Value\ Weight_{i,t}}$). Panel A reports the results for variance ratio and return autocorrelation as the proxies for price efficiency, while Panel B reports the results for price delay measures. I report all results using two different samples, a full sample of all firms listed on the First Section of the Tokyo Stock Exchange and a sample of firms included in the Nikkei 225 index. The detailed definitions and data sources of all variables are described in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: Deviation of Stock Price from the Random Walk

	Variance Ratio		Autocorrelation	
	(1)	(2)	(3)	(4)
ETF $\widehat{Ownership}$	1.525***	0.750**	0.435***	0.378**
	(6.007)	(2.026)	(4.598)	(2.368)
Bias	0.001	0.001	-0.000	-0.001
	(0.201)	(0.068)	(-0.004)	(-0.274)
Size	0.021	0.005	-0.005	-0.002
	(1.436)	(0.120)	(-0.888)	(-0.141)
Volatility	-0.080	-1.568*	-0.128	-0.343
	(-0.340)	(-1.656)	(-1.530)	(-0.896)
Price	-0.031**	-0.010	0.002	-0.006
	(-2.094)	(-0.244)	(0.404)	(-0.378)
Turnover	-0.002	-0.004	-0.004***	-0.005
	(-0.579)	(-0.266)	(-5.017)	(-1.023)
Observations	48,589	6,102	48,589	6,102
Adj. R^2	0.199	0.343	0.145	0.280
Sample	Full	Nikkei	Full	Nikkei

Panel B: Price Delays

	D1		D2		D3	
	(1)	(2)	(3)	(4)	(5)	(6)
ETF $\widehat{Ownership}$	1.773***	0.848***	1.491***	0.880***	1.497***	0.881***
	(8.677)	(4.747)	(8.428)	(4.565)	(8.470)	(4.565)
Bias	-0.005	0.000	-0.007**	-0.004	-0.007**	-0.004
	(-1.220)	(0.024)	(-1.970)	(-0.733)	(-1.967)	(-0.746)
Size	-0.044***	-0.076***	-0.033***	-0.072***	-0.033***	-0.072***
	(-3.936)	(-3.134)	(-4.249)	(-3.246)	(-4.242)	(-3.239)
Volatility	1.296***	-1.555***	0.736***	-1.888***	0.734***	-1.894***
	(5.170)	(-2.723)	(4.716)	(-3.516)	(4.707)	(-3.524)
Price	0.040***	0.049**	0.031***	0.040*	0.031***	0.040*
	(3.343)	(1.978)	(3.625)	(1.807)	(3.625)	(1.805)
Turnover	-0.002	0.034***	-0.000	0.031***	-0.000	0.031***
	(-0.904)	(3.628)	(-0.287)	(4.013)	(-0.266)	(4.013)
Observations	48,589	6,102	48,589	6,102	48,589	6,102
Adj. R^2	0.415	0.536	0.452	0.529	0.450	0.526
Sample	Full	Nikkei	Full	Nikkei	Full	Nikkei

4.4.2. Ruling out Time-varying Omitted Variables Problem

The empirical specification in Section 4.4.1 ensures that the negative relation between ETF ownership and price efficiency I find is free from fixed firm characteristics that jointly determine both ETF ownership and price efficiency. However, time-varying changes in certain firm characteristics may affect both the efficiency measures and the main explanatory variable. I adopt the same technique used in Chapter 3 Section 3.3 and use a pseudo measure of ETF ownership held by the BOJ in a firm as the main explanatory variable to address this concern. The pseudo measure is estimated based on a firm's index weight in 2010, which is exogenous to changes in firm characteristics in the years after 2010. The definition and the statistical rationale behind the measure are described in more detail in Chapter 3. Specifically, I estimate the following regression model:

$$Efficiency_{i,t} = \beta_0 + \beta_1 Pseudo\ Holdings_{i,t} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t-1} + \beta_4 Volatility_{i,t-1} + \beta_5 Price_{i,t-1} + \beta_6 Turnover_{i,t-1} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t} \quad (4.2)$$

I present the results in Table 4.3. Panel A reports the results for variance ratio and return autocorrelation as the proxies for price efficiency, while Panel B reports the results for price delay measures. I report all results using two different samples, a full sample of all firms listed on the First Section of the Tokyo Stock Exchange and a sample of firms included in the Nikkei 225 index. The coefficients on $Pseudo\ Holdings$ remain positive and significant, which indicate that the negative effect on price efficiency is robust to the concern that the results are driven by time-series changes in firm characteristics.

Table 4.3: Effect on Price Efficiency – Ruling out Time-varying Omitted Variable Issue

The table presents results using the pseudo holdings of BOJ as the main explanatory variable. The regression specification is as follows:

$$Efficiency_{i,t} = \beta_0 + \beta_1 Pseudo\ Holdings_{i,t} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t} + \beta_4 Volatility_{i,t} + \beta_5 Price_{i,t} + \beta_6 Turnover_{i,t} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t}$$

where the pseudo holdings measure is calculated as follows:
$Pseudo\ Holdings_{i,t} = \%\ BOJ\ Holdings\ in\ Nikkei_t \times Bias_{i,2010} + \%\ BOJ\ Holding\ in\ TOPIX_t$.

$Bias_{i,2010}$ is the relative difference between a firm's Nikkei index weight and its weight in a value-weighted index at the first quarter end of 2010, calculated as $\frac{Nikkei\ Weight_{i,2010}}{Nikkei\ Value\ Weight_{i,2010}}$. Panel A reports the results for variance ratio and return autocorrelation as the proxies for price efficiency, while Panel B reports the results for price delay measures. I report all results using two different samples, a full sample of all firms listed on the First Section of the Tokyo Stock Exchange and a sample of firms included in the Nikkei 225 index. The detailed definitions and data sources of all variables are described in the Appendix. The sample period is from 2010 to 2016. t-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: Deviation of Stock Price from the Random Walk

	Variance Ratio		Autocorrelation	
	(1)	(2)	(3)	(4)
Pseudo Holdings	1.093***	0.451***	0.265***	0.151
	(4.489)	(3.065)	(2.998)	(1.533)
Bias	0.007	0.001	0.002	-0.001
	(1.321)	(0.060)	(0.749)	(-0.273)
Size	0.023	0.003	-0.003	-0.003
	(1.519)	(0.074)	(-0.647)	(-0.166)
Volatility	0.002	-1.532	-0.149*	-0.282
	(0.008)	(-1.607)	(-1.686)	(-0.731)
Price	-0.026*	-0.003	0.003	-0.003
	(-1.709)	(-0.075)	(0.560)	(-0.168)
Turnover	-0.003	-0.006	-0.005***	-0.005
	(-0.982)	(-0.447)	(-5.370)	(-0.998)
Observations	43,665	5,948	43,665	5,948
Adj. R^2	0.204	0.342	0.144	0.280
Sample	Full	Nikkei	Full	Nikkei

