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THE IMPACTS OF JAPAN'S NEGATIVE INTEREST RATE POLICY ON ASIAN FINANCIAL MARKETS

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Abstract

The purpose of this paper is to explore the spillover effects Japan's negative interest rate policy (NIRP) had on Asian financial markets. Unlike the quantitative and qualitative monetary easing (QQE) without a negative interest rate, the NIRP not only had limited impacts on Japan's economy but also raised a serious concern about profitability of local financial institutions. It is thus likely that its spillover effects are very different from those of the QQE without a negative interest rate. In the analysis, we examine spillover effects on Asian stock markets. We find that Japan's long-term interest rate had significant negative effects on Asian stock prices during the NIRP period. We also find that the spillover effects were especially significant through a decline of excess returns in Japan's finance sector. The results imply that the NIRP that lowered the long-term rate below zero might have benefited Asian economies. 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: negative interest rate, international spillover, emerging economies, stock markets in Asia, financial institutions

JEL Classification: F10, F32, E52

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1. INTRODUCTION

After the 2007–2009 global financial crisis (GFC), central banks in advanced countries implemented a new set of unconventional monetary policies that was labeled as quantitative easing (QE), credit easing, forward guidance policies, or negative interest rate. A number of studies suggested that the highly accommodative monetary policies 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]; Bowman et al. [2014]; Bauer and Neely [2014]; Rogers et al. [2014]; and Neely [2015]). In particular, several authors 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, and increasing external debt levels (see, for example, Morgan [2011] and Park and Um [2016]).

In this paper, we explore what spillover effects Japan's unconventional monetary policy, especially the negative interest rate policy (NIRP), had on Asian financial markets. As summarized in Table 1, the Bank of Japan (BOJ) adopted a series of unconventional monetary policies after the GFC. But after the introduction of quantitative and qualitative monetary easing (QQE) on 4 April 2013, the BOJ became more aggressive in its unconventional policy. The BOJ expanded the QQE on 31 October 2014. In particular, the BOJ introduced "QQE with a Negative Interest Rate" on 29 January 2016 and "QQE with Yield Curve Control" on 21 September 2016 to achieve the price stability target of 2% at the earliest possible time. This paper investigates how different spillover effects the NIRP in 2016 had on Asian financial markets.

Table 1: Timeline of Japan's Unconventional Monetary Policy

Date	Description	Governor
19 Dec 2008	Lowering of the bank's target for the uncollateralized overnight call rate by 20 basis points; it will be encouraged to remain at around 0.1 %	Shirakawa
18 Dec 2009	The midpoints of most Policy Board members' "understanding" are around 1% CPI inflation rate	Shirakawa
5 Oct 2010	Comprehensive Monetary Easing	Shirakawa
22 Jan 2013	The "2% Price Stability Target" under the Framework for the Conduct of Monetary Policy	Shirakawa
4 Apr 2013	Introduction of the "Quantitative and Qualitative Monetary Easing (QQE)"	Kuroda
31 Oct 2014	Expansion of the Quantitative and Qualitative Monetary Easing	Kuroda
29 Jan 2016	Introduction of "Quantitative and Qualitative Monetary Easing with a Negative Interest Rate"	Kuroda
21 Sep 2016	New Framework for Strengthening Monetary Easing: "Quantitative and Qualitative Monetary Easing with Yield Curve Control"	Kuroda

CPI = consumer price index.

Source: Bank of Japan.

At the early phase of the QQE, several Asian EMEs showed serious concern about the yen's depreciation because of a potential beggar-thy-neighbor effect, which may result in regional competitive devaluation. However, authors such as Dekle and Hamada (2015) and Kawai (2015), pointed out that unlike the quantitative easing of the United States (US), Japan's QQE without a negative interest rate may have positive spillover effects on the rest of the world. In particular, Fukuda (2016) 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. But in earlier literature, it is not well known what spillover effects Japan's QQE with a negative interest rate had on Asian financial markets.

