The Effects of Japan's Unconventional Monetary Policy on Asian Stock Markets*

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Abstract

This paper explores structural changes in the spillover effects of Japan's quantitative and qualitative easing (QQE) and negative interest rate policy (NIRP) on Asian stock markets. Our empirical investigation finds that Asian stock markets first reacted to the yen's depreciation negatively, yet came to respond positively as the QQE progressed. We show that the QQE had a much smaller beggar-thy-neighbor effect than what was originally feared because positive spillover effect of Japan's stock market recovery dominated the beggar-thy-neighbor effect in the region. We also find that decline of Japan's long-term interest rate had significantly positive effects on the Asian stock prices in the NIRP period. We discuss that this might have happened because local financial institutions who lost their profit opportunities in domestic markets explored a new profit opportunity in emerging Asia after the NIRP was announced.

Keywords: unconventional monetary policy, beggar-thy-neighbor effect, stock markets in Asia

JEL Classification: F10, F32, E52

1. Introduction

After the global financial crisis (GFC), central banks in advanced countries implemented a variety of untested and unconventional monetary policies. They cut interest rates aggressively and then, as policy rates approached zero, deployed a new set of policies that have been labeled as quantitative easing (QE), credit-easing, forward guidance policies, or negative interest rate. These policies were effective in achieving their domestic goals at the time of greatest financial turmoil. But a number of studies suggested that they had large spillover effects on the rest of the world, especially on emerging market economies (EMEs) (see, for example, Fratzscher et al. 2013, Chen et al. 2014, Bauer and Neely 2014, Rogers et al. 2014, Bowman et al. 2015, and Neely 2015). Several authors also found that unconventional monetary policies in advanced countries had large spillover effects on emerging Asian economies which might be vulnerable to volatile swings in currencies, international capital flows,

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and increasing external debt levels (see, for example, Morgan 2011, Park and Um 2016, Tillmann 2016, Didier et al. 2017, and Belke, et al. 2018). Volatile capital mobility may call for macroprudential policy in the globalized financial markets.

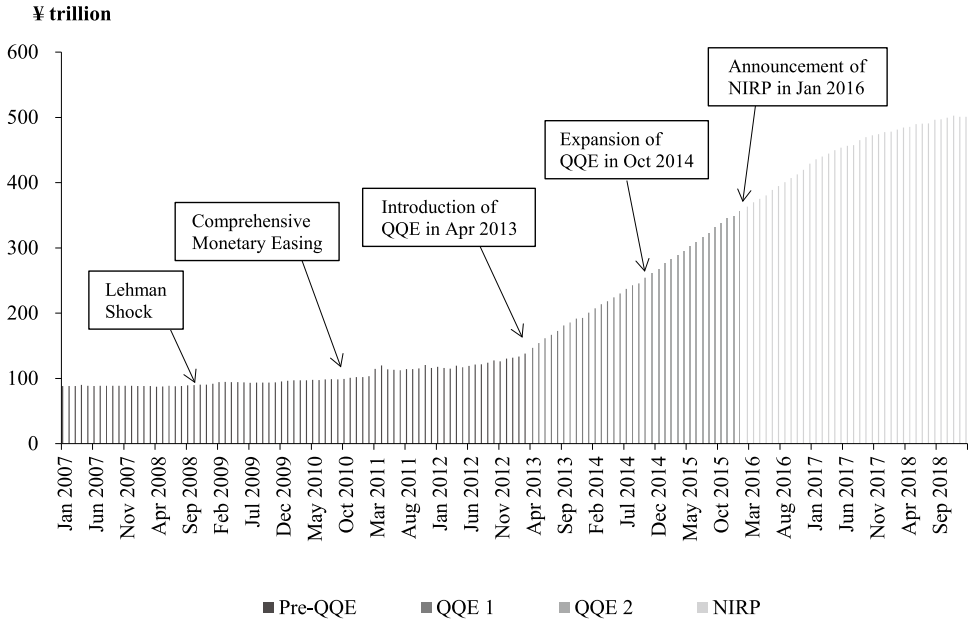
In this paper, we explore what spillover effects Japan's unconventional monetary policy had on Asian stock markets. As is summarized in Table 1, the Bank of Japan (BOJ) adopted a series of unconventional monetary policies after the GFC. In particular, after the introduction of the "Quantitative and Qualitative Monetary Easing (QQE)" on 4 April 2013, the BOJ became highly aggressive in its unconventional policy. The BOJ expanded the QQE on 31 October 2014. Figure 1 depicts monthly data of the base money in Japan from 2007 to 2018. Unlike central banks in the other advanced countries, the base money had changed rather modestly until 2012. However, it started to increase dramatically when the BOJ introduced the QQE. However, regardless of dramatic increases in the base money, the QQE could not achieve the price stability target of 2 percent. This was why the BOJ introduced a new framework for strengthening monetary easing, that is, "QQE with a Negative Interest Rate" on 29 January 2016 and "QQE with Yield Curve Control" on 21 September 2016. This paper investigates how different spillover effects these unconventional policies had on Asian stock markets.

The QQE without a negative interest rate brought dramatic depreciation of the yen and had positive effects on the Japanese economy. The yen-dollar rate, which had been around 80 yen per dollar in 2012, depreciated to 102 yen per dollar on 15 May 2013. The expansion of the QQE on 31 October 2014 led to further depreciation of the yen, which had positive effects on the Japanese economy (see, for example, Fukuda 2015, Kano 2015, and Shioji 2015). At the early phase of the QQE, several Asian EMEs showed a serious concern about

Table 1. Timeline of Japan's Unconventional Monetary Policy

Date	Description		Governor
19-Dec-08	Lowering of the Bank's target for the uncollateralized overnight call rate		Shirakawa
	by 20 basis points; it will be encouraged to remain at around 0.1 percent.		
18-Dec-09	The midpoints of most Policy Board members' "understanding" are around		Shirakawa
	1 percent CPI inflation rate.		
5-Oct-10	Comprehensive Monetary Easing		Shirakawa
22-Jan-13	The "2% Price Stability Target" under the Framework for the Conduct of		Shirakawa
	Monetary Policy		
4-Apr-13	Introduction of the "Quantitative and Qualitative Monetary	QQE1	Kuroda
	Easing (QQE)"		
31-Oct-14	Expansion of the Quantitative and Qualitative Monetary Easing	QQE2	Kuroda
29-Jan-16	Introduction of "Quantitative and Qualitative Monetary Easing with a Negative Interest Rate"	NIRP1	Kuroda
21-Sep-16	New Framework for Strengthening Monetary Easing: "Quantitative and Qualitative Monetary Easing with Yield Curve Control"	NIRP2	Kuroda

Figure 1. Base Money in Japan from 2007 to 2018



Note) QQE = quantitative and qualitative monetary easing and NIRP = negative interest rate policy.
Source) The Bank of Japan.

its potential beggar-thy-neighbor effect which may result in regional competitive devaluation. However, the authors such as Dekle and Hamada (2015) and Kawai (2015) pointed out that unlike US quantitative easing, Japan's QQE without a negative interest rate may have positive spillover effects on the rest of the world (see also Ganelli and Tawk 2016). Fukuda (2019) showed that it benefited East Asian economies because positive spillover effects of Japan's stock market recovery dominated beggar-thy-neighbor effects in the region. In contrast, unlike the QQE without a negative interest rate, the negative interest rate policy (NIRP) had limited impacts on the yen-dollar exchange rate and stock prices in Japan. Instead it had substantial impacts on long-term interest rates and raised a serious concern about profitability of local financial institutions. Fukuda (2018) thus suggested that the NIRP might have had different spillover effects on Asian stock markets. To shed some light on these structural changes, the following analysis explores how the responses in Asian stock markets to Japan's unconventional monetary policies had changed over time by using daily data.