Panel B: Price Delays

	D1		D2		D3	
	(1)	(2)	(3)	(4)	(5)	(6)
Pseudo Holdings	1.500***	0.184**	1.279***	0.218***	1.285***	0.218***
	(8.249)	(2.471)	(7.883)	(2.585)	(7.939)	(2.593)
Bias	0.003	0.001	-0.000	-0.003	-0.000	-0.003
	(0.701)	(0.131)	(-0.065)	(-0.629)	(-0.061)	(-0.642)
Size	-0.044***	-0.074***	-0.031***	-0.070***	-0.031***	-0.070***
	(-3.893)	(-2.994)	(-3.919)	(-3.093)	(-3.915)	(-3.083)
Volatility	1.415***	-1.564***	0.790***	-1.878***	0.788***	-1.885***
	(5.328)	(-2.671)	(4.840)	(-3.413)	(4.828)	(-3.421)
Price	0.050***	0.055**	0.037***	0.046**	0.037***	0.046**
	(4.106)	(2.131)	(4.225)	(2.024)	(4.232)	(2.018)
Turnover	-0.005**	0.033***	-0.002	0.031***	-0.002	0.031***
	(-2.300)	(3.473)	(-1.516)	(3.887)	(-1.493)	(3.890)
Observations	43,665	5,948	43,665	5,948	43,665	5,948
Adj. R^2	0.409	0.533	0.448	0.528	0.446	0.525
Sample	Full	Nikkei	Full	Nikkei	Full	Nikkei

4.4.3. Controlling for Changes in Macroeconomic Factors

Even though I have included industry-time fixed effects in the model to control for the effect of industry shocks and aggregate macroeconomic factors on price efficiency, the heterogeneous effect on firms of cyclical changes in market conditions may endogenously affect the results. Firms that receive more biased investment from the BOJ through ETFs may be affected more or less by changes in market factors compared to those firms with less biased ETF ownership and these market factors could potentially influence price efficiency at the same time. I address this concern by directly controlling for the interaction of $Bias_{i,t-1}$ with two macroeconomic factors including annual Gross Domestic Product (GDP) growth and inflation. Specifically, I use the following regression model:

$$Efficiency_{i,t} = \beta_0 + \beta_1 Pseudo\ Holdings_{i,t} + \beta_2 Bias_{i,t-1} \times GDP\ Growth_t + \beta_3 Bias_{i,t-1} \times Inflation_t + \beta_4 Bias_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Volatility_{i,t-1} + \beta_7 Price_{i,t-1} + \beta_8 Turnover_{i,t-1} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t} \quad (4.3)$$

where $GDP\ Growth_t$ is the annual percentage change in Gross Domestic Product (GDP). $Inflation_t$ is the annual increase in the general price level in Japan's economy. Data on both variables are from the World Bank.

Table 4.4 presents the estimated coefficients from estimating the above model. Panel A reports the results for measures of price deviation from a random walk, while Panel B reports the results for price delays. I obtain similar results as earlier specifications after adding the interaction of bias and macroeconomic variables, suggesting that the findings are unlikely to be driven by any heterogeneous impacts of market condition changes on sample firms.

Table 4.4: Effect on Price Efficiency – Controlling for Changes in Macroeconomic Factors

This table includes the interaction of bias and macroeconomic variables to control for the heterogeneous impacts of macroeconomic factors on biased firms. I use the following specification:

$$Efficiency_{i,t} = \beta_0 + \beta_1 Pseudo\ Holdings_{i,t} + \beta_2 Bias_{i,t-1} \times\ GDP\ Growth_t + \beta_3 Bias_{i,t-1} \times\ Inflation_t + \beta_4 Bias_{i,t-1} + \beta_5 Size_{i,t} + \beta_6 Volatility_{i,t} + \beta_7 Price_{i,t} + \beta_8 Turnover_{i,t} + Firm\ FEs + Industry\ \times\ Time\ FE + \varepsilon_{i,t}$$

where $GDP\ Growth_t$ is the annual percentage change in Gross Domestic Product (GDP). $Inflation_t$ is the annual increase in the general price level in Japan's economy. Panel A reports the results for variance ratio and return autocorrelation as the proxies for price efficiency, while Panel B reports the results for price delay measures. I report all results using two different samples, a full sample of all firms listed on the First Section of the Tokyo Stock Exchange and a sample of firms included in the Nikkei 225 index. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

Panel A: Deviation of Stock Price from the Random Walk

	Variance Ratio		Autocorrelation	
	(1)	(2)	(3)	(4)
Pseudo Holdings	1.077***	0.425***	0.258***	0.094*
	(4.335)	(2.949)	(2.925)	(1.651)
GDP × Bias	0.001	0.001	0.000*	0.001
	(1.472)	(1.559)	(1.864)	(1.580)
Inflation × Bias	0.002**	0.002*	0.001***	0.000
	(2.224)	(1.919)	(2.764)	(0.639)
Bias	0.008	0.002	0.002	-0.002
	(1.458)	(0.183)	(0.890)	(-0.400)
Size	0.023	-0.001	-0.004	-0.003
	(1.494)	(-0.029)	(-0.682)	(-0.200)
Volatility	-0.030	-1.668*	-0.164*	-0.290
	(-0.122)	(-1.748)	(-1.863)	(-0.749)
Price	-0.026*	-0.000	0.003	-0.002
	(-1.695)	(-0.001)	(0.581)	(-0.139)
Turnover	-0.002	-0.004	-0.005***	-0.005
	(-0.845)	(-0.288)	(-5.136)	(-0.978)
Observations	43,665	5,948	43,665	5,948
Adj. R^2	0.204	0.342	0.144	0.280
Sample	Full	Nikkei	Full	Nikkei

Panel B: Price Delays

	D1		D2		D3	
	(1)	(2)	(3)	(4)	(5)	(6)
Pseudo Holdings	1.408***	0.179**	1.195***	0.212**	1.202***	0.212**
	(7.709)	(2.428)	(7.342)	(2.528)	(7.397)	(2.537)
GDP × Bias	-0.002***	0.000	-0.002***	-0.000	-0.002***	-0.000
	(-4.448)	(0.066)	(-5.445)	(-0.929)	(-5.448)	(-0.935)
Inflation × Bias	-0.000	0.001	-0.000	-0.000	-0.000	-0.000
	(-0.453)	(1.116)	(-0.950)	(-0.037)	(-0.965)	(-0.022)
Bias	0.005	0.002	0.002	-0.002	0.002	-0.002
	(1.281)	(0.352)	(0.589)	(-0.459)	(0.590)	(-0.466)
Size	-0.045***	-0.075***	-0.032***	-0.070***	-0.031***	-0.070***
	(-3.919)	(-3.039)	(-3.957)	(-3.082)	(-3.953)	(-3.073)
Volatility	1.432***	-1.608***	0.808***	-1.885***	0.806***	-1.893***
	(5.384)	(-2.741)	(4.937)	(-3.416)	(4.926)	(-3.425)
Price	0.050***	0.055**	0.036***	0.046**	0.036***	0.046**
	(4.099)	(2.164)	(4.217)	(2.018)	(4.224)	(2.013)
Turnover	-0.005**	0.034***	-0.002	0.031***	-0.002	0.031***
	(-2.285)	(3.520)	(-1.523)	(3.886)	(-1.501)	(3.890)
Observations	43,665	5,948	43,665	5,948	43,665	5,948
Adj. R^2	0.409	0.533	0.449	0.528	0.446	0.525
Sample	Full	Nikkei	Full	Nikkei	Full	Nikkei

4.4.4. Other Robustness Tests

I further show that the results persist by using matched samples and alternative empirical specifications.

First, due to possible imbalance in the sample selection that might contaminate the results, I construct a matched sample and redo the baseline tests using the matched sample. I match each Nikkei firm that has greater than 3% of its shares held by the BOJ through ETFs with a similar control firm with replacement using the propensity score matching procedure including all the control variables in the baseline model. The control firm is required to operate in the same Fama French 48 industry and has the closest propensity scores. Table 4.5 reports the regression results using this matched sample. The results are consistent with a significant and negative relation between ETF ownership and price efficiency.