To shed some light on this important policy issue, the following analysis explores what happened in Asia's financial markets after the introduction of the NIRP by using daily data. As pointed out by Fukuda (2015), the QQE initially brought about the yen's dramatic depreciation and stock price recovery in Japan. However, 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 concern about profitability of local financial institutions. It is thus likely that the effects of the NIRP on Asian financial markets are very different from those of the QQE without a negative interest rate.

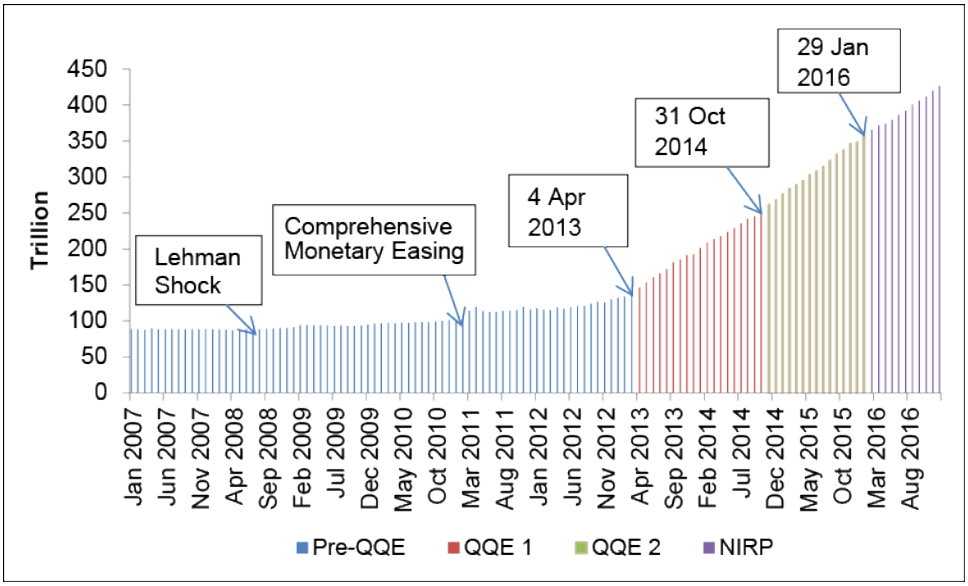
After giving an overview of the impacts of the NIRP on Japan's economy, the following analysis investigates what spillover effects Japan's financial market shocks had on East Asian financial markets before and after the introduction of the NIRP. In the analysis, we examine spillover effects on stock markets in the Republic of Korea; Singapore; Taipei,China; and Thailand. We find that during the NIRP period, a fall in Japan's long-term interest rate significantly increased Asian stock prices except those at the Republic of Korea. We also find that the spillover effects in the NIRP period were especially larger through a decline of excess returns in Japan's finance sector. The results imply that the NIRP that lowered the long-term rate below zero might have benefited emerging Asian economies. 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 introduction of the NIRP.