After overviewing the impacts of a series of unconventional monetary policies on the Japanese financial markets, the following analysis investigates what spillover effects Japan's financial market shocks had on East Asian financial markets after the introduction of the QQE. In the analysis, we examine spillover effects on stock markets in Korea, Singapore, Taiwan, and Thailand. We find that the East Asian stock markets, which had first reacted to the depreciation of the yen negatively, came to respond positively as the QQE progressed.

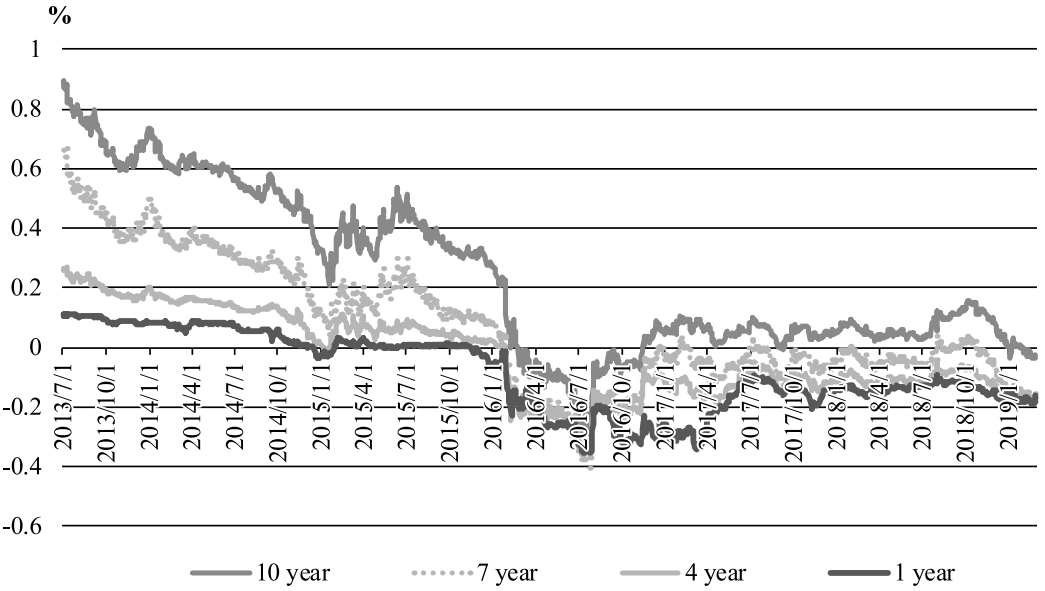
At the early phase of the QQE, several Asian EMEs showed a serious concern because the BOJ's unconventional monetary policy could have a beggar-thy-neighbor effect. However, the QQE caused not only the depreciation of the yen, but also substantial stock price recovery in Japan. Since the stock price recovery had a positive spillover effect on neighboring economies, the positive spillovers came to dominate the beggar-thy-neighbor effect as the QQE progressed. We also find that in the NIRP period, a fall in Japan's long-term interest rate significantly increased the Asian stock prices. The NIRP did not have positive spillovers through stock price recovery in Japan because the stock price recovery was limited. However, since Japanese banks aggressively expanded their assets overseas to increase their stubbornly low profitability, the NIRP could have substantial spillovers on Asian stock markets. These results imply that not only the QQE but also the NIRP might have benefited emerging Asian economies. However, they also suggest that the transmission mechanisms had several structural changes as the BOJ extended its unconventional monetary policies.

2. The Impacts of the QQE on the Japanese Financial Markets

Before investigating spillover effects on Asian stock markets, this section overviews the impacts of a series of unconventional monetary policies on Japanese financial markets. After the GFC, the BOJ induced its policy rate, that is, overnight call rate, around the zero bound. However, under a series of unconventional monetary policies, not only short-term interest rates but also long-term interest rates declined substantially. Figure 2 depicts daily data of the Japanese government bond (JGB) yields with various terms to maturity from July 2013 to February 2019. Before the introduction of the QQE, long-term interest rates were far above zero, although they had already been historically low. However, as the QQE progressed, the gaps between long-term and short-term interest rates had shrunk substantially. In particular, after the announcement of the NIRP, both long-term and short-term interest rates had fallen below zero and their gaps became negligible until the BOJ introduced "QQE with Yield Curve Control" on 21 September 2016.

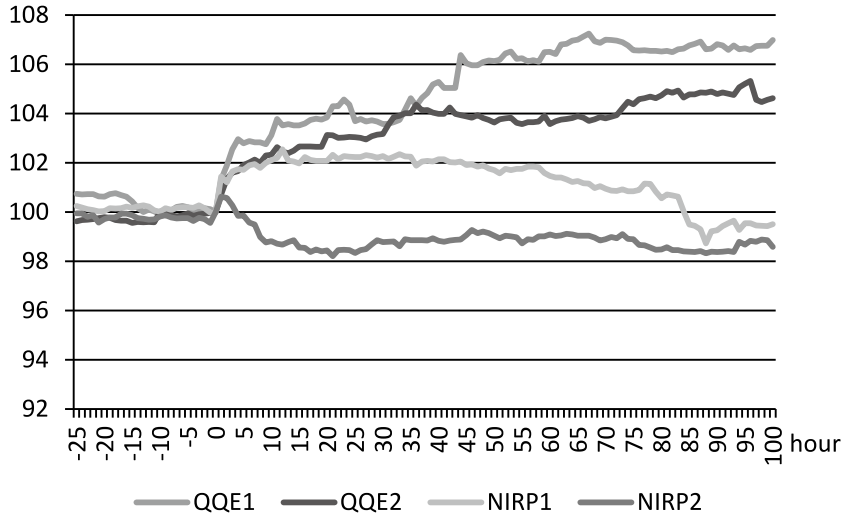
The QQE without a negative interest rate had large impacts on the yen-dollar exchange rate and Japan's stock prices. The yen-dollar rate, which had been around 80 yen per dollar in 2012, depreciated to 102 yen per dollar on 15 May 2013. Japan's average stock price index (Nikkei 225), which stagnated around 9,000 yen in 2012, rose up to 15,000 yen on 15 May 2013. The expansion of QQE on 31 October 2014 led to further yen's depreciation and stock price recovery. However, unlike the QQE without a negative interest rate, the NIRP had limited impacts on the yen-dollar exchange rate and the stock price in Japan. Figure 3 depicts hourly data of the yen-denominated dollar exchange rate before and after the announcement of the four types of the QQEs: the introduction of the QQE on 4 April 2013 (i.e., QQE1), the expansion of the QQE on 31 October 2014 (i.e., QQE2), the introduction of QQE with a negative interest rate on 29 January 2016 (i.e., NIRP1), and the introduction of QQE with yield curve control on 21 September 2016 (i.e., NIRP2). In the figure, we define the latest hour before the BOJ's policy announcement by "0 hour" and normalize the

Figure 2. Japanese Government Bond (JGB) Yields



Source) *Datastream*.

