Master Thesis

The Bank of Japan's Exchange-Traded Fund Purchase Program and its Impact on Daily Stock Market Returns

submitted in partial fulfillment of the requirements
for the degree of Master of Arts

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To my parents.

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Contents

List of Figures

List of Tables

List of Abbreviations

APP	Asset Purchase Program
ATE	average treatment effect
ATT	average treatment effect for the treated
BOE	Bank of England
BOJ	Bank of Japan
CB	corporate bond
CME	Comprehensive Monetary Easing
CP	corporate paper
ECB	European Central Bank
ELB	effective lower bound
ETF	index-linked exchange-traded fund
FED	Federal Reserve System
FSOPC	funds-supplying operation against pooled collateral
GFC	Great Financial Crisis
GPIF	Government Pension Investment Fund
JGB	Japanese government bond
JGS	Japanese government securities
JPX-Nikkei 400	JPX-Nikkei Index 400
J-REIT	Japan real estate investment trust
LSAP	large-scale asset purchase
MPM	monetary policy meeting
MFFP	money-financed fiscal programs
NIKKEI	Nikkei 225 Stock Average
P/B Ratio	price-to-book ratio
P/E Ratio	price-to-earnings ratio
POF	potential outcome framework
QE	quantitative easing
QQE	Quantitative and Qualitative Monetary Easing

RCT	randomized controlled trial
SMP	Securities Markets Programme
T-Bill	Treasury discount bill
TOPIX	Tokyo Stock Price Index
VIX	CBOE Volatility Index
YCC	yield curve control
ZLB	zero nominal lower bound
ZIRP	zero interest rate policy

Summary

The Bank of Japan's ETF purchasing program has evolved from a small and subsidiary market operation instrument in the early 2010s to a behemoth monetary policy tool, with the central bank now controlling around 80% of the domestic ETF market. Given these drastic developments, one wonders whether the continued existence of this program on the Bank of Japan's balance sheet is justified. To clear up this question, it is important to assess the size and nature of the effectiveness of the central bank led ETF purchases. To this end, the present study attempts to estimate the causal effect of the ETF purchases on the TOPIX's price movements. I draw on the propensity score matching approach to imitate features of an idealized RCT setting which allows for a better apples-to-apples comparison of control and treatment observations. The results reveal statistically significant price pressure effects on the Japanese stock market's afternoon session performance under the QQE regime. Effects were non-significant under the Comprehensive Monetary Easing framework. Furthermore, it is found that the policy intervention function is primarily determined by the domestic stock markets morning session performance. The predictive contributions of other factors mentioned by a high-ranking Bank of Japan member were found to be negligible.

Chapter 1

Introduction

At the time of the writing, SARS-CoV-2 has not only taken a heavy toll on human lives and on the amount of social interactions permissible but has also ravaged the financial markets, prompting governments to take action with central banks in the hot seat. Monetary authorities all around the world have moved up a gear by cutting interbank rates, purchasing a variety of assets and setting up lending facilities to provide liquidity, accompanied by commitments to exhaust their remaining arsenal if necessary. Amid this bedlam, the BOJ decided to double its upper limit of annual purchases of index-linked exchange-traded funds (ETFs)[1] to the tune of ¥12 trillion at its 16th of March 2020 monetary policy meeting (MPM) (Bank of Japan 2020c). If the BOJ was to exhaust its ETF-purchasing scope, the central bank would find itself on a course to well overtake the Government Pension Investment Fund (GPIF) as the biggest holder of domestic stocks by the end of 2020 (Lewis and Inagaki 2020). Accordingly, the BOJ has since bought ETFs worth ¥721.6 billion within a time frame of 10 days with three purchasing transactions valued ¥200.4 billion each, representing its largest daily purchases to date. While this unprecedented hike is only the last of a series of measures undertaken by the Japanese central bank so far to ease monetary conditions for many years, it underscores the increased importance the BOJ wants to assign to its ETF purchase program.

The motivation of the present work is to give guidance to the question whether this program has empirical justifications to sustain its existence on the BOJ's balance sheet. Not only is this question discussed controversially among market participants, it has gained increased attention by foreign media as well[2],

1. "ETFs are traded securities [and each] ETF share is a claim on a trust that holds a specified pool of assets. [...] ETF shares are created when an authorized financial institution deposits a portfolio of securities with the trustee and receives ETF shares in return. These ETF shares can be sold to other investors. The market for ETF shares operates like the market for shares of a common stock. Investors can buy or sell ETF shares at any point during the day. ETF share prices may diverge from the underlying net asset value (NAV) of the securities held in the trust, although such divergence is restricted by the capacity of authorized financial institutions to create and redeem ETF shares." (Poterba and Shoven 2002).

2. Themes have been the creation of distortions in the domestic equity market where the

and the controversy over the continued use and growing scale of this market operation has been reflected even in the central bank's decision-making Policy Board:

> "Mr. T. Sato dissented considering that ETF purchases of about 6 trillion yen annually would be excessive in light of their adverse impact on the price mechanism in the stock market and the Bank's financial soundness. Mr. T. Kiuchi dissented because an increase in ETF purchases would (1) impair the Bank's financial soundness, (2) lead to a rise in volatility in the stock market, and (3) give a wrong impression that the Bank targeted stock prices." (Bank of Japan 2016d, MPM July 2016).

This research serves to complement the literature on the effectiveness of unconventional monetary policy when nominal interest rates are constrained by a lower bound. More specifically, it contributes to the yet small but growing literature on the BOJ's ETF purchase program and its impact on financial markets. The basic idea is to counterfactually answer the question:

Would the Japanese equity market have performed worse if the BOJ had not purchased ETFs?

In other words, and clarifying, the exercise is to estimate the causal effect of the Japanese central bank's ETF purchase interventions on a domestic stock market index's daily total return. Methodologically, this research draws on a matching process and the concept of potential outcomes which facilitates thinking in counterfactual terms. This is required as causality in the present non-experimental setting can only be approached by comparing trading days where the BOJ intervened with similar trading days where an intervention did not occur and by accounting for the fact that the decision whether to intervene or not is non-random. The proceeding is as follows: First off, an overview of the BOJ's ETF purchase program is given by explaining the rationale behind the adoption of this non-standard monetary policy measure and by showing how this market operation has evolved over time since its introduction at the end of 2010. Then, the evidence on the effectiveness of the program is summarized by reviewing the academic literature. Thereafter, the methodological framework is explicated followed by the presentation and discussion of the results. Here, special attention will be brought to the policy intervention function and the estimation of a causal effect called the average treatment effect for the treated (ATT). The work ends with a discussion of policy implications and an outlook for future research.

valuations are said to be inflated artificially through the central bank's ETF purchases, further exacerbated through disproportionate stakes in companies over-represented in the Nikkei 225 Stock Average (NIKKEI) which might lead to compromised corporate governance against the backdrop of unexercised share voting rights. Concern has also been raised about the program's exit strategy with investors worrying about stock devaluations once the constant stream of purchases will come to an end (Lewis 2019; Whiffin 2019; Bird 2019).

Chapter 2

The BOJ's ETF Program

> *"the Bank of Japan was a lonely forerunner and had to feel its way forward, making decisions in the uncharted territory of unorthodox policy"*
>
> — Shirakawa (2012)

So far, other central banks have shunned away from purchasing stocks through ETFs even in the aftermath of the Great Financial Crisis (GFC) with its subsequent proliferation of asset purchase programs that target an ever growing set of different asset classes. To the best of the author's knowledge, the BOJ's market operation of purchasing ETFs are unique in the central banking world[1]. Part of the reason is that this would involve taking on at least some of the aforementioned risks. The lack of role models and precedents is another reason. In fact, the BOJ has birthed three distinct ETF related programs: The main program involves the outright purchases of ETFs that began in December 2010 and the operational rules[2] can found in the "Principal Terms and Conditions for Purchases of ETFs and J-REITs" (Bank of Japan 2020e). Next, a supplement program was established for purchases of ETFs "with the aim of supporting firms that are proactively investing in physical and human capital" (Bank of Japan 2017). Lastly, and only recently, the BOJ has introduced ETF lending (Bank of Japan 2019c). For the remainder of the work, the focus will be on the main ETF program.

1. Its unconventionality is also evidenced by a lack of mention in Chapter IV of the Bank of Japan Act (Act No. 89, 1997) that enumerates the bank's authorized businesses. This makes a separate authorization from the Minister of Finance and the Commissioner of the Financial Services Agency in accordance with Article 43, § 1 and Article 61-2 of the Bank of Japan Act necessary prior to the implementation of index-linked ETF purchases and subsequent amendments.

2. The purchases are made at the Operations Department of the BOJ's Head Office and eligible ETFs comprise those that are listed on a financial instruments exchange licensed in Japan and that track the Tokyo Stock Price Index (TOPIX), the NIKKEI or the JPX-Nikkei Index 400 (JPX-Nikkei 400). An appointed trust bank performs the ETFs purchases on the BOJ's behalf and handles these assets as trust property. While the BOJ reports the date and total amount of ETF purchases, it refrains from publishing the exact time of order executions and whether the order is split into smaller units and distributed over a time period.

2.1 Purpose

In earlier times when the BOJ and other central banks were not constrained by the binding zero nominal lower bound (ZLB) or the effective lower bound (ELB), setting the nominal policy interest rate and keeping it stable represented the core of the conduct of conventional monetary policy. The reserve requirement system allows central banks to flatten the reserve demand curve by varying the quantity of bank reserves, eliciting a high interest rate elasticity of reserves. In combination with a corridor system with the basic loan rate and the interest rate applied under the complementary deposit facility acting as the policy rate ceiling and floor respectively, the BOJ has perfect controllability over the very short end of the yield curve dubbed uncollateralized overnight call rate. For many years however, the BOJ has found itself in a position where it had to resort to unconventional monetary policy to achieve its inflation target. Generally speaking, present unconventional monetary policy in the Japanese context can be thought to consist of four elements[3]: zero interest rate policy (ZIRP) (or even slightly negative interest rate policy), forward guidance about future interest rate policies, quantitative easing (QE)[4] or large-scale asset purchases (LSAPs) and lastly yield curve control (YCC) as is reflected by the structure and content of the BOJ's statements on monetary policy (see for example Bank of Japan 2020b)[5]. Table 2.1 features these tools in the order of the date of introduction in Japan.

The ETF purchase program is designed to support the monetary easing efforts by the BOJ and can be associated with QE. It is different from the stock purchasing rounds of November 2002 – September 2004 and February 2009 – April 2010 that aimed at helping distressed banks resolve their problems with non-performing loans and promote financial stability (Shirai 2018). The ETF program launched as part of the Asset Purchase Program (APP) that ran from the end of 2010 to early 2013, although originally conceived only as a temporary measure to be conducted until the end of 2011. The APP itself was situated

3. Other measures that have been discussed in the literature include a temporary intervention in the foreign exchange market in combination with price level targeting and helicopter money. Svensson (2001) suggested for the BOJ "a foolproof way of escaping from its liquidity trap and recession, namely combining a price level target path corresponding to positive inflation with a devaluation of the yen and a temporary exchange rate peg to jump-start the economy" while Bernanke (2016) wrote about money-financed fiscal programs (MFFP) as a last-resort strategy which is "an expansionary fiscal policy – an increase in public spending or a tax cut – financed by a permanent increase in the money stock", arguing for its effectiveness even at the ZLB and high debt levels. Just recently, the Bank of England (BOE) agreed to finance additional fiscal spending by the UK government related to SARS-CoV-2 (Giles and Georgiadis 2020). Both aforementioned measures would require a close coordination with the Treasury.

4. While associated with balance sheet operations, a narrow definition involves only an increase of the balance sheet *size* whereas a narrowly defined credit easing refers to changes in the *composition* of balance sheets (Shiratsuka 2010; see also Bernanke and Reinhart 2004). An example of the latter was the Federal Reserve System (FED)'s *Operation Twist* in the early 60's (Alon and Swanson 2011).

5. Ueda 2012 differentiates unconventional monetary policy between forward guidance of future policy rates, targeted asset purchases, and quantitative easing.

Table 2.1: BOJ's Unconventional Policy Tools

Tool	Period
Zero interest rate policy (ZIRP)	February 1999 – July 2000
Quantitative easing (QE)	March 2001 – March 2006
ZIRP	April 2006 – July 2006
Comprehensive Monetary Easing (CME)	October 2010 – March 2013
Quantitative and Qualitative Monetary Easing (QQE)	April 2013 –
QQE with negative interest rate	February 2016 –
QQE with YCC	September 2016 –

Source: Cabinet Office (2020)

within the wider Comprehensive Monetary Easing (CME) policy introduced at the October 5th 2010 MPM. Recognizing the constraint by the ELB, the central bank decided to "encourage the decline in longer-term interest rates and various risk premiums to further enhance monetary easing" and therefore it judged it necessary to "establish a program on its balance sheet through which the Bank will purchase various financial assets" (Bank of Japan 2010a). Thus assumably, the official version of this goal translates into lowering the equity risk premium with respect to the purchases of ETFs. Implicitly however, it must have been clear that as a direct consequence of this market operation the domestic equity market valuations would experience an upcurrent[6]. Higher share prices would not only create a wealth effect through which consumer spending is bolstered, but also incentivize firms to higher investment spending by reducing their cost of capital, eventually stimulating economic activity and exerting upward pressure on price developments[7].