2. IMPACTS OF THE NIRP ON JAPAN'S ECONOMY

2.1 The Difference between the QQE with and the QQE without a Negative Interest Rate

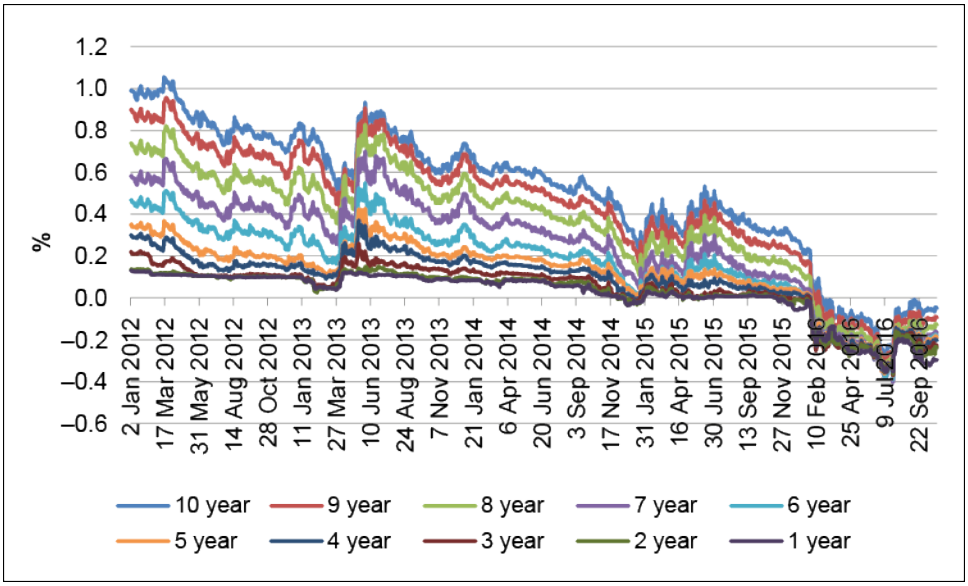
After the GFC, the BOJ adopted a series of unconventional monetary policies. Figure 1 depicts monthly data of the base money in Japan from 2007 to 2016. Unlike central banks in other advanced countries, the base money had changed rather modestly until 2012. However, it started to increase dramatically when the BOJ introduced the QQE in April 2013. Its growth rate accelerated when the QQE was expanded in October 2014. However, regardless of the dramatic increases in the base money, the BOJ could not achieve the price stability target of 2%. Hence, the BOJ introduced a new framework for strengthening monetary easing, that is, the NIRP on 29 January 2016.

Figure 1: Base Money in Japan from 2007 to 2016



NIRP = negative interest rate policy, QQE = quantitative and qualitative monetary easing.
Source: Bank of Japan.

Figure 2: Japanese Government Bond Yields



Source: Datastream.

With the NIRP, the BOJ applied a negative interest rate of –0.1% to current accounts, which financial institutions hold at the BOJ. Its direct target was to make the policy rate, that is, overnight call rate, negative. However, the NIRP made not only short-term interest rates but also long-term interest rates negative. Figure 2 depicts Japanese government bond (JGB) yields since 2012. Due to a series of unconventional monetary policies, short-term interest rates were close to zero even before the QQE. In contrast, long-term interest rates were far above zero in January 2012, although they had already dropped to historically low levels. However, as the QQE progressed, the gaps between long-term and short-term interest rates had shrunk substantially. In particular,

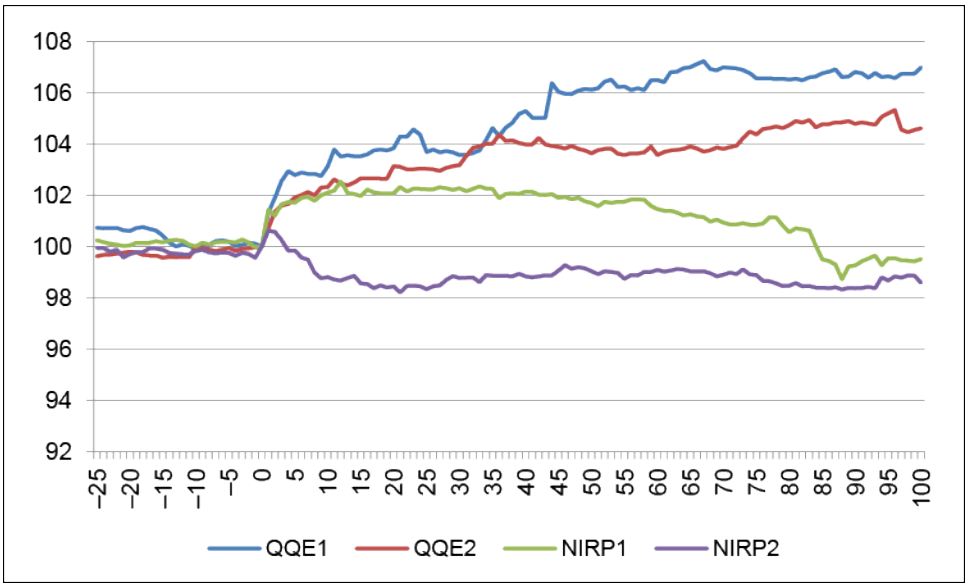
after the announcement of the NIRP, both long-term and short-term interest rates fell below zero and their gaps became negligible.