Figure 3. Hourly Yen-dollar Exchange Rate after the Policy Announcements



Source) *Datastream*.

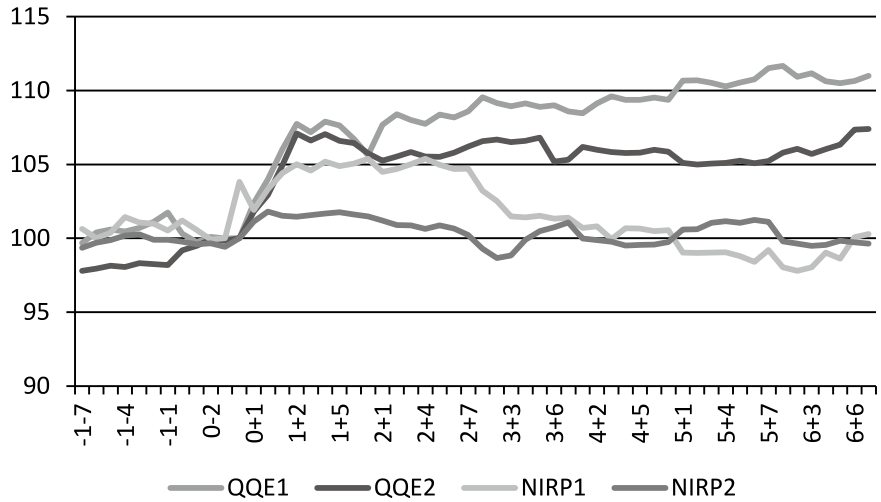
exchange rate at the 0 hour to be 100. We then depict the hourly yen-dollar exchange rate from -25 hours to 100 hours for the 4 types of the QQEs.

The figure shows that the QQE1 and the QQE2 caused persistent depreciation of the yen-dollar exchange rate after the announcement. This implies that the QQE without a nega-

tive interest rate brought dramatic depreciation of the yen. In contrast, the NIRP1 and the NIRP2 did not cause persistent depreciation of the yen-dollar exchange rate. The announcement of the QQE with a negative interest rate on 29 January 2016 (i.e., NIRP1) caused depreciation of the yen-dollar exchange rate for the first 12 hours. But the depreciation was only temporary. Unlike in the QQE1 and the QQE2, the yen-dollar exchange rate stopped depreciating after the first 12 hours and started appreciating after about 36 hours. The depreciation of the yen-dollar exchange rate was much more short-lived after the introduction of the QQE with yield curve control on 21 September 2016 (i.e., NIRP2). The yen-dollar exchange rate depreciated by 6% in the first hour after the policy announcement. But it started to appreciate in the next 1 hour and resulted in about 1.5% appreciation in the next 9 hours. Regardless of substantial decline in long-term interest rates, the NIRP had no persistent impact on the yen-dollar exchange rate.

Figure 4 depicts intra-daily data of the Nikkei 225 stock price index before and after the announcement of the 4 types of the QQEs: the QQE1 on 4 April 2013, the QQE2 on 31 October 2014, the NIRP1 on 29 January 2016, and the NIRP2 on 21 September 2016. It depicts the level of the stock price index for 7 different time zones in each day: 9AM, 9:15AM, 10AM, 11:30AM, 12:30PM, 2PM, and 3PM. In the figure, we define the latest time zone before the BOJ's policy announcement by "time 0" and normalize the stock price index at the time 0 to be 100. We then depict the intra-daily stock price index from the opening time on the day before the announcement to the closing time on the sixth day after the announcement for the four types of the QQEs.

Figure 4. Intra-daily Data of the Nikkei 225 Stock Price Index



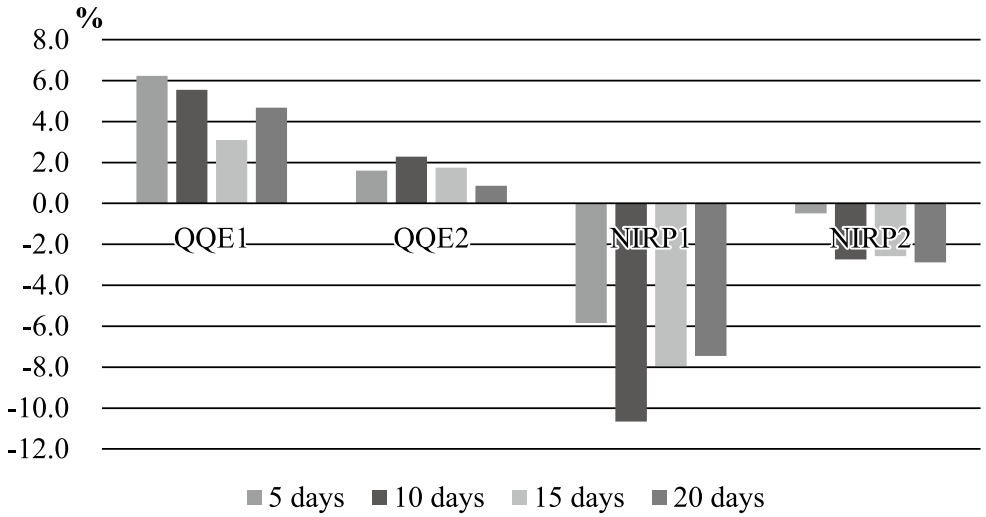
Source) *Datastream*.

The figure shows that the QQE1 and the QQE2 caused persistent increases in the stock price index after the announcement. This implies that the QQE without a negative interest rate brought dramatic stock price increases in Japan. In contrast, the NIRP1 and the NIRP2

did not cause persistent increases in the stock price index. The announcement of QQE with a negative interest rate on 29 January 2016 (i.e., NIRP1) had increased the stock price index until the closing time of the next day. But the increases were only temporary. Unlike in the QQE1 and the QQE2, the stock price index stopped rising after the second day and started to decline in the afternoon of the second day. The stock price increases were much more short-lived after the introduction of QQE with yield curve control on 21 September 2016 (i.e., NIRP2). The stock price index increased by 1.8% on the day of the policy announcement. But it started declining the next day and returned to the level before the announcement.

The NIRP had limited impacts on the yen-dollar exchange rate and on Japan's average stock price index. However, it raised serious concern about the profitability of local financial institutions and had large negative impacts on financial sector's stock prices in Japan. After the announcement of the NIRP, financial sector's stock prices declined substantially in Japan. Figure 5 depicts excess stock returns of the Japanese financial sector after the announcement of the 4 types of the QQEs: QQE1 on 4 April 2013, QQE2 on 31 October 2014, NIRP1 on 29 January 2016, and NIRP2 on 21 September 2016. In the figure, excess stock returns are defined by daily stock returns of the Japanese financial sector minus daily returns of TOPIX (Tokyo Stock Price Index). Normalizing their value on the day of the policy announcement to be zero, we calculated their accumulated excess stock returns of the financial sector in 5 business days, 10 business days, 15 business days, and 20 business days after the policy announcement respectively. The figure shows that while the QQE1 and the QQE2 in-

Figure 5. Excess Stock Returns of Financial Sector in Japan



Note) Excess stock returns are defined by daily stock returns of the financial sector minus daily returns of TOPIX (Tokyo Stock Price Index). Normalizing their value on the day of the policy announcement to be zero, we calculated their accumulated excess stock returns after the policy announcement.
Source) *Datastream*.

creased significantly positive excess stock returns, the NIRP1 and the NIRP2 caused persistent negative excess stock returns in the financial sector. The negative excess stock returns were especially conspicuous in the NIRP1.