2.2 Evolution

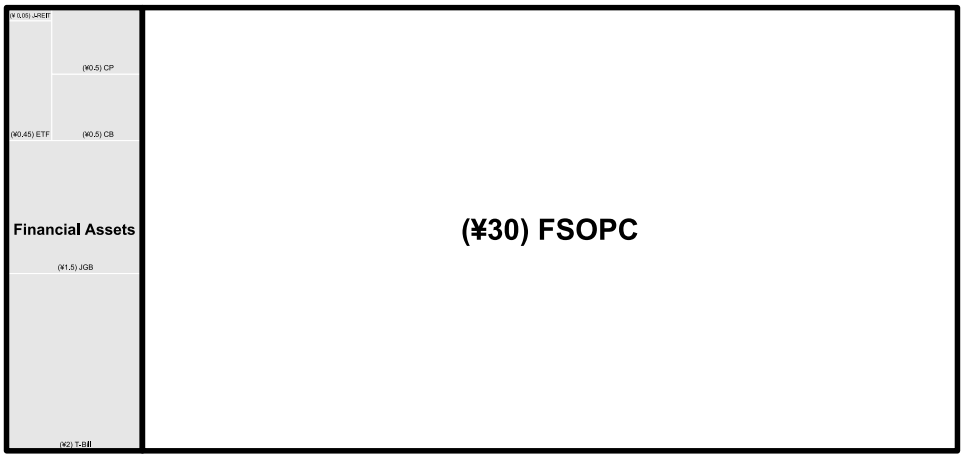
When the ETF purchase program was first introduced, the Policy Board set the maximum outstanding amount to ¥450 billion to be reached by the end of 2011. It took a back seat to other market operations such as the outright purchases of Japanese government securities (JGS) and the funds-supplying operation against pooled collateral (FSOPC). Figure 2.1 illustrates the relative sizes of the maximum outstanding amount earmarked for individual APP market operations which pooled together ¥35 trillion in total of which ¥5 trillion are financial assets and ¥30 trillion are loans. Against this backdrop, the BOJ's ETF program's continuance and its current behemoth status in the Japanese equity market is all the more astonishing.

6. See again the dissenting opinion of former Policy Board member Takahide Kiuchi (Bank of Japan 2016d, MPM July 2016).

7. As a side benefit of holding ETFs, the BOJ would be able to diversify its asset holding.

8. Corporate papers (CPs) comprise commercial paper, asset-backed commercial paper, and commercial paper issued by real estate. Corporate bonds (CBs) comprise corporate bonds and bonds issued by real estate investment corporations investment corporations.

Figure 2.1: Initial APP under the CME policy (in ¥ trillion)[8]



Source: Bank of Japan (2010c)

While table 2.2 traces chronologically and in detail the policy decisions concerning the ETF program, it can be summarized that over the last ten years the BOJ has (1) expanded the scope of eligible ETF issues to be purchased, (2) subsequently raised the upper limit of annual purchasing amounts while switching from a fixed amount outstanding regime (stock target) to an open-ended purchasing policy (flow target), (3) rebalanced the relative sizes of the maximum amounts of each ETF issue to be purchased with TOPIX tracking ETFs gaining in importance, and (4) added two complementary ETF programs that are intended to support firms' investment in physical and human capital and help inject liquidity in ETF markets respectively.

Table 2.2: Outline of ETF related Events[9]

Date	Decision
October 5th, 2010	Implementation of the CME and establishment of the APP (Bank of Japan 2010a)
October 28th, 2010	Establishment of "Principal Terms and Conditions for the Asset Purchase Program" – Maximimum amount outstanding of ETFs set to ¥450 billion (Bank of Japan 2010c, 2010d)
November 5th, 2010	Establishment of "Principal Terms and Conditions for Purchases of ETFs and Japan real estate investment trusts (J-REITs) Conducted through the Asset Purchase Program" – ETFs shall track the TOPIX or the NIKKEI[10] and the maximum amount of each ETF shall be roughly proportionate to the total market value of the ETF issued (Bank of Japan 2010b)

(continued on next page)

9. The BOJ was headed by governor Masaaki Shirakawa from April 2008 to March 2013. As of March 20, 2013, the governor has been Haruhiko Kuroda.

10. The "TOPIX is a free-float adjusted market capitalization-weighted index that is calculated based on all the domestic common stocks listed on the TSE First Section" (Japan

Table 2.2 continued

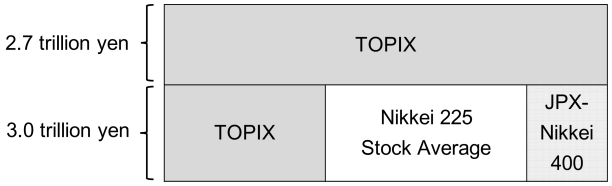
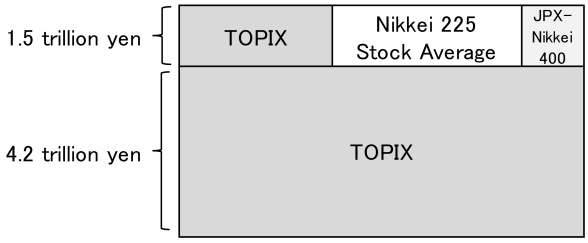
Date	Decision
March 14th, 2011	"Enhancement of Monetary Easing" in response to the Tohoku Pacific Earthquake on March 11th, 2011 – Maximum amount outstanding of ETFs set to ¥0.9 trillion (Bank of Japan 2011c, 2011b)
August 4th, 2011	– Maximum amount outstanding of ETFs set to ¥1.4 trillion (Bank of Japan 2011a)
April 27th, 2012	– Maximum amount outstanding of ETFs set to ¥1.6 trillion (Bank of Japan 2012c, 2012a)
October 30th, 2012	– Maximum amount outstanding of ETFs set to ¥2.1 trillion (Bank of Japan 2012b, 2012d)
January 22th, 2013[11]	Introduction of the "Open-Ended Asset Purchasing Method" – From January 2014, "the Bank will introduce a method of purchasing a certain amount of financial assets every month without setting any termination date", but for financial assets other than JGSs the BOJ will "aim to maintain the amount outstanding of those assets" (Bank of Japan 2013a, 2013c)
April 4th, 2013	Introduction of the Quantitative and Qualitative Monetary Easing & Termination of the APP & Establishment of the "Principal Terms and Conditions for Purchases of ETFs and J-REITs" – "With a view to lowering risk premia of asset prices, the Bank will purchase ETFs [...] so that [the amount] outstanding will increase at an annual pace of 1 trillion yen [...]" (Bank of Japan 2013b, 2013d)
October 31th, 2014	– ETFs amount outstanding will increase at an annual pace of ¥3 trillion – ETFs that track the JPX-Nikkei 400 are made eligible for purchase (Bank of Japan 2014a, 2014b)
December 18th, 2015	Establishment of a supplementary program for purchases of ETFs to support firms' investment in physical and human capital – "[T]he Bank will purchase ETFs composed of stocks issued by firms that are proactively making investment in physical and human capital" at an annual pace of about ¥300 billion – "The new program will start with purchases of ETFs which track the JPX-Nikkei Index 400" from April 2016 onwards (Bank of Japan 2015) – For detailed rules governing this supplementary program, see Bank of Japan 2016b, 2016c, 2016d, 2017 from the March 15th, 2016 MPM
July 29th, 2016	– ETFs amount outstanding will increase at an annual pace of ¥6 trillion (Bank of Japan 2016e)

(continued on next page)

Exchange Group 2020a) whereas the NIKKEI is a price-weighted index of 225 domestic stock constituents (Nikkei Inc. 2020).

11. On the same date, the "Price Stability Target" was introduced and the "Joint Statement of the Government and the Bank of Japan on Overcoming Deflation and Achieving Sustainable Economic Growth" released.

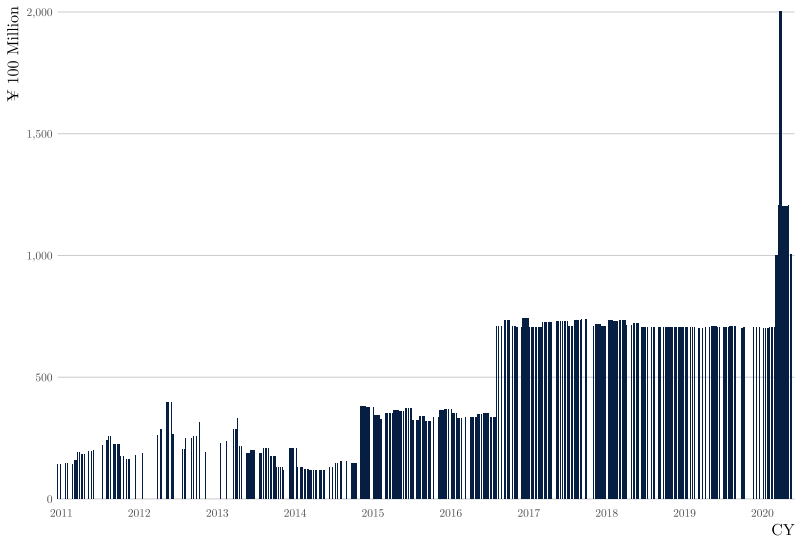
Table 2.2 continued

Date	Decision
September 21th, 2016	Change in the maximum amount of each ETF to be purchased (effective on October 3rd, 2016) - Purchases shall *take into account* the total market value of each ETF issued and the coverage of the index which that ETF tracks - "Of the annual purchase amount of 5.7 trillion yen, 3 trillion yen will be used for ETFs that track any of the three indices as before. The maximum amount of each ETF to be purchased shall be set so that the Bank's purchase would roughly be proportionate to the total market value of that ETF issued" - "The remaining 2.7 trillion yen will be used for ETFs that track the TOPIX. The maximum amount of each ETF to be purchased shall be set so that the Bank's purchase would roughly be proportionate to the total market value of that ETF issued" (Bank of Japan 2016a):  - ¥0.3 trillion remain allocated for ETFs that support investments in physical and human capital
July 31st, 2018	– Change in the maximum amount of each ETF to be purchased (effective on August 6th, 2018) (Bank of Japan 2018):  - ¥0.3 trillion remain allocated for ETFs that support investments in physical and human capital
December 19th, 2019	Introduction of the ETF Lending Facility & Establishment of "Special Rules for Lending of ETFs" – Aims at improving the liquidity in ETF markets (Bank of Japan 2019a, 2019b, 2019c) – Amount of cash collateral is calculated by multiplying market prices of ETFs to be lent by 108%, effective on April 1st, 2020 (Bank of Japan 2020d)
March 16th, 2020	"Enhancement of Monetary Easing in Light of the Impact of the Outbreak of the Novel Coronavirus (COVID-19)" – ETFs amount outstanding will increase at an annual pace of ¥12 trillion (Bank of Japan 2020c)
April 27th, 2020	– "The maximum amount of each ETF to be purchased shall [...] be set so that the Bank's purchase would take into account the *amount outstanding in circulation* of that ETF issued and the coverage of the index which that ETF tracks" (Bank of Japan 2020a)

This part is brought to a close by illustrating that the BOJ is on the track for becoming the biggest holder of domestic stocks: Figure 2.2 shows the amount of ETFs bought for each trading day and figures 2.3 and 2.4 aggregate these individual purchases by months and years respectively. The

spikes at the right end of the figures (daily and monthly figures) are owed to the aggressive monetary easing efforts by the central bank to combat the repercussions of the SARS-CoV-2 pandemic. Looking at the cumulative sum of the BOJ's spending on ETF purchases to date, figure 2.5, the total spending currently stands at well over ¥30 trillion and one can also observe the increasing slope of the graph, the result of the subsequent decisions by the Policy Board to raise annual purchasing targets. All in one, it can be said that the BOJ apparently wants to assign greater importance to the ETF program, making inquiries into its effectiveness called for.