Second, I employ the first difference model. The dependent variable in the model is changes in either of the five price inefficiency measures over a quarter. The independent variables are changes in $ETF\ \widehat{Ownership}$ over the previous quarter as well as changes in the same set of control variables over the previous quarter. Table 4.6 presents the results. Again, similar results are obtained suggesting that the results are robust to controlling for lagged dependent variables.

Third, the large ETF order flows placed by the BOJ during purchases can impose price pressure on the underlying stocks and cause temporary mispricing. To show that the results are not driven by the direct trading impact of BOJ purchase activities, I calculate the amount of contemporaneous and one-period lagged ETF purchases by the BOJ in a quarter and include them as additional controls in the regression. Table 4.7 reports the results. Consistent with this concern, ETF purchases significantly affect price delays. However, the coefficient estimated for $ETF\ \widehat{Ownership}$ remains positive and significant after controlling for quarterly contemporaneous and lagged ETF purchases.

Lastly, if index inclusion and exclusion events imply changes in price efficiency for reasons other than changes in ETF ownership, the negative relation between ETF ownership and price efficiency could be just a coincidence without implying causality. To eliminate the possibility that these events may contaminate the results, I add two dummy variables indicating Nikkei index additions and deletions in the regression model. Table 4.8 presents the results. Consistent with earlier studies, index inclusion is associated with better price efficiency. $ETF\ \widehat{Ownership}$ remains positively and significantly associated with price inefficiency, suggesting that the results are robust to index inclusion and exclusion effects.

Table 4.5: Robustness Tests – Matched Samples

This table reports the results of the baseline model using matched samples. I match each Nikkei firm that has greater than 3% of its shares held by the BOJ with a similar control firm with replacement using the propensity score matching procedure including all the control variables in the baseline model. The control firm is required to operate in the same Fama French 48 industry and has the closest propensity scores. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	Variance Ratio	Autocorrelation	D1	D2	D3
	(1)	(2)	(3)	(4)	(5)
ETF $\widehat{\text{Ownership}}$	0.885**	0.308*	0.695***	0.569**	0.570**
	(2.430)	(1.872)	(2.760)	(2.475)	(2.476)
Bias	0.010	-0.004	-0.003	-0.000	-0.000
	(0.875)	(-0.731)	(-0.434)	(-0.059)	(-0.052)
Size	0.087	0.001	-0.138**	-0.127***	-0.127***
	(1.191)	(0.032)	(-2.510)	(-2.793)	(-2.794)
Volatility	-1.488	-0.862*	0.263	-0.179	-0.182
	(-1.121)	(-1.672)	(0.304)	(-0.248)	(-0.254)
Price	-0.075	0.008	0.128**	0.113**	0.113**
	(-1.030)	(0.283)	(2.346)	(2.472)	(2.473)
Turnover	0.015	0.000	0.039***	0.029***	0.029***
	(1.009)	(0.059)	(2.834)	(2.790)	(2.800)
Observations	4,701	4,701	4,701	4,701	4,701
Adj. R^2	0.362	0.351	0.626	0.610	0.609

Table 4.6: Robustness Tests – Change Regression

This table reports the results using the first difference model and regresses changes in $\widehat{ETF\ Ownership}$ over a quarter on changes in price efficiency following the model below:

$$\Delta Efficiency_{i,t} = \beta_0 + \beta_1 \Delta BOJ\ Ownership_{i,t-1} + \beta_2 \Delta Bias_{i,t-1} + \beta_3 \Delta Size_{i,t} + \beta_4 \Delta Volatility_{i,t} + \beta_5 \Delta Price_{i,t} + \beta_6 \Delta Turnover_{i,t} + Industry \times Time\ FE + \varepsilon_{i,t}$$

where Δ indicates change in the value of a variable from quarter *t* to *t-1*. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	ΔVariance_Ratio	ΔAutocorrelation	ΔD1	ΔD2	ΔD3
	(1)	(2)	(3)	(4)	(5)
$\Delta \widehat{\text{ETF Ownership}}$	1.138***	0.396***	1.007***	0.629***	0.633***
	(4.077)	(3.513)	(4.044)	(2.996)	(3.028)
ΔBias	0.001	-0.001	-0.010	-0.008*	-0.008*
	(0.199)	(-0.615)	(-1.580)	(-1.753)	(-1.758)
ΔSize	0.057**	-0.003	-0.086***	-0.061***	-0.061***
	(2.074)	(-0.412)	(-4.136)	(-4.186)	(-4.174)
ΔVolatility	0.021	-0.109	0.249	0.003	-0.006
	(0.059)	(-1.195)	(0.433)	(0.008)	(-0.017)
ΔPrice	-0.080**	0.001	0.115***	0.083***	0.083***
	(-2.530)	(0.141)	(5.398)	(5.601)	(5.577)
ΔTurnover	0.005	-0.005***	0.009	0.008**	0.008**
	(1.284)	(-3.551)	(1.478)	(2.016)	(2.057)
Observations	36,442	36,442	36,442	36,442	36,442
Adj. R^2	0.078	0.035	0.225	0.285	0.279

Table 4.7: Robustness Tests – Quarterly ETF Purchase Amount

This table reports the results controlling for contemporaneous amount of ETF purchases by the BOJ and the lagged purchases amount. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	Variance Ratio	Autocorrelation	D1	D2	D3
	(1)	(2)	(3)	(4)	(5)
ETF $\widehat{Ownership}$	1.582***	0.495***	2.078***	1.757***	1.765***
	(5.184)	(3.998)	(8.940)	(9.077)	(9.151)
Purchase	-0.096	-0.637	2.438***	1.581***	1.593***
	(-0.098)	(-1.143)	(2.821)	(3.301)	(3.315)
Lag Purchase	-0.557	-0.180	-4.669***	-3.738***	-3.772***
	(-0.381)	(-0.228)	(-3.603)	(-4.217)	(-4.300)
Bias	0.002	0.000	-0.001	-0.004	-0.004
	(0.272)	(0.086)	(-0.329)	(-1.217)	(-1.214)
Size	0.021	-0.005	-0.045***	-0.033***	-0.033***
	(1.431)	(-0.972)	(-4.006)	(-4.310)	(-4.304)
Volatility	-0.042	-0.120	1.336***	0.749***	0.747***
	(-0.174)	(-1.423)	(5.338)	(4.823)	(4.815)
Price	-0.032**	0.002	0.041***	0.031***	0.031***
	(-2.100)	(0.378)	(3.401)	(3.680)	(3.680)
Turnover	-0.002	-0.004***	-0.002	-0.000	-0.000
	(-0.745)	(-4.922)	(-0.785)	(-0.105)	(-0.082)
Observations	48,214	48,214	48,214	48,214	48,214
Adj. R^2	0.199	0.146	0.415	0.452	0.450