3. Empirical Methodology

The purpose of the following sections is to explore what spillover effects Japan's different unconventional monetary policies had on Asian stock markets. To investigate structural changes in the spillover effects, we explore how daily stock market returns in Asian emerging economies reacted to financial shocks in Japan for alternative monetary policy regimes. For alternative subsample periods, we estimate GARCH (1,1) model to capture daily financial spillover returns on stock prices in emerging Asian economies.

$$Y_t^i = \alpha + \sum_{h=1}^{H}\sum_{j=0}^{1}\beta_h X_{t-j}^h + \sum_{k=1}^{K}\sum_{j=0}^{1}\gamma_k Z_{t-j}^k + \sum_{l=1}^{L}\sum_{j=1}^{1}\delta_l Z_{t-j}^l + u_t, \quad (1a)$$

$$\sigma_t^2 = \phi + \eta\, Resid_{t-1}^2 + \lambda\, \sigma_{t-1}^2 + \varepsilon_t, \quad (1b)$$

where Y_t^i is stock returns in Asian economy i (i = Korea, Singapore, Taiwan, and Thailand), X_t^h is Japan's financial variable h (h = change of the yen-dollar exchange rate, stock returns of the Nikkei 225 index, and change of 10-year Japanese government bond yields), Z_t^k is stock returns in Asian economy k (k = China and Hong Kong), and Z_t^l is a financial variable l in Europe or in the United States. σ_t^2 is variance of the disturbance term u_t and $Resid_t$ is the estimated residual of (1a). The estimation of the GARCH model is done with the number of lags set to one.[1]

Since our main interest is to explore spillover effects on Asian stock markets, we chose stock returns in Korea, Singapore, Taiwan, and Thailand as a dependent variable. We chose these four Asian economies partly because they have a developed stock market and partly because their market size is not large enough to have significant reverse causality to Japan's financial variables. The country-specific equity returns refer to those of the main stock market index in local currency, that is, Seoul Composite Index, Singapore (SES) Strait Times Index, Taiwan Weighted Price, and Thailand SET-Index.

The set of explanatory variables consists of three subsets. The first subset (X_t^h) is three of Japan's financial variables: daily change of the yen-dollar (dollar per yen) exchange rate, daily returns of the Nikkei 225 stock price index, and daily change of 10-year Japanese government bond (JGB) yields. Since the yen-dollar rate decreases when the yen depreciates against the U.S. dollar, its coefficient takes a positive (negative) sign if depreciation of the yen has a negative (positive) spillover effect on country i's stock price. Since the yen depreciated against the U.S. dollar dramatically under the QQE, one of our main focuses in the following empirical analysis is which sign the coefficient of the exchange rate takes in the QQE1 and QQE2 periods. We also focus on the sign of 10-year JGB yields in the NIRP1

[1] Schwarz SC chose one lag in all cases, and so did Akaike AIC in most cases.

and NIRP2 periods. Unlike the QQE1 and the QQE2, the NIRP had limited impacts on the yen-dollar exchange rate and the Nikkei 225 stock price index but large impacts on the 10-year JGB yields. It is thus important to explore what different effects the 10-year JGB yields had before and after introducing the NIRP.

The second subset (Z_t^k) is daily stock returns in China (i.e., Shanghai SSEC) and Hong Kong (i.e., Hang Seng Stock Index). Because of its remarkable economic development, China now plays a critical role in supply chains in Asia and becomes the biggest trade partner for most of the Asian economies. It is thus likely that spillovers from stock prices in China to those in the other Asian economies have increased dramatically after the GFC. In addition, after late 2014, stock returns in China became highly volatile reflecting growth slowdown of the Chinese economy. Including the second subset of variables may also control the effect of such volatile Chinese stock prices on Asian stock markets.

The third subset (Z_t^l) consists of daily stock returns in London (i.e., FTSE 100) and New York (i.e., Dow Jones Industrials), daily log-difference of the VIX, and daily differenced 10-year U.S. government bond yields. These variables are included to control the effects of common/systematic global factors. Since European and New York markets are open after Asian financial markets are closed, we only included their lagged variables in the regressions.

All daily data was downloaded from *Datastream*. The sample starts in 5 October 2010 when the BOJ started "Comprehensive Monetary Easing" and ends in 31 July 2018. We split the sample into five subsample periods: pre-QQE period (i.e., 5 October 2010 to 3 April 2013), QQE1 period (i.e., 4 April 2013 to 30 October 2014), QQE2 period (i.e., 31 October 2014 to 28 January 2016), NIRP1 period (i.e., 29 January 2016 to 21 September 2016), and NIRP2 period (i.e., 22 September 2016 to 31 July 2018). We split the QQE period into the QQE1 period and the QQE2 period because the BOJ expanded the QQE on 31 October 2014. We also split the NIRP period into the NIRP1 period and the NIRP2 period because the BOJ introduced "QQE with Yield Curve Control" on 21 September 2016.

4. Empirical results before and after the QQE

This section explores spillover effects of three of Japan's financial variables on Asian stock markets in the pre-QQE period, the QQE1 period, and the QQE2 period. We use the estimation results in the pre-QQE period as a benchmark and see how the effects of Japan's financial variables changed after the BOJ introduced the QQE. We also examine whether the spillover effects had a structural change before and after the BOJ expanded the QQE on 31 October 2014. The expansion of the QQE led to further depreciation of the yen and Japan's stock price increases. It is worthy to see whether the expansion caused any structural change in the spillover effects.

Table 2 summarizes the estimation results for the three alternative subsample periods: the pre-QQE period, the QQE1 period, and the QQE2 period. Since our main purpose is to explore what spillover effects Japan's unconventional monetary policy had on stock prices

Table 2. Basic Estimation Results for Alternative Subsample Periods

(1) Pre-QQE period (October 2010 to 3 April 2013)