Figure 2.2: Daily ETF Spending



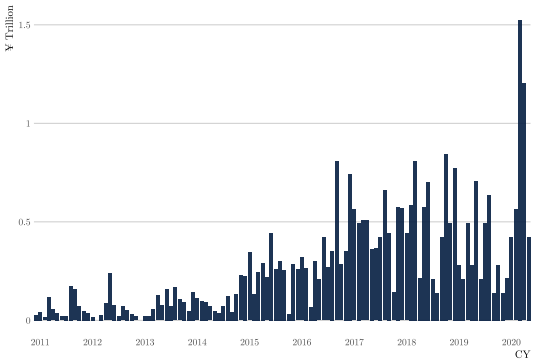


Figure 2.3: Monthly ETF Spending

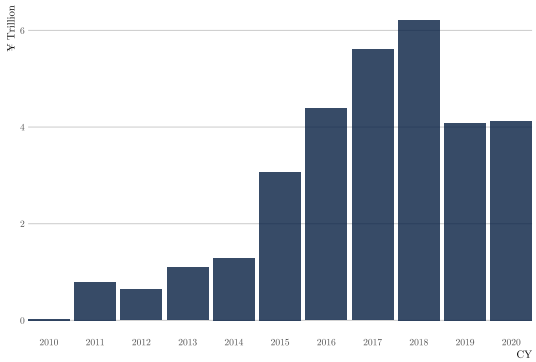
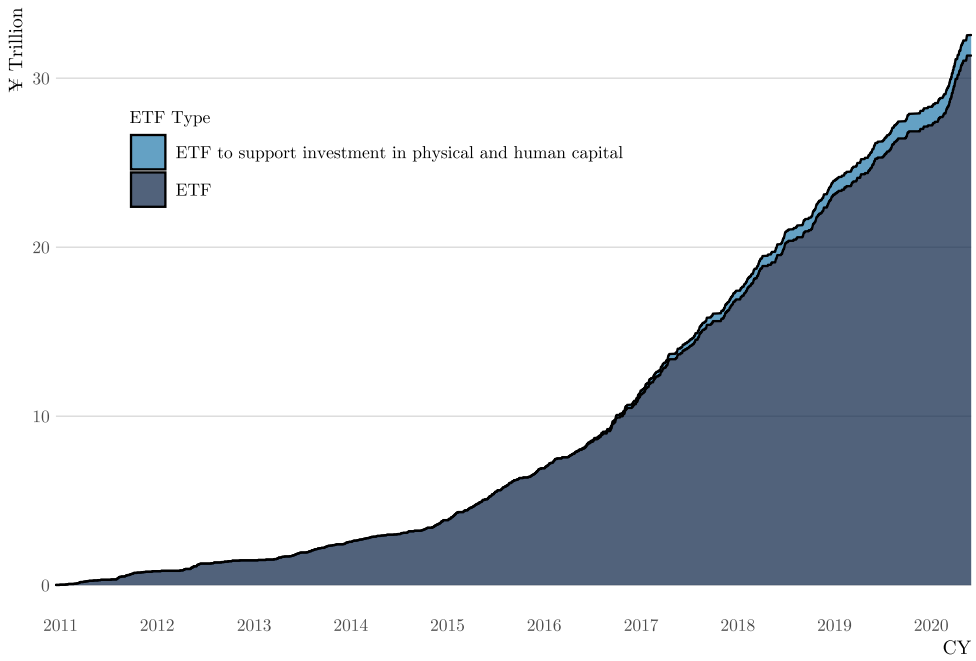


Figure 2.4: Annual ETF Spending

Source: Bank of Japan (2020)

Figure 2.5: Running Total of the BOJ's ETF Purchase Spending



Source: Bank of Japan (2020)

Chapter 3

Literature Review

The present work joins a strand of macroeconomic research that addresses the effectiveness of unconventional monetary policy. Thereunder, a substantial amount of academic efforts have been undertaken to better understand transmission mechanisms of QE or LSAPs (cf. Hamilton and Wu 2012; Joyce et al. 2012; Krishnamurthy and Vissing-Jorgensen 2013; Haldane et al. 2016) and to empirically estimate their effects on financial markets with a particular focus on changes in bond yields and prices as well as on inflation and output (D'Amico and King 2013, discusses the FED's 2009 LSAP programme in terms of stock and flow effects; Eser and Schwaab 2016, investigates the Securities Markets Programme (SMP) of the European Central Bank (ECB) during the sovereign debt crisis). Studies on the effectiveness of QE in Japan include Hayashi and Koeda 2013, Matsuki, Sugimoto, and Satoma 2015, Kimura and Nakajima 2016, and Otsubo 2018, who use sophisticated VAR models and report positive impulse responses of inflation and output (gap) to a bank reserve shock (monetary policy shock) for periods prior to the implementation of Abenomics. Similar results are also found under QQE by Miyao and Okimoto 2017 and Michaelis and Watzka 2017 who also draw attention to the existence of time variations corresponding to the then prevailing monetary policy regimes. Hanisch 2017 by contrast employs a large structural dynamic factor model and finds that a monetary base increase has a weak and transitory effect on output but stronger effects on prices and stocks. Ueda 2013 looked at how stock and yen valuations have been affected by unconventional monetary policy and highlights the role of speculative trades by foreign investors.

Concerning the aforementioned studies, Shibamoto and Tachibana 2013 have pointed out that more often than not the stance of unconventional monetary policy is assumed to be sufficiently represented by the quantity of reserves or monetary base. Moreover, a separation between individual market operations have not been consistently taken into consideration notwithstanding the growing list of monetary policy measures utilized by the BOJ and the possibility that "[t]he effectiveness of monetary transmission on the real economy might depend on the differences among unconventional monetary policy tools" (Shibamoto and Tachibana 2013). The situation has

improved, however, with recent research focusing specifically on the BOJ's ETF related market operations. For instance, Harada and Okimoto 2019 compare the afternoon performance of stocks included in the NIKKEI with other stocks' afternoon performance not included in the NIKKEI drawing on a difference-in-differences analysis and report that the returns of the former is higher on days when the BOJ purchases ETFs. The study also spotlights the existence of diminishing returns. Barbon and Gianinazzi 2019 advocate that the ETF program has led to "supply shocks at the individual stock level" due to the creation and redemption process of ETF shares and conclude that the "results suggest that demand curves for stocks are downward sloping in the long run". Charoenwong, Morck, and Wiwattanakantang 2019 confirm that ETF purchases boost share valuations and are not fully reversing - at least not immediately. They also find that while equity financing is stimulated, there seems to be no meaningful increases in corporate investments but instead cash holdings seem to be encouraged. Lastly, the study at hand builds on Shirota 2018 who finds significant demand pressure effects during QQE employing a matching process based on propensity scores. Deviations concern a respecification of the policy intervention function and the attempt to estimate the ATT instead of the average treatment effect (ATE).

Despite mounting evidence on the effectiveness of the ETF program, a recent study by Maeda and Shino 2019 crucially focuses on the nexus between the BOJ's ETF program and the stock lending market. They find that due to the expansion of the ETF program, the stock lending market has grown substantially in parallel. Importantly, their study suggests that the program has a built in "distortion stabilizer", possibly mitigating the share valuation effects estimated in the studies above. In turn, this would imply that the effectiveness of the ETF program could have been critically attenuated in a self-defeating manner. Unfortunately, a separate assessment of this finding is beyond the scope of the present work and not yet supported by other studies so that at this point one shall be contented with just a reference for future research purposes.

All in all, although recent empirical studies have found some evidence on the effectiveness of the BOJ's ETF program, there still exists a considerable research gap. To start with, the exact transmission channels of the ETF program are still rather poorly understood and will require in the future tailored theoretical foundations. For instance, Barbon and Gianinazzi 2019 hint at the existence of flow effects that needs to be distinguished from stock effects in line with D'Amico and King 2013. This research will assume and focus on the former. Moreover, to the best of the author's knowledge no existing research has devoted a special focus on the intervention function of the BOJ's ETF purchases yet. The plan is to shed light on this matter as well besides the attempt to estimate a causal effect of the BOJ's ETF program.

Chapter 4

Analysis

In this part, causal effects of the BOJ's ETF purchases on daily stock market performances are estimated. To this end, the potential outcome framework (POF) is invoked. Moreover, the effect estimation procedure will draw on the method of propensity score matching, the rationale being that this research takes place in an observational setting. Importantly, unlike in randomized controlled trials (RCTs), the researcher has had no control over the treatment assignment process to guarantee randomization, while at the same time there is reason to believe that the ETF purchase interventions have occurred in a random fashion. In other words, there is the possibility that selection bias exists, rendering a simple difference-in-means test between stock price changes on intervention days and non-intervention days inappropriate.

The remainder will proceed as follows: First, the econometric framework that builds on the POF and propensity score matching will be introduced. Second, the policy intervention function for the ETF purchases will be modeled which is at the same time the first step of the matching process. Third, the matched data is presented and evaluated in terms of mean balances. Lastly, based on the matched data set, a final regression will be run with the afternoon stock market return as the outcome variable of interest.

To preempt confusion at a later stage, it is made explicit that hereinafter *treatment* shall stand for the BOJ's ETF purchases or more succinctly (stock market) interventions, *treatment cases* or observations are to be equated with intervention days and conversely *control cases* will refer to non-intervention days.

The observation period stretches from December 15$^{\text{th}}$, 2010 (the first date the BOJ purchased ETFs) to March 31$^{\text{st}}$, 2020. All data are at daily frequency and were obtained through publicly available sources except for TOPIX related data such as aggregate price-to-earnings ratio (P/E Ratio) and price-to-book ratio (P/B Ratio) which were accessed through the Bloomberg Terminal (see appendix A).

Data are divided into three subsamples to account for regime changes. Subsample A contains all trading days before the announcement of the QQE, subsample B ends the day before the annual purchasing limit was raised to ¥6 trillion. Subsample C comprises of the remaining trading days until the

end of March 2020. Table 4.1 reports some descriptive statistics pertaining to the subsamples:

Table 4.1: Subsample Descriptives

Subsample	Trading Days	Interventions	%	Avg. Purchase (¥100 MM.)	Avg. PM Return (Control)	Avg. PM Return (Treatment)	Avg. AM Return (Control)	Avg. AM Return (Treatment)
A	565	70	12	229	0.010	-0.040	0.270	-1.700
B	813	268	33	267	-0.010	-0.020	0.620	-1.100
C	895	284	32	738	-0.040	0.170	0.410	-0.900

4.1 Econometric Framework

4.1.1 Potential Outcome Framework

Borrowing from Morgan and Winship 2015, following notations for the POF will be maintained:

- Y^0: Potential outcome random variable Y in control state (population level)
- Y^1: Potential outcome random variable Y in treatment state (population level)
- y_i^0: Potential outcome in the control state for individual i
- y_i^1: Potential outcome in the treatment state for individual i
- D: Causal exposure variable (realizations are in lowercase)
- δ_i: Individual-level causal effect (the *what if* difference between y_i^1 and y_i^0)

The lines below show how the value of Y is conditional on the value of D. More importantly, they imply that individual causal effects cannot be observed for that would necessitate the observation of both y_i^0 and y_i^1 at the same time. This impossibility has been termed the *fundamental problem of causal inference* (Holland 1986).

$$\left.\begin{array}{lll} Y = Y^1 & \text{if} & D = 1 \\ Y = Y^0 & \text{if} & D = 0 \end{array}\right\} \quad \text{or} \quad Y = DY^1 + (1 - D)Y^0$$

Then, the ATE is defined as:

$$\begin{aligned} [E[\delta] &= E[Y^1 - Y^0] \\ &= E[Y^1] - E[Y^0] \end{aligned}$$

In RCT settings, treatment statuses can be assumed to be independent of potential outcomes, or in other words, the treatment assignment mechanism is assumed to be ignorable:

$$(Y^0, Y^1) \perp\!\!\!\perp D$$

However, observational studies require that the researcher investigates the treatment selection/assignment process because naive estimates of the ATE might introduce a *baseline bias* and a *differential treatment effect bias*. Under these circumstances, the ignorability assumption can still hold, "when the potential outcomes [...] are independent of the treatment variable, D, within strata defined by all combinations of values on all variables, S, that systematically determine all treatment assignment patterns" (Morgan and Winship 2015) and when "all variables in S are observed" (ibid.):

$$(Y^0, Y^1) \perp\!\!\!\perp D \mid S$$

Later, it will be argued that indeed S is observed which allows the maintenance of the ignorability assumption.

4.1.2 Matching Framework

Matching follows a conditioning on observables approach to justify conditional versions of the ignorability assumption. It is often used *ex post* in observational studies and is a non-parametric alternative to multivariate regression that can adjust for treatment assignment patterns. Essentially, it tries to find similar treatment-control pairs, with similar values on supposed confounders. In exact matching, the first step involves the identification of relevant confounders. Then treated subjects are matched with a similar control subject and unmatched subjects outside the common support area are dropped off. However, when there are unmatched subjects, the interpretation of the treatment effect estimate changes. Lastly, the causal effect is estimated through $E[Y|D=1,S] - E[Y|D=0,S]$.

$$(1) \quad E[Y^1|D=1,S] = E[Y^1|D=0,S]$$
$$(2) \quad E[Y^0|D=1,S] = E[Y^0|D=0,S]$$

(1) and (2) are the two conditional independence assumptions. For instance, if (2) is holding but (1) is invalid, then only the ATT can be estimated. Indeed, this is the position the present work takes, as it is argued that an implicit policy intervention rule, similar to an eligibility rule, for the ETF purchases effectively prevents the estimation of the intervention effect for control cases of a certain stratum, even though perfect stratification of the data might have been achieved through S. As "[D]eveloping such estimates would require going well beyond the data, introducing assumptions that allow for extrapolation off of the joint distribution of S and D" (cf.), it will be contented with the estimation of the ATT, assuming $E[Y^1|D=1,S] \neq E[Y^1|D=0,S]$. It shall be noted that the focus on the ATT also follows from dropping unmatched control cases off the common support.