Table 4.8: Robustness Tests – Index Inclusion and Exclusion

This table presents the results including two indicator variables of index inclusion and exclusion as additional control variables. Addition (Deletion) equals one if the firm is added (excluded) from the Nikkei index at the beginning of a quarter, and zero otherwise. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	Variance Ratio	Autocorrelation	D1	D2	D3
	(1)	(5)	(2)	(3)	(4)
ETF $\widehat{Ownership}$	1.535***	0.436***	1.760***	1.485***	1.490***
	(6.039)	(4.587)	(8.651)	(8.475)	(8.519)
Addition	-0.029	0.025	-0.062**	-0.078***	-0.078***
	(-0.572)	(1.378)	(-2.501)	(-3.457)	(-3.456)
Deletion	-0.044	-0.005	0.082*	0.050	0.049
	(-0.986)	(-0.214)	(1.685)	(1.421)	(1.390)
Bias	0.002	-0.000	-0.005	-0.006*	-0.006*
	(0.319)	(-0.168)	(-1.131)	(-1.827)	(-1.824)
Size	0.021	-0.005	-0.044***	-0.033***	-0.033***
	(1.440)	(-0.889)	(-3.940)	(-4.250)	(-4.244)
Volatility	-0.079	-0.129	1.298***	0.738***	0.736***
	(-0.335)	(-1.540)	(5.176)	(4.733)	(4.724)
Price	-0.032**	0.002	0.040***	0.031***	0.031***
	(-2.100)	(0.404)	(3.352)	(3.631)	(3.632)
Turnover	-0.002	-0.004***	-0.002	-0.000	-0.000
	(-0.575)	(-5.018)	(-0.908)	(-0.288)	(-0.267)
Observations	48,589	48,589	48,589	48,589	48,589
Adj. R^2	0.199	0.145	0.415	0.452	0.450

4.5. Post-Earnings Announcement Drift (PEAD)

Another commonly used measure of price efficiency is PEAD analysis. PEAD is a persistent market anomaly that indicates some degree of inefficiency in the capital market. It is based on the notion that stock returns will drift up for a positive surprise and down for a negative surprise after earnings announcements when information contained in an earnings surprise is not fully incorporated into prices (Ball and Brown 1968, Bernard and Thomas 1989). If ETF ownership reduces price efficiency, the PEAD of firms that experience greater increase in ETF ownership due to BOJ purchases should be larger in magnitude. To test this hypothesis, I employ the following regression specification:

$$CAR_{i,t} = \beta_0 + \beta_1 Surprise_{i,t} + \beta_2 ETF\ \widehat{Ownership}_{i,t-1} + \beta_3 Surprise_{i,t} \times ETF\ \widehat{Ownership}_{t-1} + \beta_4 Bias_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Volatility_{i,t-1} + \beta_7 Price_{i,t-1} + \beta_8 Turnover_{i,t-1} + \beta_9 Beta_{i,t-1} + Industry \times Time\ FE + \varepsilon_{i,t} \tag{4.4}$$

where $CAR_{i,t}$ is the cumulative abnormal return in window (2, 6) or window (2, 10) following an earnings announcement. $Surprise_{i,t}$ is the proxy for earnings surprise. $Beta_{i,t-1}$ is the market model beta of stock *i* estimated from regressing daily stock returns on daily value-weighted market index returns during the last quarter before the earnings announcement. I include beta to account for the potential impact of systemic risk on post-earnings stock returns.

Specifically, the cumulative abnormal return following earnings announcement is calculated as $\prod(1 + r_{i,s}) - \prod(1 + r_{p,s})$, where $r_{i,s}$ is the return of stock *i* on day *s* after earnings announcement, and $r_{p,s}$ is the value-weighted return of a portfolio containing stocks within the same market value decile as stock *i*. To measure earnings surprise, I use the scale decile ranking of the cumulative abnormal return from two days before the announcement date to one day after, i.e. CAR (-2, 1), following Frazzini (2006) and Qin and Singal (2015). To check whether stock returns of Japanese firms exhibit PEAD during the sample period of 2010 to 2016, I regress only earnings surprise and control variables on post-earnings abnormal returns and present the results in Table 4.9 Panel A. The coefficients of earnings surprise are positive and significant over all drift windows and for different samples, indicating that investors under-react to earnings news, leading post-earnings announcement returns to drift in the same direction as earnings news.

When $ETF\ \widehat{Ownership}$ and the interaction of $ETF\ \widehat{Ownership}$ and earnings surprise are included in the regression (results shown in Table 4.9 Panel B), I find that the effect of ETF ownership on PEAD is positive and significant. As the existence of PEAD generally indicates some degree of informational inefficiency of prices, the positive impact of $ETF\ \widehat{Ownership}$ on PEAD is consistent with the previous finding that ETF investment by the BOJ reduces stock price efficiency.

As a robustness measure, I also follow Ayers, Li and Yeung (2011) and measure earnings surprise as the difference in earnings between current quarter and the same quarter last year scaled by the stock price at the end of the previous quarter. Another commonly used proxy for earnings surprise is the difference between analyst forecast and actual earnings. However, the data for quarterly earnings forecast in Japan are very limited and using the data will result in large loss of sample firms. Moreover, as suggested in Frazzini (2006), abnormal returns around the earnings announcement date reflect actual market reaction and are free from assumptions underlying analyst forecasts. I obtain a similar result using this alternative measure of earnings surprise as shown in Table 4.9 Panel C.

Table 4.9: Post-Earnings Announcement Drift (PEAD)

This table reports the results of the PEAD analysis following the model below:

$$CAR_{i,t} = \beta_0 + \beta_1 Surprise_{i,t} + \beta_2 ETF\ \widehat{Ownership}_{i,t-1} + \beta_3 Surprise_{i,t} \times BOJ\ Ownership_{t-1} + \beta_4 Bias_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Volatility_{i,t-1} + \beta_7 Price_{i,t-1} + \beta_8 Turnover_{i,t-1} + \beta_9 Beta_{i,t-1} + Industry \times Time\ FE + \varepsilon_{i,t}$$

where $CAR_{i,t}$ is the cumulative abnormal return in window (2, 6) or window (2, 10) following earnings announcement. $Surprise_{i,t}$ is the earnings surprise measured using the scale decile ranking of the cumulative abnormal return from two days before the announcement date to one day after, i.e. CAR (-2, 1). $Beta_{i,t-1}$ is the market model beta of stock *i*. Panel A reports the results using only earnings surprise and control variables as dependent variables. Panel B reports the main results of the regression model. Panel C reports the results using an alternative measure of earnings surprise, the scale decile ranking of the difference in earnings between current quarter and the same quarter last year scaled by the stock price at the end of the previous quarter. The detailed definitions and data sources of all variables are described in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by industry and quarter.

Panel A: PEAD

	CAR (2, 6)		CAR (2, 10)	
	(1)	(2)	(3)	(4)
Surprise	0.028***	0.031*	0.045***	0.039**
	(4.542)	(1.814)	(6.200)	(2.105)
Bias	0.013	0.038*	0.027	0.053**
	(0.937)	(1.769)	(1.619)	(2.135)
Size	0.009	-0.045	0.010	-0.043
	(0.539)	(-0.682)	(0.504)	(-0.548)
Volatility	-6.979***	-48.214***	-1.811	-52.224***
	(-2.656)	(-4.607)	(-0.592)	(-4.245)
Price	0.129***	0.019	0.175***	0.072
	(5.818)	(0.269)	(6.783)	(0.881)
Turnover	0.012	0.390***	0.015	0.461***
	(0.564)	(3.448)	(0.578)	(3.461)
Beta	-9.805	10.256	-27.125**	10.146
	(-0.987)	(0.356)	(-2.348)	(0.300)
Observations	47,128	6,147	47,132	6,147
Adj. R^2	0.006	0.022	0.007	0.030
Sample	Full	Nikkei	Full	Nikkei