		Korea			Singapore			Taiwan			Thailand		
explanatory variable		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic	
	constant term	-0.001	-0.05		0.010	0.50		0.007	0.24		0.090	2.98	***
Japan's	ΔNikkei 225	0.188	6.32	***	0.084	3.90	***	0.192	5.16	***	0.025	0.83	
financial	ΔNikkei 225(-1)	-0.006	-0.20		0.000	0.00		0.023	0.72		0.013	0.41	
variables	ΔYen	0.016	0.33		0.020	0.55		0.071	1.47		0.014	0.25	
	ΔYen(-1)	0.238	4.49	***	0.009	0.26		0.142	3.25	***	0.001	0.01	
	ΔJGB yields	0.007	0.35		0.003	0.19		0.024	1.21		-0.013	-0.69	
	ΔJGB yields(-1)	0.012	0.71		-0.013	-1.12		0.009	0.47		-0.003	-0.17	
control	ΔChina stock	-0.046	-1.59		-0.027	-1.30		0.030	1.06		-0.005	-0.17	
variables	ΔChina stock(-1)	-0.050	-1.93	*	-0.057	-2.52	**	-0.063	-2.40	**	-0.019	-0.64	
	ΔHK stock	0.466	13.00	***	0.443	16.62	***	0.346	9.93	***	0.428	11.98	***
	ΔHK stock(-1)	0.010	0.29		0.070	2.85	**	0.071	2.23	**	0.058	1.62	
	ΔUK stock(-1)	0.010	0.21		-0.048	-1.51		0.013	0.29		-0.085	-1.98	**
	ΔNY stock(-1)	0.215	3.36	***	0.028	0.62		0.149	2.51	**	0.107	1.51	
	ΔVIX(-1)	0.009	1.36		-0.002	-0.49		0.008	1.17		0.003	0.42	
	ΔUS yields(-1)	0.006	0.92		0.011	2.22	**	-0.002	-0.24		0.000	0.07	
variance	C	0.027	2.75	***	0.020	2.63	***	0.011	2.03	**	0.060	3.11	***
equation	RESID(-1)^2	0.127	4.41	***	0.118	4.28	***	0.057	4.29	***	0.195	5.93	***
	GARCH(-1)	0.836	26.02	***	0.822	21.05	***	0.925	59.67	***	0.736	16.07	***
	Adj. R^2	0.49			0.55			0.46			0.33		
	D.W. Stat.	2.20			2.43			1.95			2.15		

(2) QQE1 period (4 April 2013 to 30 October 2014)

		Korea			Singapore			Taiwan			Thailand		
explanatory variable		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic	
	constant term	-0.006	-0.22		-0.023	-0.99		0.024	0.81		0.065	1.42	
Japan's	ΔNikkei 225	0.117	4.27	***	0.079	3.55	***	0.091	3.52	***	0.057	1.34	
financial	ΔNikkei 225(-1)	-0.038	-1.48		-0.002	-0.13		0.020	0.78		-0.009	-0.27	
variables	ΔYen	0.014	0.30		-0.106	-2.78	***	-0.004	-0.08		-0.121	-1.57	
	ΔYen(-1)	0.124	2.33	**	0.031	0.54		0.145	2.04	**	0.256	3.06	***
	ΔJGB yields	-0.040	-2.56	**	-0.015	-0.87		-0.010	-0.44		-0.010	-0.40	
	ΔJGB yields(-1)	0.035	1.82	*	0.000	0.01		0.004	0.23		0.037	1.25	
control	ΔChina stock	0.052	1.46		-0.015	-0.55		0.048	1.42		0.002	0.03	
variables	ΔChina stock(-1)	0.003	0.09		-0.043	-1.53		-0.046	-1.34		-0.038	-0.66	
	ΔHK stock	0.268	6.93	***	0.256	8.10	***	0.254	6.72	***	0.233	4.09	***
	ΔHK stock(-1)	0.062	1.64		0.012	0.35		0.083	1.91	*	0.062	0.83	
	ΔUK stock(-1)	0.114	2.27	**	0.035	0.88		0.122	2.39	**	0.052	0.57	
	ΔNY stock(-1)	0.156	1.89	*	0.199	3.20	***	0.160	1.69	*	0.050	0.38	
	ΔVIX(-1)	0.001	0.15		0.007	1.37		0.006	0.76		-0.009	-0.66	
	ΔUS yields(-1)	0.002	0.32		-0.005	-0.83		-0.006	-0.88		-0.017	-1.37	
variance	C	0.065	1.24		0.011	1.44		0.044	1.66	*	0.013	1.91	*
equation	RESID(-1)^2	0.072	1.34		0.052	1.83	*	0.082	1.94	*	0.082	3.72	***
	GARCH(-1)	0.696	3.04	***	0.894	17.50	***	0.779	6.95	***	0.909	45.13	***
	Adj. R^2	0.40			0.39			0.31			0.16		
	D.W. Stat.	2.24			2.13			1.95			2.15		

Table 2. Basic Estimation Results for Alternative Subsample Periods (continued)

(3) QQE2 period (31 October 2014 to 28 January 2016)

		Korea			Singapore			Taiwan			Thailand		
explanatory variable		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic	
	constant term	0.009	0.25		-0.040	-1.20		-0.022	-0.53		-0.063	-1.41	
Japan's	ΔNikkei 225	0.198	5.69	***	0.116	3.16	***	0.166	3.61	***	0.063	1.28	
financial	ΔNikkei 225(-1)	-0.016	-0.55		-0.003	-0.08		0.004	0.10		-0.049	-1.14	
variables	ΔYen	-0.012	-0.16		-0.161	-2.69	***	-0.054	-0.68		-0.230	-2.90	***
	ΔYen(-1)	0.156	1.91	*	0.037	0.50		-0.022	-0.19		-0.023	-0.23	
	ΔJGB yields	0.010	0.45		0.022	1.15		-0.016	-0.69		-0.040	-2.01	**
	ΔJGB yields(-1)	0.013	0.58		0.015	0.78		-0.002	-0.09		0.030	1.31	
control	ΔChina stock	-0.026	-1.76	*	-0.003	-0.22		-0.021	-1.01		0.003	0.15	
variables	ΔChina stock(-1)	-0.034	-2.06	**	-0.025	-1.73	*	0.006	0.30		-0.016	-0.76	
	ΔHK stock	0.187	5.95	***	0.264	7.96	***	0.287	6.77	***	0.211	4.15	***
	ΔHK stock(-1)	0.027	0.71		0.054	1.81	*	0.063	1.41		-0.027	-0.53	
	ΔUK stock(-1)	0.080	1.89	*	-0.081	-1.89	*	-0.017	-0.32		-0.085	-1.53	
	ΔNY stock(-1)	-0.078	-1.09		0.205	2.71	***	0.013	0.12		0.033	0.36	
	ΔVIX(-1)	-0.021	-2.73	***	0.007	0.98		-0.008	-0.74		-0.011	-1.25	
	ΔUS yields(-1)	0.003	0.36		-0.003	-0.31		-0.001	-0.11		0.011	1.07	
variance	C	0.023	0.83		0.028	1.38		0.165	1.70	*	0.042	1.15	
equation	RESID(-1)^2	0.043	0.93		0.089	1.91	*	0.169	2.90	***	0.036	1.05	
	GARCH(-1)	0.891	7.50	***	0.833	9.31	***	0.522	2.40	**	0.892	10.82	***
	Adj. R^2	0.40			0.45			0.36			0.24		
	D.W. Stat.	2.15			2.15			2.07			2.11		

Note 1) * = significant at 10%, ** = significant at 5%, *** = significant at 1%.

2) See note in Table 2 for the definition of each explanatory variable.