Having said that, exact matching is infeasible when many covariates are considered. Instead, propensity score matching is turned to where the matching is done on all observed variables that may affect both treatment D

and outcome Y. There, the propensity score represents the probability of taking the treatment D as a function of S, i.e.,

$$P[D = 1|S]$$

equivalent to mapping S onto a single dimension. Conditional independence only requires similar distributions of S under treatment and control. Thereafter, a matching based on the estimated propensity score is conducted according to the nearest-neighbor algorithm. After the matching, the balance of the matched data has ideally improved with respect to S. If that is not the case, it is encouraged to respecify the propensity score model.

Following Ho et al. 2007 who see matching as a "nonparametric preprocessing" step for a later regression, the present work will run a final regression on the matched data set. In particular, they reason that this approach is *doubly robust*: "That is, if the parametric model is misspecified, but the matching is correct, or if the matching is inadequate but the parametric model is correctly specified, then estimates will still be consistent".

4.2 The Policy Intervention Function

When does the BOJ buy ETFs? Attentive market participants might have observed or read that the BOJ usually buys ETFs when the return of the TOPIX during the morning session[1] falls by more than 0.5% and this has been particularly true after the Japanese central bank decided to increase its annual purchasing target to ¥6 trillion in July 2016 (cf. Ide 2019; Uetake 2019). For a long time, the public could only guess whether the morning session return was the sole predictor for ETF purchases. Although the *Principal Terms and Conditions for Purchases of ETFs and J-REITs* mentions that "[p]urchases of ETFs and J-REITs shall, taking into account the conditions in the market, be conducted by the trustee *pursuant to a standard prescribed by the Bank*" (Bank of Japan 2020e, emphasis added), these rules are not disclosed. However, when last year deputy governor Masayoshi Amamiya attended the 12$^{\text{th}}$ Meeting of the Committee on Financial Affairs of the House of Councillors on May 30$^{\text{th}}$, 2019, he gave away clues with regards to other factors besides the morning session returns that the central bank deems relevant in gauging the equity risk premium, the target parameter the ETF program officially tries to influence[2].

Deputy governor Masayoshi Amamiya said that while the measurement of the risk premium proves difficult, the BOJ would have a close look at yield spreads (difference between stock yields and risk-free government bond yields), the P/E Ratio, the P/B Ratio and the U.S. CBOE Volatility Index (VIX) (Hasegawa 2019; House of Councillors 2019). Exploiting these information, the right-hand side of the policy intervention function will be

1. For stocks, the morning trading session is from 9:00 AM to 11:30 AM and the afternoon trading session is from 0:30 PM to 3:00 PM (Tokyo Stock Exchange, Inc. 2019). Before November 21$^{\text{st}}$, 2011, the morning session ended at 11:00 AM (Japan Exchange Group 2020b).

2. It can only be assumed whether the disclosure of these information was intentional or happened by accident

specified by exactly those variables and given that these remarks came from a Policy Board member, there are grounds to believe that those metrics should be able to predict stock market interventions by the Japanese central bank. Because the BOJ should know best its own intervention decision determinants, it is posited that the perfectly stratifying confounder vector S is fully observed and is comprised of the morning session performance of the TOPIX, P/E Ratio, P/B Ratio, U.S. VIX, and the yield spread (equity risk premium) calculated as

$$\frac{1}{\text{P/E Ratio}} - 10\ year\ JGB\ yield$$

Table 4.2: Policy Intervention Model

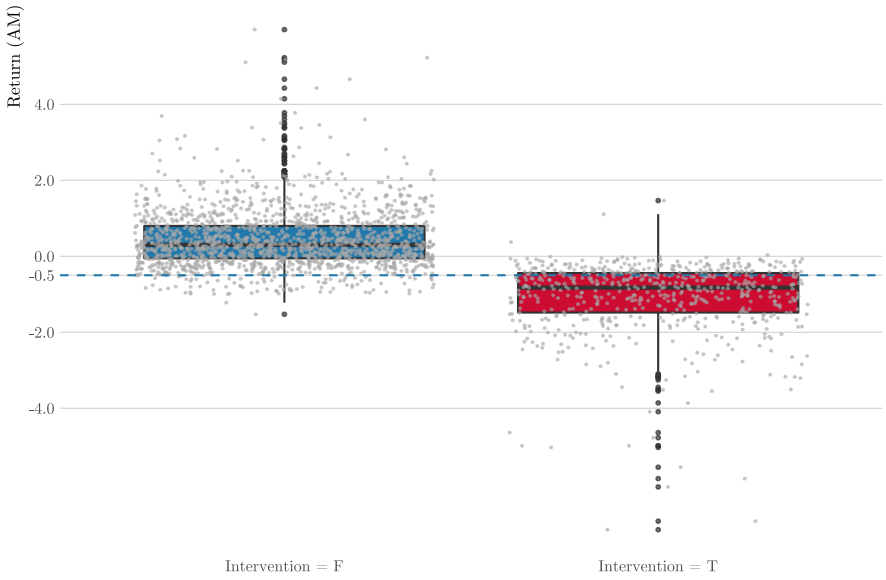
	$Intervention_t$								
	A	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta\ Yield\ Spread_{t-1}$	−0.047	0.005	0.0001	−0.240	0.010	−0.001	−0.260	0.008	−0.001^{+}
	(0.082)	(0.004)	(0.0002)	(0.200)	(0.018)	(0.0003)	(0.210)	(0.018)	(0.0003)
$\Delta\ P/E\ Ratio_{t-1}$	0.021	0.100	0.029	0.022	0.220	0.003	−0.057	0.049	−0.370
	(0.051)	(0.120)	(0.120)	(0.380)	(0.360)	(0.210)	(0.480)	(0.540)	(0.340)
$\Delta\ P/B\ Ratio_{t-1}$	0.079	−0.140	−0.170	0.500	−0.720^{+}	−0.590*	3.900	0.200	2.500
	(0.130)	(0.140)	(0.140)	(0.550)	(0.380)	(0.270)	(9.500)	(1.100)	(1.600)
$U.S.\ VIX_{t-1}$	0.150***	0.110***	0.120***	0.026	0.013	0.032	0.026	0.013	0.026
	(0.020)	(0.013)	(0.012)	(0.054)	(0.022)	(0.020)	(0.053)	(0.024)	(0.021)
$Return\ AM_t$				−15.000***	−6.600***	−7.200***	−15.000***	−6.600***	−7.200***
				(3.000)	(0.590)	(0.610)	(3.000)	(0.600)	(0.610)
$\Delta\ Crude\ Oil_{t-1}$							−0.120	−0.019	−0.029
							(0.220)	(0.069)	(0.065)
$\Delta\ Effective\ Exchange\ Rate_{t-1}$							0.009	−0.410	0.570^{+}
							(0.720)	(0.350)	(0.330)
$Return\ Total_{t-1}$							−3.300	−0.880	−2.700^{+}
							(9.200)	(0.740)	(1.500)
Constant	−2.400***	−0.810***	−0.890***	−15.000***	−2.100***	−2.200***	−15.000***	−2.000***	−2.200***
	(0.160)	(0.082)	(0.079)	(3.000)	(0.210)	(0.200)	(3.000)	(0.210)	(0.200)
Observations	565	813	895	565	813	895	565	813	895
Log Likelihood	-174	-460	-490	-29	-150	-198	-29	-149	-193
Akaike Inf. Crit.	358	930	990	71	313	408	76	316	405

Note: $^{+}$p<0.1 *p<0.05 **p<0.01 ***p<0.001

The results of running the propensity score model (logit) are reported in table 4.2. Surprisingly, none of the factors mentioned by deputy governor Masayoshi Amamiya seems to be able to predict a stock market intervention at the 0.05 significance level, once the morning session return is controlled for and with the inclusion of the covariates used by Shirota 2018 (price changes in crude oil, exchange rate indicator and the previous day's total return of the stock market index). Apparently, the morning session return of the stock market seems to be the sole and highly predictive determinant of the BOJ's ETF purchases. To explore this feature further, it is instructive to have a look at figure 4.3 that shows the morning session returns by intervention status. Upon zooming, it becomes clear that especially with the start of the QQE the number −0.5% has sort of become a magic threshold at which the BOJ will almost certainly purchase ETFs. Deviations are concentrated in the period

before QQE and no exceptions to this rule are registered after early 2016. In fact, this intervention rule is downright lending itself to be exploited in a regression discontinuity design. Unfortunately, given time constraints, this has to be a matter of future investigation for now. Figure 4.1 is a more concise representation of the cut-off threshold and the distribution of morning session returns by treatment status.

Figure 4.1: TOPIX Return (Morning Session) and Market Intervention (2)



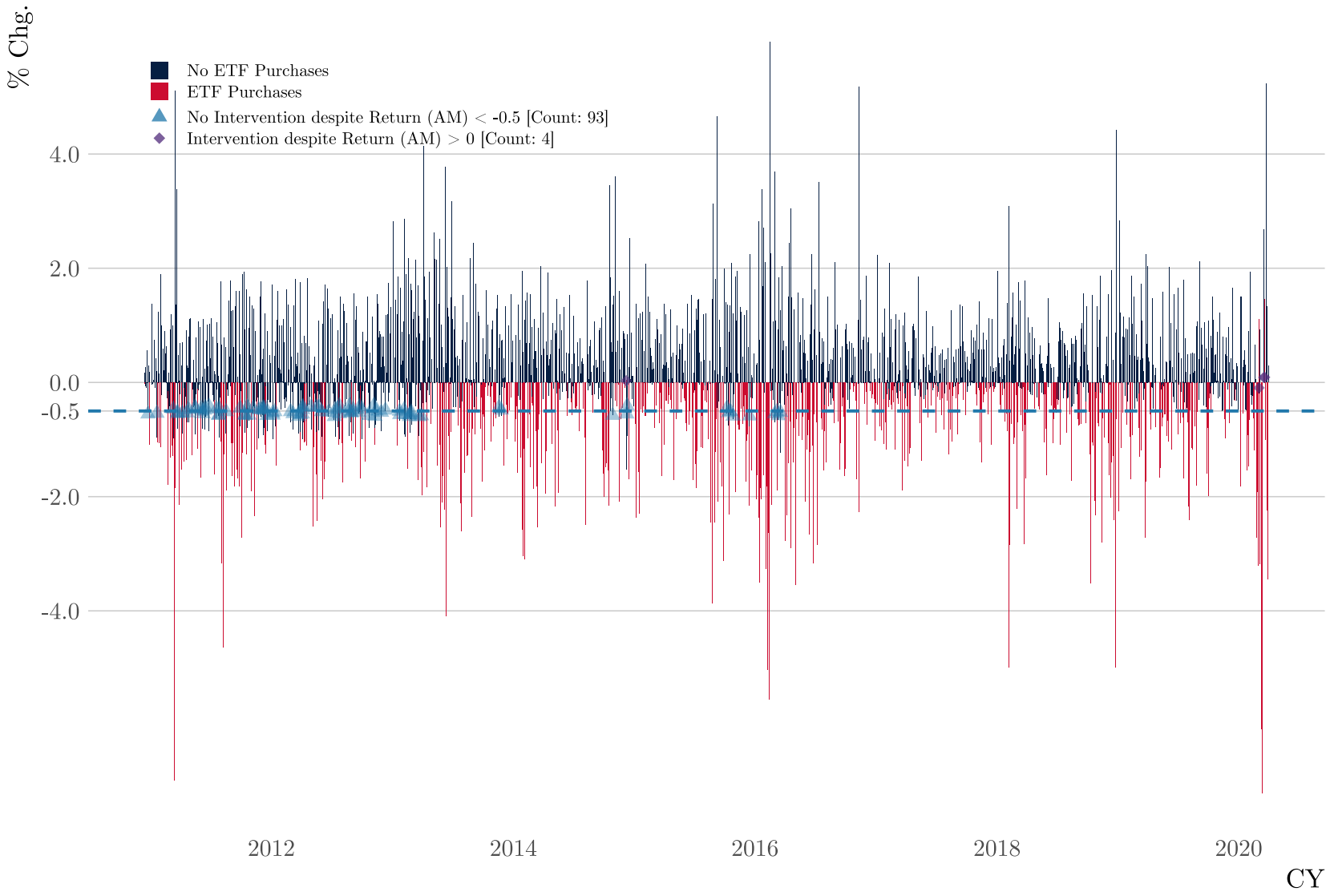
Source: Bank of Japan (2020)

Given the propensity score model, the probabilities of being exposed to an intervention for each trading day observation can be fitted. This is done for models (1) to (6). After obtaining the propensity scores, it merits to plot histograms to compare the overlap, i.e. the common support (see figure 4.2).