Panel B: The Effect of ETF $\widehat{Ownership}$ on PEADs

	CAR (2, 6)		CAR (2, 10)	
	(1)	(2)	(3)	(4)
Surprise	0.020***	0.025	0.035***	0.037**
	(2.864)	(1.576)	(4.211)	(2.045)
ETF $\widehat{Ownership}$	-0.999	4.264	-0.180	10.007
	(-0.198)	(0.678)	(-0.031)	(1.354)
ETF $\widehat{Ownership}$ × Surprise	1.750**	1.615	2.225**	1.827*
	(2.281)	(1.612)	(2.491)	(1.807)
Bias	-0.008	0.013	-0.004	0.008
	(-0.434)	(0.537)	(-0.187)	(0.267)
Size	0.006	-0.033	0.006	-0.020
	(0.386)	(-0.493)	(0.318)	(-0.256)
Volatility	-7.006***	-47.112***	-1.844	-50.144***
	(-2.667)	(-4.495)	(-0.603)	(-4.072)
Price	0.130***	0.006	0.176***	0.048
	(5.858)	(0.080)	(6.833)	(0.590)
Turnover	0.013	0.387***	0.015	0.455***
	(0.581)	(3.421)	(0.596)	(3.419)
Beta	-10.763	6.217	-28.459**	2.825
	(-1.083)	(0.216)	(-2.461)	(0.083)
Observations	47,128	6,147	47,132	6,147
Adj. R^2	0.006	0.023	0.007	0.032
Sample	Full	Nikkei	Full	Nikkei

Panel C: Alternative Measure of Earnings Surprise

	CAR (2, 6)		CAR (2, 10)	
	(1)	(2)	(3)	(4)
Surprise	0.054***	0.032	0.064***	0.037**
	(7.515)	(1.589)	(7.626)	(2.045)
ETF $\widehat{Ownership}$	-0.589	5.267	2.367	10.758
	(-0.109)	(0.790)	(0.377)	(1.371)
ETF $\widehat{Ownership}$ × Surprise	1.561*	1.403*	1.628	1.571*
	(1.831)	(1.851)	(1.639)	(1.906)
Bias	-0.007	0.015	-0.003	0.008
	(-0.353)	(0.579)	(-0.141)	(0.280)
Size	0.008	-0.030	0.010	-0.019
	(0.467)	(-0.458)	(0.540)	(-0.248)
Volatility	-7.192***	-43.165***	-1.847	-46.372***
	(-2.728)	(-4.094)	(-0.602)	(-3.738)
Price	0.134***	0.014	0.182***	0.058
	(6.064)	(0.205)	(7.075)	(0.702)
Turnover	0.004	0.352***	0.003	0.414***
	(0.197)	(3.098)	(0.117)	(3.095)
Beta	-13.466	6.701	-32.125***	6.829
	(-1.349)	(0.231)	(-2.765)	(0.200)
Observations	46,935	6,107	46,939	6,107
Adj. R^2	0.020	0.020	0.020	0.020
Sample	Full	Nikkei	Full	Nikkei

4.6. Channels through which ETF Ownership Affects Price Efficiency

This section discusses possible channels through which ETF ownership adversely affects price efficiency. First, an "excessive" fraction of passive shareholders can "lock up" a large proportion of a firm's outstanding shares and hence reduce the proportion of investors with the incentive to acquire information and result in less information production. Boehmer and Kelley (2009) show that greater institutional ownership facilitates more efficient stock prices. Moreover, to the extent that institutional investors are informed traders, competition among institutions should lead to quicker adjustment toward full information values and reduce the importance of trading (Holden and Subrahmanyam 1992). Passive block ownership could also proportionately reduce the number of individual investors trading a stock and consequently reduce the profit of information arbitrage against uninformed investors. Therefore, large ETF ownership can lead to lower price efficiency through reducing the number of institutional investors and individual investors trading a stock. From the results shown in Table 3.12, BOJ investment significantly reduces the number of institutional investors and individual investors. For robustness, I replicate the tests using the sample in this study and find very similar results. The coefficients of $ETF\ \widehat{Ownership}$ imply that a 1% increase in ETF ownership reduces the number of institutional shareholders by approximately 0.8%, institutional ownership by 0.4%, and the total number of shareholders by 0.9%. For brevity, the table is not reported.

Second, as shown in Chapter 3, the presence of passive investors reduces stock liquidity. As stock liquidity generally reflects the transaction costs of trade, ETF ownership can increase the cost of informed arbitrage which reduces the incentive of price discovery by active investors. To test the liquidity channel, I augment the baseline regression model by including a stock liquidity measure as an additional independent variable. Table 4.10 reports the regression results. Effective spread, which is a widely used measure of stock illiquidity, is significantly and positively related to price inefficiency, supporting my conjecture that greater transaction costs lead to lower efficiency of stock prices. In addition, controlling for stock liquidity largely reduces the magnitude of the coefficients of $ETF\ \widehat{Ownership}$ in all models compared to the baseline regression results. This suggests that part of the negative impact of ETF ownership on price efficiency is explained by stock liquidity.

Table 4.10: The Liquidity Channel

This table presents the results for including stock liquidity measured by effective spread as an additional independent variable. The definitions and data sources of all variables are described in detail in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by firm and quarter.

	Variance Ratio	Autocorrelation	D1	D2	D3
	(1)	(2)	(3)	(4)	(5)
ETF $\widehat{Ownership}$	0.241***	0.432***	1.383***	1.124***	1.128***
	(4.017)	(4.567)	(7.178)	(6.413)	(6.436)
Effective Spread	1.854***	1.333***	8.392***	5.650***	5.658***
	(10.168)	(3.565)	(9.112)	(8.553)	(8.573)
Bias	0.004***	-0.000	-0.003	-0.002	-0.002
	(4.828)	(-0.003)	(-0.743)	(-0.648)	(-0.644)
Size	0.003	-0.003	-0.034***	-0.027***	-0.027***
	(1.326)	(-0.556)	(-3.075)	(-3.415)	(-3.415)
Volatility	0.217***	-0.257***	0.518**	0.352**	0.348**
	(5.087)	(-2.839)	(2.045)	(2.095)	(2.074)
Price	0.002	0.002	0.039***	0.030***	0.030***
	(0.716)	(0.375)	(3.316)	(3.495)	(3.499)
Turnover	0.003***	-0.002**	0.010***	0.006***	0.006***
	(5.641)	(-2.500)	(3.788)	(3.525)	(3.534)
Observations	43,614	48,587	48,587	48,587	48,587
Adj. R^2	0.389	0.084	0.365	0.403	0.401

4.7. Analyst Coverage

It is widely believed that analyst coverage is a source of information production and improves the information environment of a firm. Financial analysts expend resources to acquire and process firm-specific information and issue forecasts and recommendations that improve the transmission of information into prices. Hong, Lim and Stein (2000) show that analyst coverage facilitates the flow of firm-specific information to the investing public. However, the incentive of analysts to follow a firm can be affected by the number of investors seeking information and willing to pay for the service. Due to the nature of their investment strategy, ETFs do not trade based on firm-specific information, hence do not require analyst following. I would expect to find a reduction in analyst coverage in firms with greater ETF ownership. To test this hypothesis, I test the following regression specification:

$$Analyst_{i,t} = \beta_0 + \beta_1 ETF\ \widehat{Ownership}_{i,t-1} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t-1} + \beta_4 Volatility_{i,t-1} + \beta_5 Price_{i,t-1} + \beta_6 Turnover_{i,t-1} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t} \tag{4.5}$$

where *i* denotes firms and *t* denotes quarter-years. $Analyst_{i,t}$ is the log of the number of unique analysts covering firm *i* during a quarter obtained from the I/B/E/S database.