3) ΔNikkei 225 ≡ daily returns of the Nikkei 225 stock price index, ΔYen ≡ daily change of the yen-dollar exchange rate, ΔJGB yields ≡ daily change of 10-year JGB yields, ΔChina stock ≡ daily stock returns of Shanghai SSEC, ΔHK stock ≡ daily stock returns of Hang Seng Stock Index, ΔUK stock ≡ daily stock returns of FTSE 100, ΔNY stock ≡ daily stock returns of Dow Jones Industrials, ΔVIX ≡ daily log-difference of the VIX, and ΔUS yields ≡ daily differenced 10-year U.S. government bond yields.

in the Asian economies, we will focus on what spillover effects the three financial variables in Japan had on returns on the stock price index in each of the four Asian economies.

Among the three financial variables in Japan, most of the coefficients of 10-year JGB yields were not statistically significant throughout the three subsample periods. The simultaneous effect of 10-year JGB yields on the stock price was significantly negative in Korea in the QQE1 period and in Thailand in the QQE2 period. But since the lagged effect was positive in both cases, the sum of the coefficients indicates that the total effect was not significant in any Asian economy before the NIRP period. This indicates that a change of low but still positive long-term interest rates in Japan had no significant spillover effects on the Asian economies.

Current Japanese stock returns (that is, daily returns of the Nikkei 225 stock price index), on the other hand, had significantly positive effects on stock markets in Korea, Singapore, and Taiwan throughout the three subsample periods. The positive spillover effects suggest that except for the Thai stock market, the Asian stock markets had strong instantaneous

linkage with the Japanese stock market. The linkage was strong even before the BOJ introduced the QQE. But since the QQE raised Japan's stock prices dramatically, it suggests that the QQE had strong positive spillover effects on the Asian stock markets through recovering Japan's stock prices.

Unlike the other two financial variables in Japan, the effects of the exchange rate (that is, daily change of the yen-dollar exchange rate) were not only heterogeneous across the Asian economies but also had substantial structural changes throughout the three subsample periods. In the pre-QQE period (that is, the benchmark period), the coefficient of one-lagged yen-dollar rate took a significantly positive sign only in Korea and Taiwan. This implies that even before the BOJ introduced the QQE, yen's depreciation had a negative spillover effect on stock prices in Korea and Taiwan. This probably happened because Japanese manufacturing exports were competitive with manufacturing exports in Korea and Taiwan. Since depreciation of the yen benefits Japanese exporters, it is likely that the stock markets in Korea and Taiwan had a tendency to regard it as bad news.

Even in the QQE1 period, the coefficient of one-lagged yen-dollar rate remained significantly positive in Korea and Taiwan. But in the QQE1 period, the coefficient of one-lagged yen-dollar rate was also significantly positive in Thailand. This implies that after the BOJ introduced the QQE, negative spillovers of depreciation of the yen also arose in Thailand. When the yen depreciated dramatically after the BOJ introduced the QQE, several Asian emerging countries showed a serious concern about the yen's depreciation because it may have a beggar-thy-neighbor effect in the region. It is likely that the positive coefficient of the yen-dollar rate in the QQE1 period reflected such a concern in Korea, Taiwan, and Thailand.

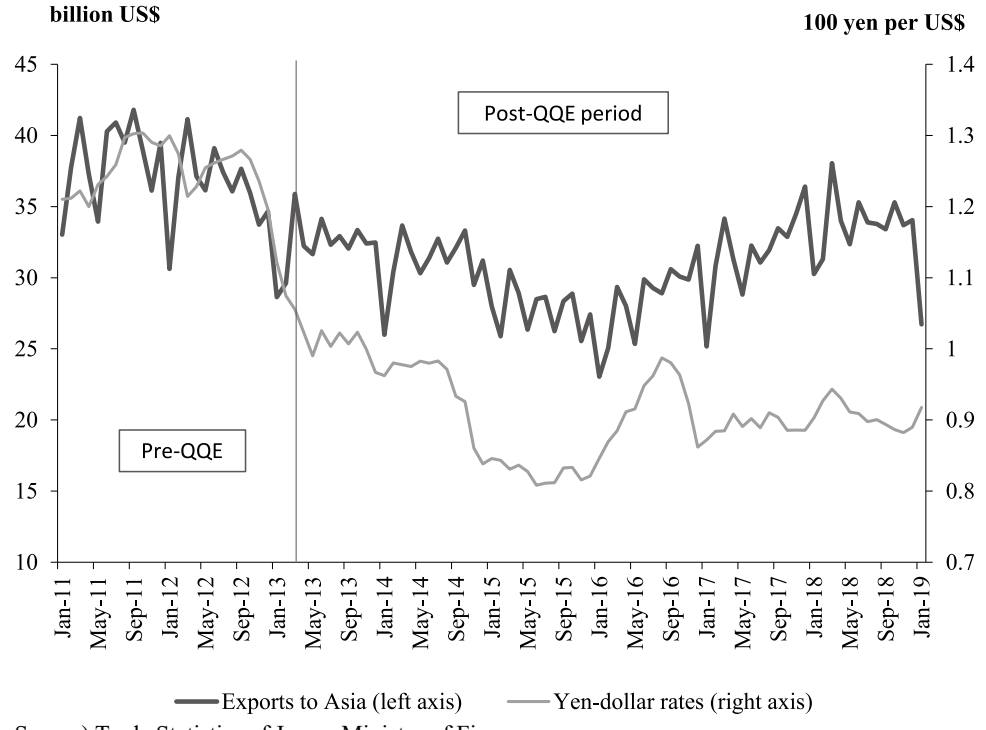
Unlike the other three Asian economies, the coefficient of current yen-dollar rate was significantly positive in Singapore in the QQE1 period. This suggests that after the BOJ introduced the QQE, yen's depreciation had positive spillover effects on stock prices in Singapore. This probably happened because unlike the other three Asian economies, Singapore was not a strong competitor against Japan in the exports. Singapore is a highly export-oriented economy. But its major exports are not necessarily close substitutes of Japanese exports. Instead, Singapore has had highly developed financial markets. The negative coefficient of the yen-dollar rate might have reflected such unique features in Singapore.

The coefficient of the yen-dollar rate remained significantly negative in Singapore even in the QQE2. This implies that the expansion of the QQE on 31 October 2014 did not change the spillover effect of the yen-dollar rate on stock prices in Singapore even though the yen had further depreciated. In contrast, the coefficient of the yen-dollar rate showed substantial structural changes in the other three Asian economies in the QQE2 period. In the case of Korea, the coefficient of the yen-dollar rate remained negative. But it became significant only at the 10% level in the QQE2 period. More importantly, the coefficient of the yen-dollar rate became negative in Taiwan and Thailand in the QQE2 period. In the case of Taiwan, it was not statistically significant but both current and one-lagged yen-dollar rates had a negative coefficient. In the case of Thailand, current yen-dollar rates had a significantly negative coefficient. These results indicate that a concern about the yen's depreciation

was weakened in Korea and disappeared in Taiwan and Thailand. As the QQE progressed, most Asian stock markets came to welcome positive spillover effects of Japan's unprecedented, unconventional monetary policy.