What stands out is that while the common support of treatment and control group for models (1) to (3) seems rather accommodative, the common support for models (4) to (6) are almost non-existent due to very high or very low predicted probabilities of treatment exposure, induced by the inclusion of the morning session return in the models. Although it was contemplated to match on the propensity scores based on models (4) to (6), the extreme weights for observations that would be generated through an inverse probability weighting would be unruly and therefore the matching was conducted based on models (1) to (3), drawing on the the nearest-neighbor without replacement matching algorithm that matches each intervention day with a single similar non-intervention day based on the calculated propensity scores. Naturally, given the different group sizes this leads to unmatched and

Figure 4.2: Common Support

Figure 4.3: TOPIX Return (Morning Session) and Market Intervention (1)



therefore dropped off control cases. This coincides with the aforementioned goal to estimate the ATT instead of the ATE, founded in the possibility that the effect of a treatment might be bigger for the treatment group than for the control group. The fact that the highly predictive morning session return has not been considered for the matching process can be justified with a a reference to the doubly robustness of regressions on matched data (Ho et al. 2007) and Morgan and Winship 2015 considers an incomplete propensity score model a possible remedy for extreme weights, as long as the variable that is responsible for the extreme propensity scores is later reintegrated in the outcome regression analysis.

After the matching, matched data sets are obtained and can be used to evaluate the improvement of the covariate mean balances. The balancing has worked best for subsample C (table 4.5), intermediately for subsample B (table 4.4) and worst for subsample A (table 4.3). Future research might try to respecify the propensity score model to achieve better balances but at least in view of the latest subsample periods, the balance improvements can be deemed sufficient to feed the matched data to the outcome model.

Table 4.3: Balance Check: Subsample A

Unmatched Data	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
Propensity Score	0.282	0.102	0.098	0.180	0.091	0.175	0.639
Δ *Yield Spread*$_{t-1}$	−0.261	−0.111	1.790	−0.150	0.209	0.459	4.950
Δ *P/E Ratio*$_{t-1}$	0.241	0.062	3.320	0.180	0.111	0.952	34.700
Δ *P/B Ratio*$_{t-1}$	0.019	0.004	1.240	0.016	0.115	0.181	2.080
U.S. VIX$_{t-1}$	8.040	−0.877	6.430	8.920	7.570	9.010	28.900

Matched Data	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
Propensity Score	0.282	0.237	0.182	0.045	0.001	0.045	0.335
Δ *Yield Spread*$_{t-1}$	−0.261	−0.209	1.780	−0.052	0.214	0.491	5.930
Δ *P/E Ratio*$_{t-1}$	0.241	0.729	6.430	−0.488	0.141	0.673	34.700
Δ *P/B Ratio*$_{t-1}$	0.019	−0.089	1.690	0.108	0.167	0.258	3.410
U.S. VIX$_{t-1}$	8.040	6.300	8.110	1.740	0.796	1.880	16.000

Table 4.4: Balance Check: Subsample B

Unmatched Data	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
Propensity Score	0.424	0.283	0.133	0.141	0.106	0.141	0.368
Δ *Yield Spread*$_{t-1}$	16.600	−0.191	14.300	16.800	0.325	17.500	3,599.000
Δ *P/E Ratio*$_{t-1}$	−0.151	0.069	1.980	−0.220	0.295	0.393	10.400
Δ *P/B Ratio*$_{t-1}$	−0.177	0.121	1.570	−0.298	0.288	0.334	1.740
U.S. VIX$_{t-1}$	4.320	−1.670	6.800	5.990	5.030	6.050	21.800

Matched Data	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
Propensity Score	0.424	0.358	0.139	0.066	0.026	0.066	0.252
Δ *Yield Spread*$_{t-1}$	16.600	0.479	17.100	16.100	0.440	17.300	3,599.000
Δ *P/E Ratio*$_{t-1}$	−0.151	−0.001	2.040	−0.150	0.271	0.371	10.100
Δ *P/B Ratio*$_{t-1}$	−0.177	0.015	1.650	−0.192	0.252	0.293	1.740
U.S. VIX$_{t-1}$	4.320	1.930	6.760	2.390	1.160	2.570	12.000

Table 4.5: Balance Check: Subsample C

Unmatched Data	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
Propensity Score	0.423	0.268	0.128	0.154	0.111	0.154	0.448
Δ *Yield Spread*$_{t-1}$	−12.100	−27.000	426.000	14.900	1.030	35.000	5,149.000
Δ *P/E Ratio*$_{t-1}$	−0.195	0.068	1.290	−0.263	0.270	0.368	11.800
Δ *P/B Ratio*$_{t-1}$	−0.173	0.064	0.995	−0.237	0.234	0.285	2.190
vix_lag	5.580	−1.760	6.150	7.340	4.370	7.360	89.400
Matched Data	Means Treated	Means Control	SD Control	Mean Diff	eQQ Med	eQQ Mean	eQQ Max
Propensity Score	0.423	0.345	0.135	0.078	0.022	0.078	0.345
Δ *Yield Spread*$_{t-1}$	−12.100	−11.900	369.000	−0.232	1.300	30.500	2,207.000
Δ *P/E Ratio*$_{t-1}$	−0.195	−0.130	1.440	−0.065	0.146	0.246	11.800
Δ *P/B Ratio*$_{t-1}$	−0.173	−0.117	1.010	−0.056	0.102	0.150	4.060
U.S. VIX$_{t-1}$	5.580	1.530	5.830	4.050	1.090	4.090	89.400

4.3 Estimation of the ATT

Finally, the afternoon session return of the TOPIX can be regressed on the intervention variable. Additionally, it is controlled for a vector of variables that might affect financial markets and investors' behavior. These include, besides the ones already used for the propensity score models, the date of announcement and execution of Treasury discount bill (T-Bill) and Japanese government bond (JGB)[3] outright purchases to account for the interconnectedness of the bond and equity markets, the number of shares traded in units of one billion as a proxy for market liquidity[4], and the short-term policy rate.

In short, the results in table 4.6 reveal that the stock market interventions have indeed had a significant effect on the Japanese stock market's afternoon performance. This finding applies to the period that covers QQE, but not to the CME regime. There are some indications that the domestic stock market is influenced by American share price movements. Also, under QQE with YCC the equity market seems to react more strongly to the policy rate and exchange rate movements.

3. JGBs of different maturities as well as inflation-indexed and floating-rate JGBs have been grouped by trading dates and were assigned "1" if on a trading date JGBs have been purchased irrespective of maturity and type, and "0" otherwise. Information about size of individual purchases have therefore been lost. For a typology of different JGBs see Ministry of Finance 2020.

4. Bid-ask spread was unfortunately unavailable.

Table 4.6: Outcome Model on Matched Data Sets

	TOPIX PM Return$_t$					
	A	*A*	*B*	*B*	*C*	*C*
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy : Intervention$_t$	0.142	0.113	0.218**	0.225**	0.211***	0.193***
	(0.193)	(0.155)	(0.081)	(0.083)	(0.063)	(0.057)
TOPIX AM Return$_t$	0.122	0.181*	0.112*	0.110+	−0.030	0.051
	(0.137)	(0.090)	(0.051)	(0.064)	(0.054)	(0.042)
Δ*Yield Spread*$_{t-1}$		0.032		0.0004***		0.00000
		(0.041)		(0.0001)		(0.00005)
Δ*Price/Earnings Ratio*$_{t-1}$		0.025+		0.017		−0.015
		(0.014)		(0.026)		(0.015)
Δ*Price/Book Ratio*$_{t-1}$		−0.745+		−0.005		0.080
		(0.390)		(0.056)		(0.098)
VIX_{t-1}		0.0003		0.004		−0.005
		(0.012)		(0.010)		(0.004)
Δ*Crude Oil*$_{t-1}$		−0.033		0.035*		−0.013
		(0.027)		(0.017)		(0.014)
$\Delta S\&P500_{t-1}$		−0.164*		0.035		−0.156**
		(0.071)		(0.089)		(0.048)
Δ*Effective Exchange Rate*$_{t-1}$		0.158+		0.055		0.128*
		(0.092)		(0.110)		(0.050)
Share Trading Volume$_{t-1}$		0.011		−0.134		0.034
		(0.069)		(0.094)		(0.048)
Overnight Call Rate (daily average)$_{t-1}$		−0.972		−0.440		−2.780*
		(7.050)		(0.864)		(1.190)
Dummy : JGB Outright Purchases (exercised)$_t$		0.047		−0.077		−0.018
		(0.092)		(0.066)		(0.045)
Dummy : JGB Outright Purchases (offered)$_t$		−0.166		−0.042		−0.036
		(0.112)		(0.074)		(0.038)
Dummy : T-Bill Outright Purchases (exercised)$_t$		−0.028		0.170*		0.029
		(0.180)		(0.085)		(0.056)
Dummy : T-Bill Outright Purchases (offered)$_t$		−0.083		0.199*		0.065
		(0.125)		(0.089)		(0.056)
TOPIX Total Return$_{t-1}$		0.799*		0.031		−0.015
		(0.381)		(0.064)		(0.093)
Constant	0.020	−0.016	−0.112*	0.251	−0.072**	−0.265*
	(0.061)	(0.605)	(0.046)	(0.263)	(0.027)	(0.104)
Newey West HAC robust SEs	✓	✓	✓	✓	✓	✓
Observations	140	140	536	536	568	568
R^2	0.040	0.234	0.014	0.067	0.061	0.203
Adjusted R^2	0.026	0.134	0.011	0.039	0.058	0.179
Residual Std. Error	0.629 (df = 137)	0.593 (df = 123)	0.774 (df = 533)	0.763 (df = 519)	0.495 (df = 565)	0.462 (df = 551)
F Statistic	2.860+ (df = 2; 137)	2.350** (df = 16; 123)	3.840* (df = 2; 533)	2.350** (df = 16; 519)	18.500*** (df = 2; 565)	8.740*** (df = 16; 551)

Note: +p<0.1 *p<0.05 **p<0.01 ***p<0.001

Chapter 5

Conclusion

In this study, I have given an overview of the BOJ's ETF program by explaining its purpose and tracing its development from its beginning as a subsidiary component of the APP to its contemporaneous behemoth status, with the BOJ's ETF holdings valued around 80% of the total domestic ETF market (figure C.3), almost 6% of the domestic stock market capitalization (figure C.1), and account for a 5% share of the Japanese central bank's total assets (figure C.2). Given these developments, it is not surprising that this unique balance sheet program and unconventional monetary policy tool has garnered increased attention from academia. However, the specific transmission channels pertaining to ETF purchases by a public authority are still poorly understood and need improved theoretical foundations. Future research in the same strain might want to conduct an intraday analysis at an even higher frequency. Possibly, the effects of the covariates at time $t-1$ might have already dissipated when the trading floor opens the next day. Intraday pre-treatment data would be desirable. It might be also interesting to investigate, how (fast) ETF managers react to ETF purchases by the BOJ. As pointed out by Charoenwong, Morck, and Wiwattanakantang 2019, ETF managers might act to "mitigate immediate price pressure by delaying buying the underlying shares, [so that] the immediate reaction is muted and the abnormal return is spread across a longer time window". Similarly, exploring the persistence of these price pressure effects in more detail could represent a worthwhile endeavor as well. In view of an eventual normalization of the policy, i.e. an exit strategy, and citing Barbon and Gianinazzi 2019: "if QE is mainly effective through repeated price pressure, a slow-down or a suspension of the purchases would cause a sharp drop in prices. On the contrary, in our model of the portfolio-balance channel, it is not the flow into the balance sheet of the central bank that keeps prices up, but its accumulated size. Therefore, ending the purchases should have a more limited effect on prices". Assuming that the ETF purchasing policy will not be normalized until the combined monetary easing efforts have led to appreciable developments in price levels, it will also become increasingly important to consider the potential systemic risks the ETF asset class can pose (cf. Pagano, Sánchez Serrano, and Zechner 2019).

The matching framework in the analysis part has yielded results that can be taken as supportive evidence for the findings of Shirota 2018: The ETF purchases have had a positive and significant price pressure effect on the TOPIX afternoon performance since the implementation of QQE. While the present work might be summarized as a robustness check for the predecessor study, it has extended the literature by empirically testing the deputy governor Masayoshi Amamiya's remarks on the equity risk premium at the House of Councillors in May 2019. It was assumed that the P/E Ratio, P/B Ratio, U.S. stock market volatility and the yield spread mentioned in the context of measuring equity risk premium would be prime predictors of the BOJ's stock market intervention. This has not proven to be true and instead the findings have lent strength to the market belief that the primary and maybe only determinant of the stock market interventions are the share price developments in the morning session with the probability of an intervention jumping drastically when the morning session return goes below the -0.5% threshold. Also, this can be taken as a circumstantial evidence, that the BOJ is in effect targeting stock prices.

My last remarks concerns the possibility that there exists an optimal combination of frequency, size and conditions of ETF purchase interventions given the annual purchasing amount constraint. Namely, it might be that at a certain purchasing frequency, at a certain size and under favorable circumstances (market downturn vs. market upturn for example), intervention effects could be maximized with respect to the targeted parameter, be it the equity risk premium or share prices. It is easily conceivable that the right mix has a chance to significantly affect market participants' behavior and expectations.