Table 4.11 reports the results of the above regression model. I assume firms that do not have analyst coverage information in the I/B/E/S database are not followed by any analysts, hence the number of analysts following these firms is set to zero. As shown in Panel A of Table 4.11, consistent with my conjecture, $ETF\ \widehat{Ownership}$ is negatively associated with the number of analysts following and this relation is statistically significant across different specifications and samples. In terms of economic impact, the coefficient of $ETF\ \widehat{Ownership}$ in Model 3, for example, is -2.051, which reflects a roughly 1% reduction in the number of analysts following a firm for a 1% increase in ETF ownership. The I/B/E/S database may not have complete coverage of all analysts in Japan. If this is the case, then setting firms with missing analyst coverage data as zero would be inappropriate. To address this concern, I robust test the measure of analyst coverage by excluding all observations with missing analyst following data. Panel B of Table 4.11 shows the results, which remain unchanged after this adjustment.

Table 4.11: Analyst Coverage

This table reports the results of regressing ETF $\widehat{Ownership}$ on analyst coverage following the model below:

$$Analyst_{i,t} = \beta_0 + \beta_1 ETF\ \widehat{Ownership}_{i,t-1} + \beta_2 Bias_{i,t-1} + \beta_3 Size_{i,t-1} + \beta_4 Volatility_{i,t-1} + \beta_5 Price_{i,t-1} + \beta_6 Turnover_{i,t-1} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t}$$

where *i* denotes firms and *t* denotes quarter-years. $Analyst_{i,t}$ is the number of unique analysts covering firm *i* during a quarter obtained from the I/B/E/S database. The detailed definitions and data sources of all variables are described in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by industry and quarter.

Panel A: Set Missing Data on Analyst Following as Zero

	Analyst (Log)			
	(1)	(2)	(3)	(4)
ETF $\widehat{Ownership}$	-3.096***	-1.905*	-2.051***	-2.481***
	(-6.590)	(-1.910)	(-4.655)	(-2.589)
Bias			-0.056***	-0.073**
			(-5.049)	(-2.006)
Size			0.306***	0.456***
			(10.719)	(3.999)
Volatility			-2.665***	-1.999
			(-8.766)	(-1.395)
Price			0.030	-0.135
			(1.058)	(-1.212)
Turnover			0.035***	0.023
			(10.619)	(1.115)
Observations	48,640	6,102	48,590	6,102
Adj. R^2	0.913	0.843	0.920	0.851
Sample	Full	Nikkei	Full	Nikkei

Panel B: Exclude Observations with Missing Data on Analyst Following

	Analyst (Log)			
	(1)	(2)	(3)	(4)
ETF $\widehat{Ownership}$	-1.077***	-0.818**	-0.054	-1.227***
	(-4.271)	(-2.076)	(-0.230)	(-3.065)
Bias			-0.029***	-0.029***
			(-6.657)	(-3.036)
Size			0.267***	0.380***
			(10.441)	(8.221)
Volatility			-1.940***	-1.569*
			(-5.416)	(-1.926)
Price			0.032	-0.121**
			(1.238)	(-2.529)
Turnover			0.022***	0.032***
			(6.393)	(2.662)
Observations	20,278	5,723	20,266	5,723
Adj. R^2	0.925	0.920	0.925	0.920
Sample	Full	Nikkei	Full	Nikkei

4.8. Coefficient of Current Returns on Future Earnings

In this section, I further examine whether ETF ownership held by the BOJ affects the informativeness of stock prices. If ETF ownership reduces information arbitrage activity, stock prices can reflect less information about future earnings. To test the returns-earnings relation, I estimate the following regression:

$$Return_{i,t} = \beta_0 + \beta_1 Earnings_{i,t-1} + \beta_2 Earnings_{i,t} + \beta_3 Earnings_{i,t+1} + \beta_4 Return_{i,t+1} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t} \quad (4.6)$$

where $Return_{i,t}$ denotes the annual buy-and-hold return of firm *i* for year *t* over the 12 months ending three months after the end of fiscal year *t*. $Earnings_{i,t}$ represents the annual earnings of firm *i* for fiscal year *t*, calculated as earnings before extraordinary items scaled by the market value of equity three months after the end of the previous fiscal year. I control for previous, current and future firm earnings to account for unexpected earnings news during these years. The coefficient of $Earnings_{i,t+1}$, β_3, refers to the coefficient of current returns on future earnings as in Lundholm and Myers (2002). It captures how informative the current stock returns are with respect to future earnings.

Models 1 and 2 of Table 4.12 report the results for the current return to future earnings relation. Consistent with previous literature, both $Earnings_{i,t}$ and $Earnings_{i,t+1}$have a significant and positive relation with current returns, suggesting that the current return does incorporate current and future earnings information. I control for $Return_{i,t+1}$ to exclude the effect of future earnings shock and the estimated coefficient reflects a predicted negative relation between future returns and current returns.

To test whether ETF ownership affects the degree to which current stock returns incorporate firm future earnings, I augment the above regression model by including an interaction term of $ETF\ \widehat{Ownership}$ and future earnings following Fang, Huang and Karpoff (2014) and Israeli, Lee and Sridharan (2017):

$$Return_{i,t} = \beta_0 + \beta_1 Earnings_{i,t-1} + \beta_2 Earnings_{i,t} + \beta_3 Earnings_{i,t+1} + \beta_4 Return_{i,t+1} + \beta_5 BETF\ \widehat{Ownership}_{i,t-1} + \boldsymbol{\beta_6 ETF\ \widehat{Ownership}_{i,t-1}} \times \boldsymbol{Earnings_{i,t+1}} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t} \tag{4.7}$$

β_6, the coefficient on the interaction of $ETF\ \widehat{Ownership}$ with future earnings, captures the effect of ETF ownership on the coefficient of current returns on future earnings.

The results are shown in Models 3 and 4 of Table 4.12. The interaction of future earnings with $ETF\ \widehat{Ownership}$ has a coefficient of -4.612 for the full sample and -7.289 for the Nikkei sample. A 1% increase in ETF ownership results in about a 12% and 9% reduction in the magnitude of the current return on future earnings coefficient based on the full sample and the Nikkei sample respectively. This suggests that firms with higher increase in ETF ownership due to BOJ purchases experience a weaker current return to future earnings relation. In other words, the stock returns of firms that experience a larger increase in ETF ownership reflect less information about future firm earnings.

I then decompose total earnings into "macroeconomic" and "firm-specific" components following Israeli, Lee and Sridharan (2017) to test whether ETF ownership has a differential effect on the informativeness of stock prices with respect to systematic earnings news and firm idiosyncratic earnings news. Macro-based information can be incorporated into prices through fund flows. However, for stock prices to reflect firm-specific information, it must involve trading with the specific stocks. Therefore, I would expect to see a weaker effect of ETF ownership on the extent to which stock returns incorporate systematic information and a stronger effect for firm-specific information. To decompose total firm earnings, I estimate the following regression:

$$Earnings_{i,t+1} = \beta_0 + \beta_1 Earnings_{Market_{i,t+1}} + \beta_2 Earnings_{Industry_{i,t+1}} + \varepsilon_{i,t+1}$$

(4.8)

where $Earnings_{Market_{i,t+1}}$ is the market-value weighted average earnings before extraordinary items of all firms in year *t*. $Earnings_{Industry_{i,t+1}}$ is the market-value weighted average earnings before extraordinary items of all firms within the same Fama-French 48 industry classification.