Asian stock markets eventually benefitted from the QQE because the beggar-thy-neighbor effect turned out to be much smaller than what was originally expected. Figure 6 depicts the dollar-denominated amount of Japan's exports to Asia and the yen-dollar (dollar per yen) exchange rate from January 2011 to January 2019. Before the QQE was introduced, the amount of Japan's exports to Asia was around 35 billion USD. But after the QQE was introduced, even though the yen depreciated dramatically, the amount of Japan's exports to Asia declined and became around 25 billion USD at the beginning of 2015. The amount of Japan's exports to Asia recovered only after 2016 when the yen appreciated against the U.S. dollar. This implies that despite a serious concern, the yen's depreciation did not have a beggar-thy-neighbor effect in the region. It is likely that this made negative spillovers of depreciation of the yen negligible as the QQE progressed.

Figure 6. Japan's exports to Asia and the Yen-dollar Exchange Rates



Source) Trade Statistics of Japan, Ministry of Finance.

5. Empirical results in the NIRP1 and NIRP2 Periods

This section investigates spillover effects of three of Japan's financial variables on Asian stock markets in the NIRP1 and NIRP2 periods. The BOJ's QQE was unprecedentedly ag-

gressive in its monetary easing. However, regardless of dramatic increases in the base money, the QQE could not achieve the price stability target of 2 percent. This was why the BOJ introduced the negative interest rate policy (NIRP) on 29 January 2016. Unlike the QQE without a negative interest rate, the NIRP had limited impacts on the yen-dollar exchange rate and stock prices in Japan. Instead it had substantial impacts on long-term interest rates and raised a serious concern about profitability of local financial institutions. It is thus important to investigate how different spillover effects the NIRP had on Asian stock markets.

Table 3 summarizes the estimation results of our GARCH model for the two alternative subsample periods: the NIRP1 period and the NIRP2 period. Among the three financial variables in Japan, a shock in Japan's stock market always had significantly positive impacts on the stock prices in Asian economies except in Thailand in the NIRP1 period. In particular, the coefficient of Japan's stock returns took large positive values in Korea throughout the subsample periods. This indicates that as in pre-NIRP periods, there was a strong stock market linkage across the Asian stock markets even after the introduction of the NIRP.

The coefficient of the yen-dollar exchange rate, in contrast, had mixed effects on the Asian stock markets. It took a significantly positive value in Korea and Singapore but a significantly negative value in Thailand in the NIRP1 period. The result in Korea is consistent with those in the pre-NIRP periods which indicated that the yen's depreciation might have had a beggar-thy-neighbor effect on the Korean economy. But the result in Singapore is not consistent with those in the pre-NIRP periods. More importantly, the coefficient of the

Table 3. Estimation Results for the NIRP1 and NIRP2 Period

(1) NIRP1 period (29 January 2016 to 21 September 2016)

		Korea			Singapore			Taiwan			Thailand		
explanatory variable		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic	
	constant term	-0.019	-0.51		-0.043	-0.91		0.052	1.81	*	0.077	1.49	
Japan's	ΔNikkei 225	0.165	4.87	***	0.094	2.03	**	0.055	1.65	*	0.059	1.33	
financial	ΔNikkei 225(-1)	0.028	0.90		0.067	1.46		0.034	0.98		0.003	0.06	
variables	ΔYen	0.114	1.90	*	0.023	0.30		0.005	0.09		-0.117	-1.77	*
	ΔYen(-1)	0.003	0.05		0.183	2.24	**	0.041	0.61		0.129	1.39	
	ΔJGB yields	-0.011	-0.78		-0.050	-2.37	**	-0.032	-1.47		-0.018	-0.81	
	ΔJGB yields(-1)	-0.012	-0.74		-0.010	-0.33		-0.055	-2.98	***	-0.043	-1.95	**
control	ΔChina stock	-0.042	-1.66	*	-0.055	-1.10		-0.007	-0.19		-0.052	-1.02	
variables	ΔChina stock(-1)	0.052	1.53		0.059	1.42		-0.008	-0.21		-0.031	-0.74	
	ΔHK stock	0.369	9.00	***	0.503	7.49	***	0.309	5.64	***	0.295	4.78	***
	ΔHK stock(-1)	0.072	1.39		0.032	0.53		0.081	1.48		0.100	1.75	*
	ΔUK stock(-1)	-0.094	-1.92	*	-0.004	-0.07		0.006	0.09		-0.162	-2.65	***
	ΔNY stock(-1)	0.078	0.78		-0.052	-0.37		-0.147	-1.07		0.056	0.35	
	ΔVIX(-1)	-0.005	-0.58		-0.010	-0.91		-0.022	-1.98	**	-0.007	-0.51	
	ΔUS yields(-1)	-0.023	-2.16	**	0.000	-0.01		-0.003	-0.23		-0.027	-1.72	*
variance	C	0.006	1.08		0.016	1.06		0.036	3.31	***	0.048	1.23	
equation	RESID(-1)^2	-0.076	-3.46	***	0.055	1.20		-0.139	-4.98	***	0.205	2.55	**
	GARCH(-1)	1.049	25.27		0.895	13.18	***	1.041	36.01	***	0.676	4.33	***
	Adj. R^2	0.59			0.49			0.34			0.26		
	D.W. Stat.	2.36			2.04			2.08			1.86		

Table 3. Estimation Results for the NIRP1 and NIRP2 Period (continued)

(2) NIRP2 period (22 September 2016 to 31 July 2018)

		Korea			Singapore			Taiwan			Thailand		
explanatory variable		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic		Coefficient	z-Statistic	
	constant term	0.004	0.20		-0.002	-0.11		0.025	1.17		0.021	0.89	
Japan's	ΔNikkei 225	0.226	6.97	***	0.155	5.12	***	0.147	5.95	***	0.096	2.70	***
financial	ΔNikkei 225(-1)	-0.052	-1.71	*	0.012	0.41		-0.053	-1.93	*	-0.032	-0.97	
variables	ΔYen	0.004	0.09		0.012	0.28		-0.003	-0.08		0.062	1.25	
	ΔYen(-1)	0.062	1.05		-0.017	-0.31		0.018	0.32		0.032	0.60	
	ΔJGB yields	0.066	2.33	**	-0.022	-0.68		-0.011	-0.37		-0.018	-0.58	
	ΔJGB yields(-1)	0.029	1.02		-0.022	-0.74		-0.015	-0.54		-0.024	-0.84	
control	ΔChina stock	0.029	0.82		-0.052	-1.46		0.016	0.44		0.005	0.15	
variables	ΔChina stock(-1)	-0.055	-1.67	*	0.054	1.51		0.042	1.15		0.067	2.09	**
	ΔHK stock	0.297	9.17	***	0.347	12.33	***	0.327	9.98	***	0.136	4.51	***
	ΔHK stock(-1)	0.040	1.31		-0.034	-1.09		0.069	2.18	**	0.017	0.51	
	ΔUK stock(-1)	0.110	2.58	***	0.026	0.67		0.013	0.33		-0.006	-0.17	
	ΔNY stock(-1)	0.057	1.09		0.030	0.60		0.073	1.45		-0.022	-0.50	
	ΔVIX(-1)	0.003	0.96		-0.003	-0.61		-0.014	-3.74	***	-0.005	-1.13	
	ΔUS yields(-1)	-0.021	-2.44	**	0.003	0.37		-0.014	-1.76	*	-0.001	-0.15	
variance	C	0.000	0.44		0.040	1.55		0.032	2.42	**	0.007	3.54	***
equation	RESID(-1)^2	-0.013	-1.76	*	0.082	2.16	**	0.130	2.58	***	0.067	4.30	***
	GARCH(-1)	1.013	109.67	***	0.745	5.52	***	0.731	8.14	***	0.905	42.45	***
	Adj. R^2	0.42			0.40			0.48			0.12		
	D.W. Stat.	2.18			2.13			2.22			1.80		

Note 1) * = significant at 10%, ** = significant at 5%, *** = significant at 1%.