Appendices

Appendix A

Data Sources

The data set and the *R* code are provided upon request. E-Mail to jcchung@hotmail.de

Table A.1: Variables Data Sources

Data	Source
TOPIX, NIKKEI, P/E Ratio, P/B Ratio	Bloomberg (Terminal)
ETF-purchases	Bank of Japan. https://www3.boj.or.jp/market/en/menu_etf.htm.
JGB-purchases	Bank of Japan. https://www.boj.or.jp/en/statistics/boj/fm/ope/m_release/index.htm/.
10 year JGB yield	Ministry of Finance, Government of Japan. https://www.mof.go.jp/english/jgbs/reference/interest_rate/index.htm.
Policy rate (daily average)	Bank of Japan. https://www.stat-search.boj.or.jp/index_en.html.
Stocks trading volume (liquidity)	Japan Exchange Group (JPX). https://www.jpx.co.jp/english/markets/statistics-equities/monthly/index.html.
Effective exchange rate	Bank for International Settlements (BIS). https://www.bis.org/statistics/eer.htm.
Volatility Index Japan (VJX)	Center for Mathematical Modeling and Data Science, Osaka University. http://www-mmds.sigmath.es.osaka-u.ac.jp/en/activity/vxj_download.php?.
CBOE Volatility Index (VIX)	Chicago Board Options Exchange. http://www.cboe.com/products/vix-index-volatility/vix-options-and-futures/vix-index/vix-historical-data.
Crude oil (WTI)	U.S. Department of Energy. https://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm.
S&P 500	Yahoo! Finance. https://finance.yahoo.com/quote/%5EGSPC/history?p=%5EGSPC.
Note:	Missing values occurred for crude oil, S&P 500 and U.S. VIX data due to different holidays in the U.S. and Japan. Imputation by linear interpolation.

Table A.2: Other Data Sources

Data	Source
BOJ ETF holdings	Bank of Japan. https://www.stat-search.boj.or.jp/index_en.html.
BOJ total assets	Bank of Japan. https://www.stat-search.boj.or.jp/index_en.html.
Total net assets ETFs	The Investment Trust Association, Japan. https://www.toushin.or.jp/statistics/statistics/data/#long-term_time-series_date/.
Stock market capitalization	Japan Exchange Group (JPX). https://www.jpx.co.jp/english/markets/statistics-equities/misc/02.html.

Appendix B

Softwares Used

B.1 General

LaTeX. 2020. https://www.latex-project.org/.

Microsoft Corporation. 2020. *Microsoft Excel*.

R Core Team. 2020. *R: A Language and Environment for Statistical Computing*. Vienna, Austria. https://www.R-project.org/.

RStudio Team. 2020. *RStudio: Integrated Development Environment for R*. Boston, MA. http://www.rstudio.com/.

Swiss Academic Software GmbH. 2020. *Citavi*. Wädenswil, Switzerland. https://www.citavi.com/en.

van der Zander, Benito, Jan Sundermeyer, Daniel Braun, and Tim Hoffmann. 2020. *TeXstudio*. https://www.texstudio.org/.

B.2 *R* Packages

Dowle, Matt and Arun Srinivasan. 2019. *data.table: Extension of 'data.frame'*. R package version 1.12.8. https://CRAN.R-project.org/package=data.table.

Hlavac, Marek. 2018. *stargazer: Well-Formatted Regression and Summary Statistics Tables*. R package version 5.2.1. https://CRAN.R-project.org/package=stargazer.

Ho, Daniel E., Kosuke Imai, Gary King, Elizabeth A. Stuart. 2011. *MatchIt: Nonparametric Preprocessing for Parametric Causal Inference*. Journal of Statistical Software, Vol. 42, No. 8, pp. 1-28. URL http://www.jstatsoft.org/v42/i08/.

Rudis, Bob. 2020. *hrbrthemes: Additional Themes, Theme Components and Utilities for 'ggplot2'*. R package version 0.8.0. https://CRAN.R-project.org/package=hrbrthemes.

Tennekes, Martijn. 2017. *treemap: Treemap Visualization*. R package version 2.4-2. https://CRAN.R-project.org/package=treemap.

Wickham, Hadley. 2016. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag, New York. https://ggplot2.tidyverse.org.

Wickham, Hadley and Jennifer Bryan. 2019. *readxl: Read Excel Files*. R package version 1.3.1. https://CRAN.R-project.org/package=readxl.

Wickham, Hadley and Lionel Henry. 2020. *tidyr: Tidy Messy Data*. R package version 1.1.0. https://CRAN.R-project.org/package=tidyr.

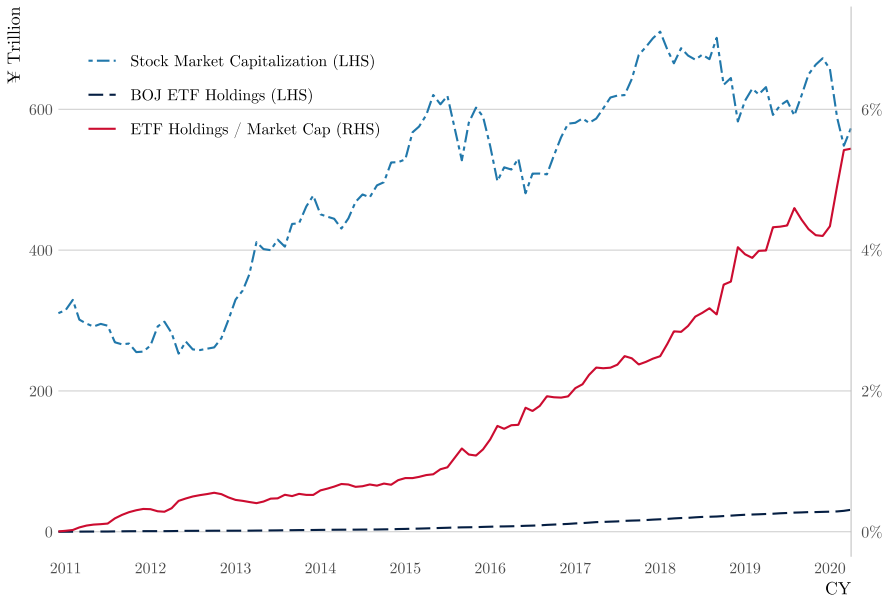
Wickham, Hadley, Romain François, Lionel Henry and Kirill Müller. 2020. *dplyr: A Grammar of Data Manipulation*. R package version 1.0.0. https://CRAN.R-project.org/package=dplyr.

Zeileis, Achim. 2004. "Econometric Computing with HC and HAC Covariance Matrix Estimators". *Journal of Statistical Software*, 11 (10): 1-17. https://doi.org/10.18637/jss.v016.i09.

Appendix C

Bonus Graphs

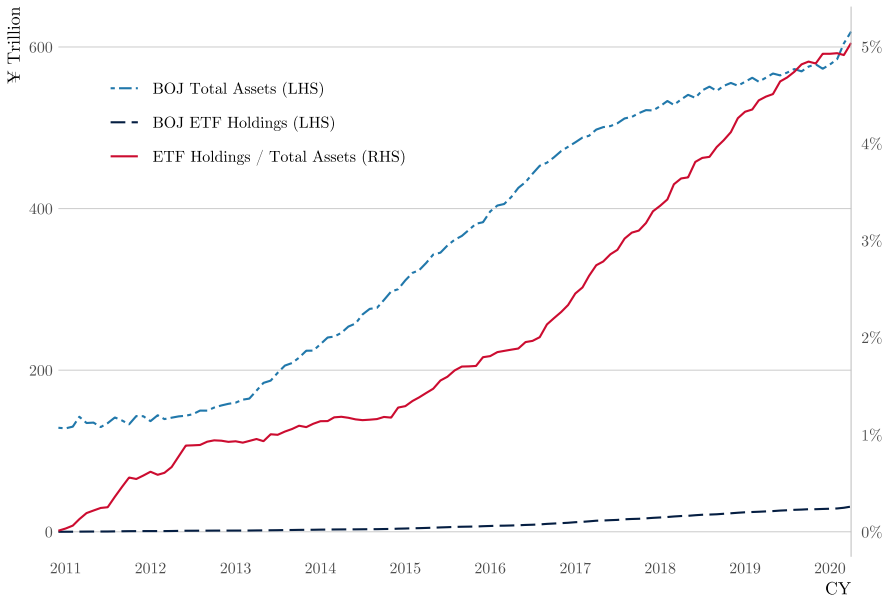
Figure C.1: BOJ ETF Holdings vs. Stock Market Capitalization[1]



Source: Bank of Japan (2020), Japan Stock Exchange (2020)

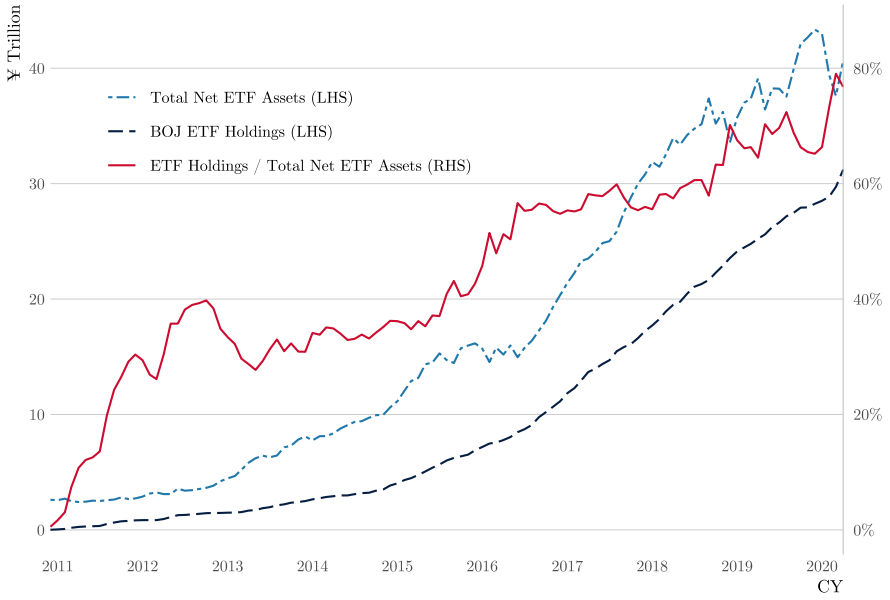
1. Total of 1st Section, 2nd Section, Mothers, TOKYO PRO Market, JASDAQ Standard and JASDAQ Growth. ETF holdings are named *pecuniary trusts* on the BOJ's balance sheet.

Figure C.2: BOJ ETF Holdings vs. BOJ Total Assets



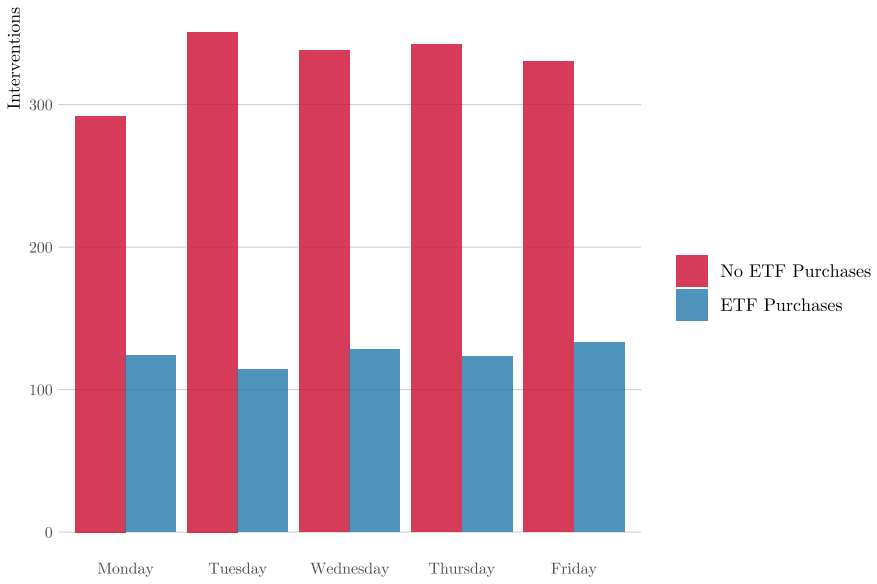
Source: Bank of Japan (2020)

Figure C.3: BOJ ETF Holdings vs. ETF Market Value



Source: Bank of Japan (2020); The Investment Trust Association, Japan (2020)

Figure C.4: Interventions and Weekdays



Appendix D

Bonus Tables

Table D.1: Policy Intervention Model (modified)