For each firm-year, “macro” or systematic component of earnings, $Earnings_{Macro_{i,t}}$, is the fitted value from the annual estimation of the above regression. Firm-specific or idiosyncratic component of earnings, $Earnings_{Firm_{i,t}}$, is the residual value from the annual regression. I then estimate the following model with the two earnings components:

$$\begin{aligned} Return_{i,t} &= \beta_0 + \beta_1 Earnings_{i,t-1} + \beta_2 Earnings_{i,t} + \beta_3 Earnings_{Macro_{i,t+1}} + \\ &\beta_3 Earnings_{Firm_{i,t+1}} + \beta_4 Return_{i,t+1} + \beta_5 ETF\ \widehat{Ownership}_{i,t-1} + \\ &\boldsymbol{\beta_6 ETF\ \widehat{Ownership}_{i,t-1}} \times \boldsymbol{Earnings_{Macro_{i,t+1}}} + \boldsymbol{\beta_6 ETF\ \widehat{Ownership}_{i,t-1}} \times \\ &\boldsymbol{Earnings_{Firm_{i,t+1}}} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t} \end{aligned} \qquad (4.9)$$

Table 4.12 Panel B presents the regression results of the above model specification using the full sample and the Nikkei sample. Looking at the interaction of $ETF\ \widehat{Ownership}$ with “macro” and “firm-specific” earnings component, I can see that the estimated coefficients are all negative, but only statistically significant for the interaction of $ETF\ \widehat{Ownership}$ with "firm-specific" earnings component. This suggests that the negative effect of ETF ownership on the coefficient of current return on future earnings primarily comes from its impact on how stock returns incorporate firm-specific earnings information, which is consistent with my conjecture.

Table 4.12: Coefficient of Current Returns on Future Earnings

This table reports the results for the analyses of the annual current returns–future earnings relation. Panel A tests the effect of ETF $\widehat{Ownership}$ on the returns–earning relation following the model:

$$Return_{i,t} = \beta_0 + \beta_1 Earnings_{i,t-1} + \beta_2 Earnings_{i,t} + \beta_3 Earnings_{i,t+1} + \beta_4 Return_{i,t+1} + Firm\ FEs + Industry \times Time\ FE + \varepsilon_{i,t}$$

where $Return_{i,t}$ denotes the annual buy-and-hold return of firm *i* for year *t* over the 12 months ending three months after the end of fiscal year *t*. $Earnings_{i,t}$ represents the annual earnings of firm *i* for fiscal year *t*.

Panel B reports the results of decomposing earnings into "macro" and firm-specific components using the following model:

$$\begin{aligned} Return_{i,t} = {} & \beta_0 + \beta_1 Earnings_{i,t-1} + \beta_2 Earnings_{i,t} + \beta_3 Earnings_{Macro_{i,t+1}} + \beta_3 Earnings_{Firm_{i,t+1}} \\ & + \beta_4 Return_{i,t+1} + \beta_5 BOJ\ Ownereship_{i,t-1} \\ & + \boldsymbol{\beta_6 ETF\ \widehat{Ownership}_{i,t-1}} \times \boldsymbol{Earnings_{Macro_{i,t+1}}} \\ & + \boldsymbol{\beta_6 ETF\ \widehat{Ownership}_{i,t-1}} \times \boldsymbol{Earnings_{Firm_{i,t+1}}} + Firm\ FEs \\ & + Industry \times Time\ FE + \varepsilon_{i,t} \end{aligned}$$

where $Earnings_{Macro_{i,t}}$, is the "macro" or systematic component of earnings estimated using the fitted value from the annual estimation of a regression of market earnings. $Earnings_{Firm_{i,t}}$, is the firm-specific or idiosyncratic component of earnings estimated using the residual value from the same annual regression.

The detailed definitions and data sources of all variables are described in the Appendix. The sample period is from 2010 to 2016. *t*-statistics are reported in the parentheses below coefficient estimates. *** (**) (*) indicates significance at the 1% (5%) (10%) two tailed level. Standard errors are adjusted for heteroskedasticity and double clustered by industry and quarter.

Panel A: Total Earnings

	Return			
	(1)	(2)	(3)	(4)
$Earnings_{t-1}$	-0.069	-0.354***	-0.070	-0.161**
	(-1.256)	(-5.306)	(-1.296)	(-2.461)
$Earnings_{t}$	0.296***	0.427**	0.301***	0.433**
	(3.525)	(2.707)	(3.596)	(2.187)
$Earnings_{t+1}$	0.312***	0.517***	0.384***	0.787***
	(3.098)	(3.833)	(3.160)	(6.143)
$Return_{t+1}$	-0.014***	-0.010**	-0.014***	-0.017***
	(-4.709)	(-2.205)	(-4.745)	(-4.026)
ETF $\widehat{Ownership}_{t-1}$			-0.845	0.888
			(-1.354)	(0.966)
ETF $\widehat{Ownership}_{t-1} \times Earnings_{t+1}$			-4.612***	-7.289***
			(-3.296)	(-3.637)
Observations	11,535	1,462	11,519	1,462
Adj. R^2	0.447	0.686	0.447	0.737
Sample	Full	Nikkei	Full	Nikkei

Panel B: Earnings Components

	Return	
	(1)	(2)
$Earnings_{t-1}$	-0.089	-0.414***
	(-1.352)	(-5.458)
$Earnings_{t}$	0.258***	0.309**
	(3.177)	(2.256)
$Earnings\_Macro_{t+1}$	0.394***	0.921***
	(3.187)	(2.959)
$Earnings\_Firm_{t+1}$	0.560***	1.300***
	(2.851)	(2.973)
$Return_{t+1}$	-0.193***	-0.269***
	(-7.323)	(-8.844)
$ETF\ \widehat{Ownership}$	-2.586	-1.195
	(-1.580)	(-0.577)
$ETF\ \widehat{Ownership}_{t-1} \times Earnings\_Macro_{t+1}$	-3.387	-0.353
	(-0.341)	(-0.025)
$ETF\ \widehat{Ownership}_{t-1} \times Earnings\_Firm_{t+1}$	-6.006***	-3.877**
	(-3.469)	(-2.364)
Observations	9,601	1,265
Adj. R^2	0.452	0.707
Sample	Full	Nikkei

4.9. Conclusion

In this study, I investigate how stock price efficiency is affected by an exogenous increase in ETF ownership by exploiting the large-scale asset purchase program adopted by the Japanese central bank, Bank of Japan, during 2010 to 2016 as the basis of my empirical strategy to address potential endogeneity problems. I find a heterogeneous effect of ETF ownership on price efficiency due to the biased capital allocation based on the Nikkei index weight. Prices of stocks that experience a larger increase in ETF ownership due to BOJ purchases become less efficient in that they deviate more from a random walk and exhibit longer delays in responding to information compared to similar firms with less increase in ETF ownership.

The empirical specifications allow me to rule out endogeneity concerns relating to heterogeneity in firm characteristics and firm-specific information and time-varying heterogeneity across firms from contaminating the results. The adverse effect of ETF ownership on price efficiency I find is robust to a battery of robustness tests and is proven to be persuasive.

To explain the adverse effect of ETF ownership on price efficiency, I find that excessive ETF ownership adversely affects price efficiency through reducing the fraction of institutional investors, who are generally considered as active investors. I also argue that ETF ownership crowds out individual investors trading a firm. ETF ownership also affects price efficiency through its adverse impact on stock liquidity. Stock illiquidity implies higher trading costs and a subsequent reduction in information arbitrage activities. I directly show that stock illiquidity reduces price efficiency.

Additional tests in this study also find an adverse impact of ETF ownership on the informativeness of stock prices. The analyses on firm-specific information production reveal that firms with higher ETF ownership experience a significant reduction in analyst following. The stock returns of these firms also incorporate less information about future earnings.