2.2 Effects on the Exchange Rate and the Stock Prices

The QQE without a negative interest rate brought a dramatic depreciation of the yen (see, for example, Kano 2015). The yen–dollar rate, which had been around ¥80 per US dollar in 2012, depreciated to ¥102 per dollar on 15 May 2013. The expansion of the QQE on 31 October 2014 led to the yen's further depreciation, which had positive effects on the Japanese economy (see, for example, Shioji 2015). However, unlike the QQE without a negative interest rate, the NIRP had limited impacts on the yen–dollar exchange rate.

Figure 3 depicts hourly data of the yen-denominated dollar exchange rate before and after the announcement of the four types of 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 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 four types of QQEs.

Figure 3: Hourly Yen–Dollar Exchange Rate after the Policy Announcements



NIRP = negative interest rate policy, QQE = quantitative and qualitative monetary easing.
Source: Datastream.

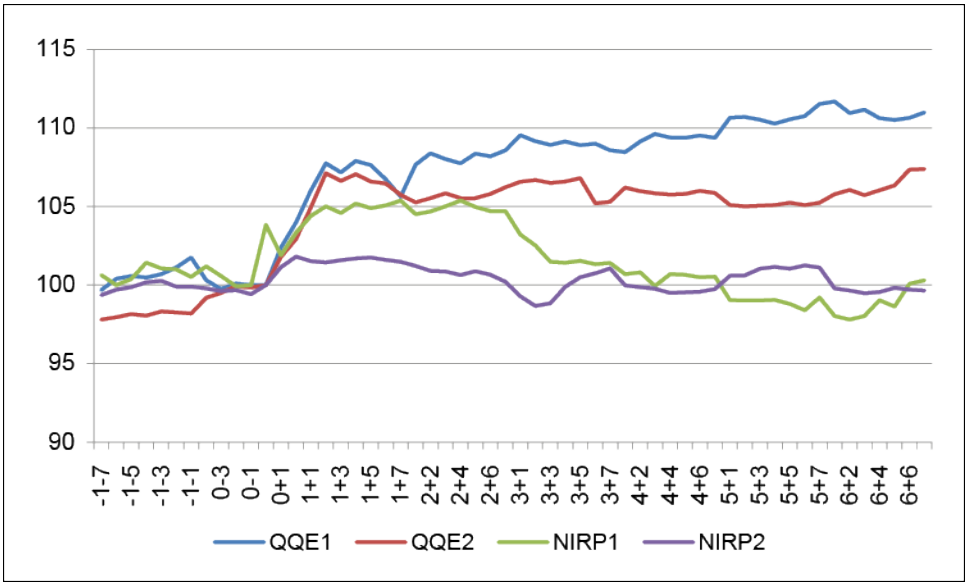
The figure shows that depreciation of the yen–dollar exchange rate persisted in QQE1 and QQE2 after the announcement. This implies that the QQE without a negative interest rate brought about the dramatic depreciation of the yen. In contrast, the NIRP1 and the NIRP2 did not cause persistent depreciation 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 QQE1 and the QQE2, the

yen–dollar exchange rate stopped depreciating after the first 12 hours and started to appreciate 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 1 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.