	$Intervention_t$								
	CME/APP	QQE	QQE (¥6trn)	CME/APP	QQE	QQE (¥6trn)	CME/APP	QQE	QQE (¥6trn)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Yield\ Spread_{t-1}$	−0.340	0.650*	−3.500**	−1.100	0.190	−4.700*	−2.600	5.700**	−3.800
	(1.100)	(0.310)	(1.200)	(2.600)	(0.610)	(2.200)	(4.200)	(1.800)	(2.400)
$P/E\ Ratio_{t-1}$	−0.130*	0.005	0.038	−0.096	−0.180+	0.180*	−0.013	0.013	−0.050
	(0.058)	(0.044)	(0.050)	(0.120)	(0.099)	(0.080)	(0.150)	(0.140)	(0.120)
$P/B\ Ratio_{t-1}$	−1.100	1.600	−2.300+	−0.200	7.000***	0.750	0.230	6.100	6.700+
	(1.700)	(1.000)	(1.200)	(4.300)	(2.000)	(2.300)	(10.000)	(4.500)	(3.700)
$U.S.\ VIX_{t-1}$	0.140***	0.110***	0.120***	0.005	0.027	0.034+	0.017	0.009	0.027
	(0.020)	(0.012)	(0.013)	(0.056)	(0.022)	(0.020)	(0.059)	(0.025)	(0.022)
$Return\ AM_t$				−15.000***	−6.400***	−7.500***	−15.000***	−7.100***	−8.700***
				(3.100)	(0.570)	(0.650)	(3.100)	(0.660)	(0.770)
$Crude\ Oil_{t-1}$							−0.073	0.062***	−0.090***
							(0.071)	(0.019)	(0.022)
$Effective\ Exchange\ Rate_{t-1}$							0.007	−0.170+	0.009
							(0.160)	(0.089)	(0.095)
$Return\ Total_{t-1}$							0.290	−0.620***	−0.780***
							(0.330)	(0.150)	(0.170)
Constant	1.000	−2.700*	1.700	−14.000*	−7.800***	−5.800*	−11.000	1.100	−5.700
	(2.200)	(1.200)	(1.500)	(5.500)	(2.100)	(3.000)	(25.000)	(10.000)	(11.000)
Observations	565	813	895	565	813	895	565	813	895
Log Likelihood	-169.000	-459	-487	-30	-152	-196	-29	-138	-177
Akaike Inf. Crit.	348	929	985	72	317	404	75	295	373

Note: +p<0.1 *p<0.05 **p<0.01 ***p<0.001

Table D.2: Intervention Effect on Implied Volatility

	Implied Volatility$_t$					
	A	*A*	*B*	*B*	*C*	*C*
	(1)	(2)	(3)	(4)	(5)	(6)
Dummy : Intervention$_t$	1.950	2.390	−2.190**	−2.530***	−0.752	−1.640
	(3.000)	(1.760)	(0.798)	(0.673)	(1.620)	(1.280)
TOPIX AM Return$_t$	−1.720	−1.230	−1.990***	−2.080***	−3.140**	−2.980*
	(1.900)	(0.772)	(0.489)	(0.452)	(1.180)	(1.300)
Δ*Yield Spread*$_{t-1}$		0.146		0.002**		0.001*
		(0.355)		(0.001)		(0.001)
Δ*Price/Earnings Ratio*$_{t-1}$		0.315*		−0.100		0.660***
		(0.142)		(0.183)		(0.185)
Δ*Price/Book Ratio*$_{t-1}$		−5.090		0.349		−1.290
		(4.250)		(0.703)		(1.260)
Δ*Crude Oil*$_{t-1}$		−0.277		0.113		−0.742*
		(0.318)		(0.113)		(0.292)
Δ*S&P500*$_{t-1}$		−1.370$^+$		−0.467		−0.786
		(0.762)		(0.477)		(1.050)
Δ*Effective Exchange Rate*$_{t-1}$		0.056		−0.233		−2.580
		(1.040)		(0.562)		(1.570)
Share Trading Volume$_{t-1}$		5.910**		3.420***		5.890***
		(1.820)		(0.404)		(1.410)
Overnight Call Rate (daily average)$_{t-1}$		−44.200		−49.200***		−15.900
		(88.600)		(5.830)		(25.000)
Dummy : JGB Outright Purchases (exercised)$_t$		−0.563		0.150		0.513
		(1.160)		(0.417)		(0.482)
Dummy : JGB Outright Purchases (offered)$_t$		0.608		0.579		−0.624
		(1.280)		(0.418)		(0.544)
Dummy : T-Bill Outright Purchases (exercised)$_t$		−2.480		0.628		−0.715
		(2.130)		(0.553)		(0.577)
Dummy : T-Bill Outright Purchases (offered)$_t$		0.338		−0.624		−0.383
		(2.210)		(0.551)		(0.785)
TOPIX Total Return$_{t-1}$		3.060		−0.746		−0.659
		(4.070)		(0.646)		(1.780)
Constant	23.300***	12.100	25.700***	18.900***	19.100***	8.310**
	(1.050)	(10.100)	(0.487)	(1.150)	(0.602)	(3.050)
Newey West HAC robust SEs	✓	✓	✓	✓	✓	✓
Observations	140	140	536	536	568	568
R^2	0.101	0.493	0.070	0.325	0.127	0.386
Adjusted R^2	0.087	0.432	0.066	0.305	0.124	0.369
Residual Std. Error	9.010 (df = 137)	7.110 (df = 124)	6.080 (df = 533)	5.240 (df = 520)	7.630 (df = 565)	6.470 (df = 552)
F Statistic	7.660*** (df = 2; 137)	8.050*** (df = 15; 124)	19.900*** (df = 2; 533)	16.700*** (df = 15; 520)	41.000*** (df = 2; 565)	23.100*** (df = 15; 552)

Note: $^+$p<0.1 *p<0.05 **p<0.01 ***p<0.001

Bibliography

Alon, Titan, and Eric Swanson. 2011. "Operation Twist and the Effect of Large-Scale Asset Purchases." *FRBSF Economic Letter,* no. 13, accessed June 15, 2020. https://www.frbsf.org/economic-research/files/el2011-13.pdf.

Bank of Japan. 2010a. "Comprehensive Monetary Easing (October 5, 2010)." Accessed March 28, 2020. https://www.boj.or.jp/en/announcements/release_2010/k101005.pdf.

———. 2010b. "Establishment of "Principal Terms and Conditions for Purchases of ETFs and J-REITs Conducted through the Asset Purchase Program" (November 5, 2010)." Accessed March 31, 2020. https://www.boj.or.jp/en/announcements/release_2010/mok1011b.pdf.

———. 2010c. "Establishment of "Principal Terms and Conditions for the Asset Purchase Program" (October 28, 2010)." Accessed March 31, 2020. https://www.boj.or.jp/en/announcements/release_2010/mok1010f.pdf.

———. 2010d. "Statement on Monetary Policy (October 28, 2010)." Accessed March 29, 2020. https://www.boj.or.jp/en/announcements/release_2010/k101028.pdf.

———. 2011a. "Amendment to "Principal Terms and Conditions for the Asset Purchase Program" (August 4, 2011)." Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2011/rel110804a.pdf.

———. 2011b. "Amendment to "Principal Terms and Conditions for the Asset Purchase Program" (March 14, 2011)." Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2011/rel110314i.pdf.

———. 2011c. "Enhancement of Monetary Easing (March 14, 2011)." Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2011/k110314a.pdf.

———. 2012a. "Amendment to "Principal Terms and Conditions for the Asset Purchase Program" (April 27, 2012)." Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2012/rel120427c.pdf.

———. 2012b. "Amendment to "Principal Terms and Conditions for the Asset Purchase Program" (October 30, 2012)." Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2012/rel121030a.pdf.

Bank of Japan. 2012c. “Enhancement of Monetary Easing (April 27, 2012).” Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2012/k120427a.pdf.

———. 2012d. “Enhancement of Monetary Easing (October 30, 2012).” Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2012/k121030a.pdf.

———. 2013a. “Amendment to "Principal Terms and Conditions for the Asset Purchase Program" (January 22, 2013).” Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2013/rel130122a.pdf.

———. 2013b. “Establishment and Abolishment of Principal Terms and Conditions in accordance with the Introduction of the "Quantitative and Qualitative Monetary Easing" (April 4, 2013).” https://www.boj.or.jp/en/announcements/release_2013/rel130404a.pdf.

———. 2013c. “Introduction of the "Price Stability Target" and the "Open-Ended Asset Purchasing Method" (January 22, 2013).” https://www.boj.or.jp/en/announcements/release_2013/k130122a.pdf.

———. 2013d. “Introduction of the "Quantitative and Qualitative Monetary Easing" (April 4, 2013).” https://www.boj.or.jp/en/announcements/release_2013/k130404a.pdf.

———. 2014a. “Minutes of the Monetary Policy Meeting on October 31, 2014.” Accessed April 1, 2020. https://www.boj.or.jp/en/mopo/mpmsche_minu/minu_2014/g141031.pdf.

———. 2014b. “Partial Amendment to "Basic Guidelines for Purchasing Beneficiary Interests of Index-Linked Listed Investment Trusts" [Transl.] (November 19, 2014).” Accessed April 1, 2020. https://www.boj.or.jp/announcements/release_2014/rel141119a.pdf.

———. 2015. “Statement on Monetary Policy (Dember 18, 2015).” Accessed April 20, 2020. https://www.boj.or.jp/en/announcements/release_2015/k151218a.pdf.

———. 2016a. “Change in the Maximum Amount of Each ETF to be Purchased (September 21, 2016).” Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2016/rel160921c.pdf.

———. 2016b. “Establishment of "Detailed Rules on Eligibility Criteria for Indices regarding Purchases of ETFs to Support Firms Proactively Investing in Physical and Human Capital" (March 15, 2016).” Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2016/rel160315d.pdf.

Bank of Japan. 2016c. “Establishment of "Special Rules for Purchases of ETFs to Support Firms Proactively Investing in Physical and Human Capital" (March 15, 2016).” Accessed April 1, 2020. https://www.boj.or.jp/en/announcements/release_2016/rel160315c.pdf.

———. 2016d. “Establishment of "Special Rules for Purchases of ETFs to Support Firms Proactively Investing in Physical and Human Capital" [Transl.] (March 15, 2016).” Accessed April 1, 2020. https://www.boj.or.jp/announcements/release_2016/rel160315c.pdf.

———. 2016e. “Minutes of the Monetary Policy Meeting on July 28 and 29, 2016.” Accessed April 1, 2020. https://www.boj.or.jp/en/mopo/mpmsche_minu/minu_2016/g160729.pdf.

———. 2017. “Special Rules for Purchases of ETFs to Support Firms Proactively Investing in Physical and Human Capital (January 31, 2017).” Accessed June 2, 2020. https://www.boj.or.jp/en/mopo/measures/term_cond/yoryo91.htm/.

———. 2018. “Outline of Purchases of ETFs (July 31, 2018).” Accessed April 2, 2020. https://www.boj.or.jp/en/announcements/release_2018/rel180731h.pdf.

———. 2019a. “Establishment of "Special Rules for Lending of ETFs" (December 19, 2019).” Accessed April 2, 2020. https://www.boj.or.jp/en/announcements/release_2019/rel191219b.pdf.

———. 2019b. “Introduction of the ETF Lending Facility (December 19, 2019).” Accessed April 2, 2020. https://www.boj.or.jp/en/announcements/release_2019/rel191219c.pdf.

———. 2019c. “Special Rules for Lending of ETFs.” Accessed June 2, 2020. https://www.boj.or.jp/en/mopo/measures/term_cond/yoryo100.htm/.

———. 2020a. “Amendment to "Principal Terms and Conditions for Purchases of ETFs and J-REITs" (May 1, 2020),” accessed June 2, 2020. https://www.boj.or.jp/en/announcements/release_2020/rel200501f.pdf.

———. 2020b. “Enhancement of Monetary Easing (April 27, 2020).” Accessed May 29, 2020. https://www.boj.or.jp/en/announcements/release_2020/k200427a.pdf.

———. 2020c. “Enhancement of Monetary Easing in Light of the Impact of the Outbreak of the Novel Coronavirus (COVID-19) (March 16, 2020).” Accessed March 27, 2020. https://www.boj.or.jp/en/announcements/release_2020/k200316b.pdf.

———. 2020d. “Establishment of "Amount of Cash Collateral for Lending of ETFs".” Accessed June 16, 2020. https://www.boj.or.jp/en/announcements/release_2020/rel200331f.pdf.

Bank of Japan. 2020e. "Principal Terms and Conditions for Purchases of ETFs and J-REITs." Accessed June 2, 2020. https://www.boj.or.jp/en/mopo/measures/term_cond/yoryo85.htm/.

Barbon, Andrea, and Virginia Gianinazzi. 2019. "Quantitative Easing and Equity Prices: Evidence from the ETF Program of the Bank of Japan" [in en]. *The Review of Asset Pricing Studies* 9 (2): 210–255. ISSN: 2045-9920, accessed March 28, 2020. https://doi.org/10.1093/rapstu/raz008.

Bernanke, Ben S. 2016. "What tools does the Fed have left? Part 3: Helicopter money." Accessed May 30, 2020. https://www.brookings.edu/blog/ben-bernanke/2016/04/11/what-tools-does-the-fed-have-left-part-3-helicopter-money/.

Bernanke, Ben S., and Vincent R. Reinhart. 2004. "Conducting Monetary Policy at Very Low Short-Term Interest Rates." *American Economic Review* 94 (2): 85–90. ISSN: 0002-8282. https://doi.org/10.1257/0002828041302118.