2) See note in Table 2 for the definition of each explanatory variable.

3) The definitions of the variables are the same as those in Table 2.

yen-dollar exchange rate was never statistically significant in the NIRP2 period. Noting that the NIRP had limited impacts on the yen-dollar exchange rate, the spillover effects of the yen-dollar exchange rate might have been small and unstable after the introduction of the NIRP.

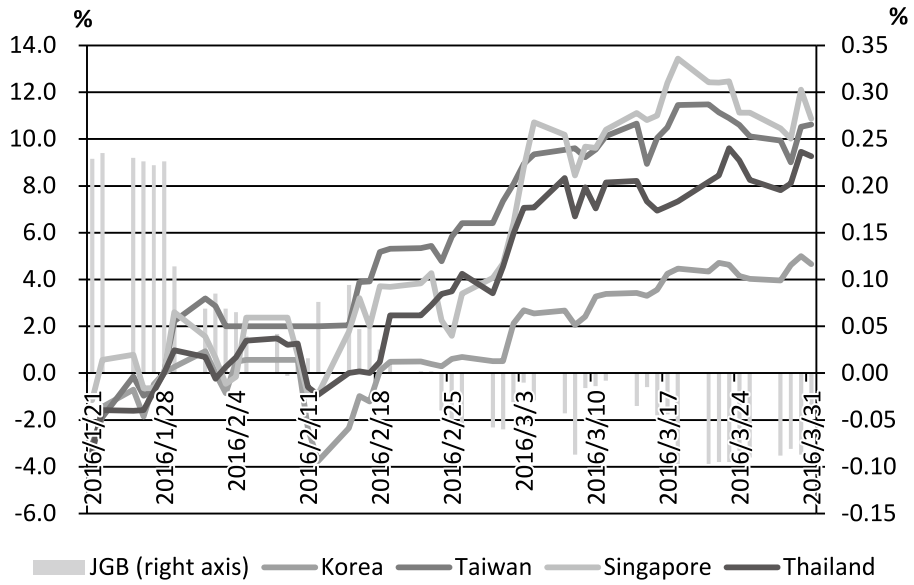
The most noteworthy result is contrasting effects of the 10-year JGB yields on the Asian stock prices before and after the introduction of the NIRP. As we saw in Table 2, the 10-year JGB yields had no significant spillover effects on most of the Asian economies before the BOJ introduced the NIRP. However, Table 3 shows that the coefficient of the 10-year JGB yields became negative in all of the East Asian economies in the NIRP1 period. In particular, except for Korea, it was statistically significant in the NIRP1 period. The sum of the estimated coefficients of the 10-year JGB yields was -1.52 in Korea, -2.7 in Singapore, -4.45 in Taiwan, and -2.76 in Thailand, which implies that when the 10-year JGB yields decline by 0.1% points, the stock prices increased by 0.152% points in Korea, 0.27% points in Singapore, 0.445% points in Taiwan, and 0.276% points in Thailand.

The introduction of the NIRP raised a serious concern about profitability of Japanese financial institutions. The concern had risen partly because its announcement was unexpected for most financial institutions but mostly because the zero bound was still relevant for some of the interest rates even in the NIRP. For example, bank lending rates declined significantly,

while deposit rates did not. Most of the Japanese banks thus suffered from substantial decline in their lending margins when long-term interest rates fell below zero. For life insurance companies, even if their investment returns declined substantially, they needed to guarantee positive nominal returns to their insurance policyholders. Negative long-term interest rates thus squeezed their profits significantly. Consequently, after the announcement of the NIRP, these Japanese financial institutions needed to explore a new profit opportunity outside Japan. It is likely that their changed investment behavior benefited Asian economies.

Figure 7 depicts accumulated returns of the stock price indexes in Korea, Singapore, Taiwan, and Thailand before and after the NIRP's announcement. For comparison, it also depicts the 10-year JGB yields during the same period. We normalized the accumulated returns on 29 January 2016 to be zero and depicted how the accumulated returns changed after the NIRP's announcement. In the figure, the accumulated returns increased only modestly soon after the NIRP's announcement even though the 10-year JGB yields became almost zero. However, they started to increase substantially after the 20th business days when the 10-year JGB yields fell below zero persistently. The increased accumulated returns were modest in Korea. But the increased accumulated returns amounted to nearly 10% in the other three Asian economies. They are consistent with our view that Asian stock prices welcomed Japan's negative long-term interest rates in the NIRP1 period.

Figure 7. Accumulated Returns in the Four Asian Economies and JGB yields



Note) Left axis shows the unit of accumulated returns and the right axis shows the unit of 10-year JGB yields.
Source) *Datastream*.

However, the coefficient of the 10-year JGB yields was never significantly negative in any Asian economy in the NIRP2 period. In particular, the coefficient of the 10-year JGB

yields took a significantly positive value in Korea. In Singapore, Taiwan, and Thailand, the coefficient of the 10-year JGB yields still took a negative sign. But even in these economies, the sum of the estimated coefficients of the 10-year JGB yields in the NIRP2 period was much smaller than that in the NIRP1 period.

Soon after the announcement of the NIRP on 29 January 2016, long-term interest rates fell below zero, which raised a serious concern about profitability of financial institutions. In order to mitigate the concern, the BOJ introduced the QQE with Yield Curve Control (NIRP2) on 21 September 2016. Even in the NIRP2 period, short-term interest rates remained significantly negative. But long-term interest rates increased above zero in the NIRP2 period. It is thus likely that the 10-year JGB yields only had small spillover effects on Asian economies in the NIRP2 period.

6. Concluding Remarks

Emerging economies have traditionally had economic structures vulnerable to international capital flows. In particular, it has been widely pointed out that since the GFC, unconventional monetary policies adopted by advanced countries have destabilized emerging economies and have become a risk factor for the global economy. In this paper, we examined how Japan's unconventional monetary policies has affected emerging Asia since the GFC. After overviewing the effects of Japan's unconventional monetary policies on financial variables in Japan, we analyzed what kind of spillover effects the Japan's QQE and NIRP had had on stock prices in Asian economies. The following implications were derived by our estimation results.

At the beginning of the QQE, the steep depreciation of the yen had negative spillover effects on stock prices in Asian economies due to concerns over the "beggar-thy-neighbor" effect. However, as the Japanese economy recovered thanks to the new monetary policy regime, favorable external effects came to be recognized, and this recognition generated positive spillover effects on stock prices in Asian economies. On the other hand, the NIRP, unlike the QQE, had only limited favorable effects on Asian economies through recovering the Japanese economy. However, negative long-term interest rates heightened concerns over the soundness of Japanese financial institutions which had positive spillover effects on stock prices in Asian economies. These results suggest that the effects of Japan's unconventional monetary policy on emerging Asia had natures that were very different from those in other developed countries although the policy objective - massive monetary easing - was the same.

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