Appendix: Variable Definitions

VARIABLE NAME	DEFINITION	DATA SOURCE
Price Efficiency Measure		
Variance Ratio	The absolute value of one minus the variance of 5-day returns divided by the variance of five times 1-day returns.	Datastream
Autocorrelation	The absolute value of first-order daily return autocorrelation estimated for each stock over each quarter by regressing daily returns on one-day lagged returns.	Datastream
D1	Compares the value of R^2 from the regression above with that of the second regression when the coefficient on lagged market returns is restricted to zero and is calculated as $D1_i = 1 - \frac{R^2_{i,Restricted\ model}}{R^2_{i,unRestricted\ model}}$ where R^2 is from the following model: $R_{i,t} = a_i + b_i R_{m,t} + \sum_{n=1}^{4} c_i^n R_{m,t-n} + \varepsilon_{i,t}$ and another regression that restricts the coefficients on lagged market returns to zero.	Datastream
D2	Captures the magnitude of the lagged coefficients relative to the magnitude of all market-return coefficients, $D2_i = \frac{\sum_{n=1}^{4} \lvert c_i^n \rvert}{\lvert b_i \rvert + \sum_{n=1}^{4} \lvert c_i^n \rvert}$ where the coefficient estimates are obtained from the above model.	Datastream
D3	Adjust D2 with the standard errors of the coefficient estimates and is estimated as $D3_i = \frac{\sum_{n=1}^{4} \frac{\lvert c_i^n \rvert}{se_{c_i^n}}}{\frac{\lvert b_i \rvert}{se_{b_i}} + \sum_{n=1}^{4} \frac{\lvert c_i^n \rvert}{se_{c_i^n}}}$, where se_* is the standard error of each of the corresponding coefficient estimates.	Datastream
Firm Characteristics		
Bias	The relative difference between a firm's Nikkei index weight and its weight in a value-weighted index (calculated as $\frac{Nikkei\ Weight_{i,t}}{Nikkei\ Value\ Weight_{i,t}}$), which captures the level of bias in BOJ investment due to the Nikkei weighting system relative to the common value-weighting system.	Bloomberg
Size	Log of market value of equity	Worldscope
Volatility	Standard deviation of stock returns over previous quarter	Datastream
Turnover	Log of the average of daily stock turnover over a quarter calculated as the ratio of the number of shares traded to the number of shares outstanding	Datastream

Price	Log of stock price at the beginning of the quarter	Datastream
Addition	A dummy variable that equals one if the firm is added into the Nikkei index at the beginning of a quarter, and zero otherwise.	Bloomberg
Deletion	A dummy variable that equals one if the firm is excluded from the Nikkei index at the beginning of a quarter, and zero otherwise.	Bloomberg
Effective Spread	Average of daily effective spread over a quarter. The effective spread for a trade is defined as $Effective\ Spread = 2 \times Sign \times \frac{Price - \frac{Ask+Bid}{2}}{\text{Price}}$ where Sign is a trade direction indicator identified following Lee and Ready (1991).	TRTH
Earnings	The annual earnings calculated as earnings before extraordinary items scaled by the market value of equity three months after the end of the previous fiscal year.	Datastream
Analyst Coverage	The number of unique analysts covering a firm during a quarter	I/B/E/S

Chapter 5: Conclusion

This thesis presents three empirical studies that explore the impact of unconventional monetary policy on the economy as well as issues relating to market frictions in financial markets.

Chapter 2 evaluates the recent large-scale ETF purchase program by the Bank of Japan and its impact on stock prices and corporate activities. The empirical results show that the policy has generated heterogeneous effects on stock prices. Firms that are subject to disproportionately higher Bank of Japan investment experience significantly positive stock returns both in the short term around the announcements of major policy expansions and in the long term up to at least one year after the announcement. The cost of equity capital proxied by several implied cost of equity measures reduces significantly corresponding to the positive price impact.

However, I fail to find evidence of any real impact on Japanese firms. Firms that benefit from a reduction in cost of equity capital do not increase external financing, corporate investment or employment. The limited policy impact can be attributed to the concentrated capital structure in Japan, the biased investment scheme adopted by the Bank of Japan and the weak influence on business confidence. The results suggest that the policy effect might not have been neutral across different firms due to the biased investment schedule away from the value-weighted market portfolio and call for careful implementation of asset purchases policies by financial authorities.

Chapter 3 examines whether and how excess reduction in free float affects stock liquidity. The Bank of Japan's intervention in Japan's equity market provides a natural experiment that enables me to tackle endogeneity problems in previous studies. The results show that firms that experience a larger reduction in free float due to the central bank's larger-scale purchases exhibit a reduction in stock liquidity and stock market trading activity. The negative effect of free float reduction on stock liquidity survives a battery of robustness tests and is proven to be persuasive. Further analyses of the underlying channels show that ownership held by the Bank of Japan significantly reduces the number of common shareholders and institutional shareholders of a firm. These results confirm my conjecture that the purchase program absorbs the holdings of existing retail and institutional investors and are consistent with both "the real friction" and the informational friction effect of free float on the process of liquidity provision.

Chapter 4 investigates the effect of index ETF ownership on price efficiency of the underlying stocks. Using the large-scale ETF purchase program of the Bank of Japan as my identification strategy, the tests show that the prices of stocks that experience an increase in ETF ownership driven by the central bank's investment become less efficient in that they deviate more from a random walk and exhibit longer delays in responding to information. The empirical specifications I adopt can rule out endogeneity concerns relating to heterogeneity in firm characteristics and time-varying heterogeneity across firms. Additional tests also find that firms with higher ETF ownership experience a significant reduction in analyst coverage and less incorporation of information about future earnings in stock returns. These results together suggest that ETF ownership exerts a negative externality by making it more difficult for stock prices to reflect information efficiently. Given the rapid growth of ETF investment in the future, it is reasonable to be cautious about its negative influence on market efficiency.

The three studies in this thesis provide distinct contributions to the literature. Chapter 2 specifically expand our knowledge on the impact of unconventional monetary policy adopted by the BOJ on Japan's financial market and firms. Unconventional monetary policy has been under spotlight after the GFC and been conducted by several central banks around the world. It is important for us to understand how these monetary policies can help central banks stabilize their economies in the era of low interest rates. I found that the inappropriate capital allocation of BOJ’s monetary easing policy contributes to the ineffectiveness of the policy in Japan. Findings presented in this chapter offer important implications on the unconventional monetary policy in uncharted territory. The results also provide evidence of a long-term downward-sloping demand curves.

The BOJ’s asset purchase program also provides a good empirical identification for us to tackle endogeneity issues in studies on market frictions in financial markets. Chapter 3 contributes to our understanding about the effect of free-floating shares on stock liquidity. The BOJ’s asset purchase program exogenously increases the fraction of free-floating shares in Japanese firms. The changes in free floating shares are free from general changes in market condition as well as internal corporate structural changes. The findings in this chapter show that strategic block shareholders can lift trading costs without trading their private information.

Chapter 4 takes a distinct perspective and uses the event as a natural experiment to examine the effect of ETF ownership on the informational efficiency of stock prices. The BOJ’s aggressive purchase schedule has significantly increased the level of index ETF ownership in affected firms and the increase is exogenous to firm-specific characteristics. Together with the special weighting system of the Nikkei index, I am able to identify significant cross-sectional variation in the level of ETF ownership across firms and provide solid evidence on the systematic impact of ETF ownership on stock price efficiency.

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