Bird, Mike. 2019. "Japan's Central Bank Shows How Not to Buy Stocks: After nine years of ETF purchases, the Bank of Japan doesn't have much to show for it." *The Wall Street Journal* (May 21, 2019). Accessed June 2, 2020. https://www.wsj.com/articles/japans-central-bank-shows-how-not-to-buy-stocks-11558433503.

Cabinet Office. 2020. "Main Economic Indicators (Financial Markets)." Accessed April 22, 2020. https://www5.cao.go.jp/keizai3/getsurei-e/index-e.html.

Charoenwong, Ben, Randall Morck, and Yupana Wiwattanakantang. 2019. "Bank of Japan Equity Purchases: The Final Frontier in Extreme Quantitative Easing." *NBER Working Paper Series,* no. No. 25525, https://doi.org/10.3386/w25525.

D'Amico, Stefania, and Thomas B. King. 2013. "Flow and stock effects of large-scale treasury purchases: Evidence on the importance of local supply." PII: S0304405X12002425, *Journal of Financial Economics* 108 (2): 425–448. ISSN: 0304405X. https://doi.org/10.1016/j.jfineco.2012.11.007.

Eser, Fabian, and Bernd Schwaab. 2016. "Evaluating the impact of unconventional monetary policy measures: Empirical evidence from the ECB's Securities Markets Programme." PII: S0304405X15000963, *Journal of Financial Economics* 119 (1): 147–167. ISSN: 0304405X. https://doi.org/10.1016/j.jfineco.2015.06.003.

Giles, Chris, and Philip Georgiadis. 2020. "Bank of England to directly finance UK government's extra spending." *Financial Times* (April 9, 2020). Accessed May 30, 2020. https://www.ft.com/content/664c575b-0f54-44e5-ab78-2fd30ef213cb.

Government of Japan. 1997. "Bank of Japan Act." Accessed March 31, 2020. http://www.japaneselawtranslation.go.jp/law/detail_main?re=01&vm=02&id=92.

Haldane, Andrew G., Matt Roberts-Sklar, Tomasz Wieladek, and Chris Young. 2016. "QE: The Story so far." *Bank of England Staff Working Paper* No. 624. https://www.bankofengland.co.uk/working-paper/2016/qe-the-story-so-far.

Hamilton, James D., and Jing Cynthia Wu. 2012. "The Effectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment." *Journal of Money, Credit and Banking* 44:3–46. ISSN: 00222879. https://doi.org/10.1111/j.1538-4616.2011.00477.x.

Hanisch, Max. 2017. "The effectiveness of conventional and unconventional monetary policy: Evidence from a structural dynamic factor model for Japan." PII: S0261560616300912, *Journal of International Money and Finance* 70:110–134. ISSN: 02615606. https://doi.org/10.1016/j.jimonfin.2016.08.002.

Harada, Kimie, and Tatsuyoshi Okimoto. 2019. "The BOJ's ETF Purchases and Its Effects on Nikkei 225 Stocks." *RIETI Discussion Paper series,* no. 19-E-014, accessed May 26, 2020. https://www.rieti.go.jp/jp/publications/dp/19e014.pdf.

Hasegawa, Toshiro. 2019. "Risk Premium Method Disclosure - Verifiable by the Bank of Japan in Purchasing ETF [Transl.]" *Bloomberg* (May 30, 2019). Accessed June 1, 2020. https://www.bloomberg.co.jp/news/articles/2019-05-30/PSAQP46KLVR501.

Hayashi, Fumio, and Junko Koeda. 2013. "A Regime-Switching SVAR Analysis of Quantitative Easing." *CARF Working Paper Series,* accessed May 26, 2020. https://www.carf.e.u-tokyo.ac.jp/old/pdf/workingpaper/fseries/F322.pdf.

Ho, Daniel E., Kosuke Imai, Gary King, and Elizabeth A. Stuart. 2007. "Matching as Nonparametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference." PII: S1047198700006483, *Political Analysis* 15 (3): 199–236. ISSN: 1047-1987. https://doi.org/10.1093/pan/mpl013.

Holland, Paul W. 1986. "Statistics and Causal Inference." *Journal of the American Statistical Association* 81 (396): 945–960. ISSN: 0162-1459. https://doi.org/10.1080/01621459.1986.10478354.

House of Councillors. 2019. "Committee on Financial Affairs Internet deliberation relay." Accessed June 14, 2020. https://www.webtv.sangiin.go.jp/webtv/detail.php?ssp=38194&type=recorded.

Ide, Shingo. 2019. "A Change in the BOJ's Buying of ETFs?" NLI Research Institute. Accessed June 15, 2020. https://www.nam.co.jp/english/news/pepdf/191220_report.pdf.

Japan Exchange Group. 2020a. "TOPIX." Copyright: (C) Japan Exchange Group, Inc. Accessed June 17, 2020. https://www.jpx.co.jp/english/markets/indices/topix/index.html.

———. 2020b. "Transition of Trading Hours." Accessed June 16, 2020. https://www.jpx.co.jp/english/equities/trading/domestic/tvdivq0000006blj-att/transition_e.pdf.

Joyce, Michael, David Miles, Andrew Scott, and Dimitri Vayanos. 2012. "Quantitative Easing and Unconventional Monetary Policy – an Introduction." *The Economic Journal* 122 (564): F271–F288. ISSN: 0013-0133. https://doi.org/10.1111/j.1468-0297.2012.02551.x.

Kimura, Takeshi, and Jouchi Nakajima. 2016. "Identifying conventional and unconventional monetary policy shocks: a latent threshold approach." *The B.E. Journal of Macroeconomics* 16 (1). ISSN: 2194-6116. https://doi.org/10.1515/bejm-2015-0074.

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen. 2013. "The Ins and Outs of LSAPs." In *Proceedings - Economic Policy Symposium,* pp. 57–111. Jackson Hole, United States: Federal Reserve Bank of Kansas City. https://www.kansascityfed.org/publicat/sympos/2013/2013Krishnamurthy.pdf.

Lewis, Leo. 2019. "BoJ's stock-buying programme starts to sputter." *Financial Times* (November 21, 2019). Accessed April 22, 2020. https://www.ft.com/content/3c2e8952-0b72-11ea-bb52-34c8d9dc6d84.

Lewis, Leo, and Kana Inagaki. 2020. "Bank of Japan ploughs deeper into stocks to ease coronavirus fears." *Financial Times* (March 16, 2020). Accessed March 27, 2020. https://www.ft.com/content/fd403436-674a-11ea-800d-da70cff6e4d3.

Maeda, Kou, and Junnosuke Shino. 2019. "Stock Lending Market and the BOJ's ETF purchasing program: Micro-Evidence from ETF Balance Sheet Data and Equity Repo Trading Data." *WINPEC Working Paper Series,* no. No. E1811, https://www.waseda.jp/fpse/winpec/assets/uploads/2019/01/No.E1811.pdf.

Matsuki, Takashi, Kimiko Sugimoto, and Katsuhiko Satoma. 2015. "Effects of the Bank of Japan's current quantitative and qualitative easing." PII: S0165176515002207, *Economics Letters* 133:112–116. ISSN: 01651765. https://doi.org/10.1016/j.econlet.2015.05.025.

Michaelis, Henrike, and Sebastian Watzka. 2017. "Are there differences in the effectiveness of quantitative easing at the zero-lower-bound in Japan over time?" PII: S0261560616301097, *Journal of International Money and Finance* 70:204–233. ISSN: 02615606. https://doi.org/10.1016/j.jimonfin.2016.08.008.

Ministry of Finance, Japan. 2020. *Debt Management Report 2019: The Government Debt Management and the State of Public Debts.* Accessed June 15, 2020. https://www.mof.go.jp/english/jgbs/publication/debt_management_report/2019/esaimu2019.pdf.

Miyao, Ryuzo, and Tatsuyoshi Okimoto. 2017. "The Macroeconomic Effects of Japan's Unconventional Monetary Policies." *RIETI Discussion Paper series,* no. 17-E-065, accessed May 26, 2020. https://www.rieti.go.jp/jp/publications/dp/17e065.pdf.

Morgan, Stephen L., and Christopher Winship. 2015. *Counterfactuals and causal inference: Methods and principles for social research.* Second Edition. Analytical methods for social research. New York NY: Cambridge University Press. ISBN: 9781107694163.

Nikkei Inc. 2020. "Nikkei Stock Average Index Guidebook." Accessed June 17, 2020. https://indexes.nikkei.co.jp/nkave/archives/file/nikkei_stock_average_guidebook_en.pdf.

Otsubo, Kansho Piotr. 2018. "How Does Unconventional Monetary Policy Influence the Economy in Japan?" *Asian Economic and Financial Review* 8 (3): 308–330. ISSN: 23052147, accessed May 26, 2020. https://doi.org/10.18488/journal.aefr.2018.83.308.330. http://www.aessweb.com/pdf-files/AEFR-2018-8(3)-308-330.pdf.

Pagano, Marco, Antonio Sánchez Serrano, and Josef Zechner. 2019. *Can ETFs contribute to systemic risk?* Vol. no 9 (June 2019). Reports of the Advisory Scientific Committee. Pagano, Marco (VerfasserIn.) Sánchez Serrano, Antonio (VerfasserIn.) Zechner, Josef (VerfasserIn.) Frankfurt am Main, Germany: ESRB, European Systemic Risk Board, European System of Financial Supervision. ISBN: 978-92-9472-121-1.

Poterba, James M., and John B. Shoven. 2002. "Exchange-Traded Funds: A New Investment Option for Taxable Investors." *American Economic Review* 92 (2): 422–427. ISSN: 0002-8282, accessed June 15, 2020. https://doi.org/10.1257/000282802320191732. https://pubs.aeaweb.org/doi/pdf/10.1257/000282802320191732.

Shibamoto, Masahiko, and Minoru Tachibana. 2013. "The Effect of Unconventional Monetary Policy on the Macro Economy: Evidence from Japan's Quantitative Easing Policy Period." *RIEB Discussion Paper Series,* no. DP2013-12, accessed May 26, 2020. https://www.rieb.kobe-u.ac.jp/academic/ra/dp/English/DP2013-12.pdf.

Shirai, Sayuri. 2018. "Bank of Japan's Exchange-Traded Fund Purchases as an Unprecedented Monetary Easing Policy." *ADBI Working Paper Series,* no. No. 865, accessed June 15, 2020. https://www.adb.org/sites/default/files/publication/447031/adbi-wp865.pdf.

Shirakawa, Masaaki. 2012. *Deleveraging and Growth: Is the Developed World Following Japan's Long and Winding Road?* LECTURE AT THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE (CO-HOSTED BY THE ASIA RESEARCH CENTRE AND STICERD, LSE).

Shiratsuka, Shigenori. 2010. "Size and Composition of the Central Bank Balance Sheet: Revisiting Japan's Experience of the Quantitative Easing Policy." *Monetary and Economic Studies,* 79–106. Accessed June 15, 2020. https://www.imes.boj.or.jp/research/papers/english/me28-6.pdf.

Shirota, Toyoichiro. 2018. "Evaluating the Unconventional Monetary Policy in Stock Markets: A Semi-parametric Approach." *Discussion Paper, Series A* No. 2018-322. Accessed May 26, 2020. https://eprints.lib.hokudai.ac.jp/dspace/bitstream/2115/68403/1/DPA322.pdf.

Svensson, Lars E. O. 2001. "The Zero Bound in an Open Economy: A Foolproof Way of Escaping from a Liquidity Trap." *Monetary and Economic Studies (Special Edition),* accessed May 30, 2020. https://www.imes.boj.or.jp/research/papers/english/me19-s1-11.pdf.

Tokyo Stock Exchange, Inc. 2019. "Business Regulations (as of July 16, 2019)." Tokyo Stock Exchange, Inc. Accessed June 16, 2020. https://www.jpx.co.jp/english/rules-participants/rules/regulations/tvdivq0000001vyt-att/busines_regs_20190716.pdf.

Ueda, Kazuo. 2012. "The Effectiveness of Non-Traditional Monetary Policy Measures: The Case of the Bank of Japan." *Japanese Economic Review* 63 (1): 1–22. ISSN: 13524739. https://doi.org/10.1111/j.1468-5876.2011.00547.x.

———. 2013. "Response of Asset Prices to Monetary Policy under Abenomics." *Asian Economic Policy Review* 8 (2): 252–269. ISSN: 18328105. https://doi.org/10.1111/aepr.12026.

Uetake, Tomo. 2019. "BOJ breaks its stock buying pattern, sparks talk of tapering." *Reuters Media* (November 15, 2019). Accessed June 15, 2020. https://www.reuters.com/article/us-japan-stocks-boj-graphic/boj-breaks-its-stock-buying-pattern-sparks-talk-of-tapering-idUSKBN1XP0JC.

Whiffin, Andrew. 2019. "BoJ's dominance over ETFs raises concern on distorting influence." *Financial Times* (April 1, 2019). Accessed April 22, 2020. https://www.ft.com/content/aba02f8c-3eab-11e9-9499-290979c9807a.