The QQE without a negative interest rate brought dramatic recovery of stock prices in Japan. Japan's average stock price index (Nikkei 225), which stagnated around ¥9,000 in 2012, rose up to ¥15,000 on 15 May 2013. The expansion of the QQE on 31 October 2014 led to further stock price recovery. However, unlike the QQE without a negative interest rate, the NIRP had limited impact on Japan's stock prices.

Figure 4 depicts intra-daily data of the Nikkei 225 stock price index before and after the announcement of the four types of 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 stock price index for seven different time zones in each day: 9 a.m., 9:15 a.m., 10 a.m., 11:30 a.m., 12:30 p.m., 2 p.m., and 3 p.m. 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 of the four types of QQEs.

Figure 4: Intra-Daily Data of the Nikkei 225 Stock Price Index



NIRP = negative interest rate policy, QQE = quantitative and qualitative monetary easing.
Source: Datastream.

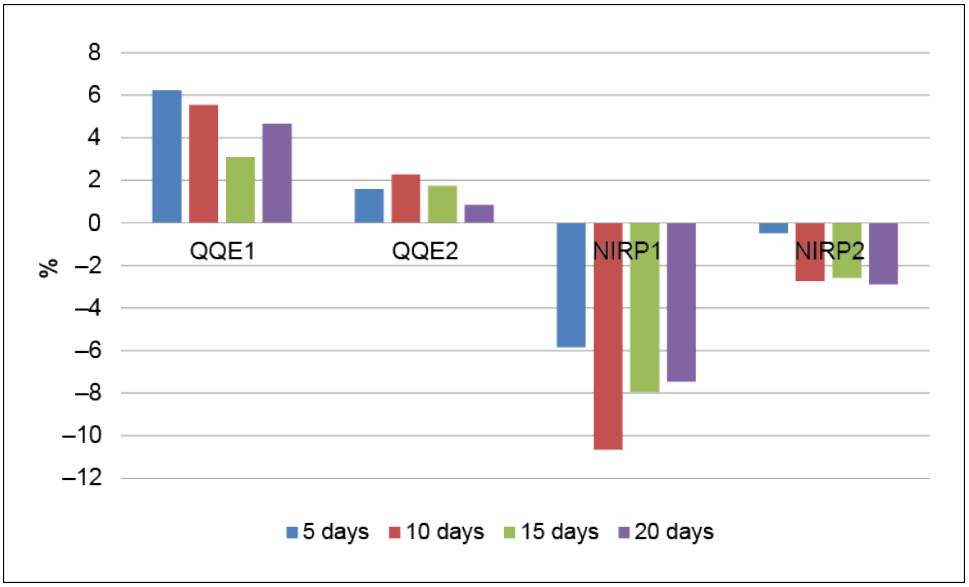
The figure shows that QQE1 and QQE2 caused persistent increases in the stock price index after the announcement. This implies that the QQE without a negative interest rate brought dramatic stock price increases in Japan. In contrast, the NIRP1 and the NIRP2 did not cause persistent increases in the stock 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 QQE1 and in QQE2, the stock price index stopped rising after the second day and started declining in the afternoon of the second day. The stock price increases were much more short-lived after the introduction of the 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 to decline the next day and returned to the level before the announcement.

2.3 Effects on Stock Prices

Unlike the QQE without a negative interest rate, the NIRPs had limited impact on the yen–dollar exchange rate and on Japan's average stock price index. However, unlike the QQE without a negative interest rate, the NIRPs had a large impact on the finance sector's stock prices in Japan. After the announcement of the NIRP, the finance sector's stock prices declined substantially. Figure 5 depicts excess stock returns of Japan's finance sector after the announcement of the four types of QQEs. In the figure, excess stock returns are defined by daily stock returns of the finance sector minus daily returns of the Tokyo Stock Price Index (TOPIX). Normalizing their value on the day of the policy announcement to be zero, we calculated the accumulated excess stock returns of the finance 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 QQE1 and QQE2 increased significant excess stock returns, the NIRP1 and the NIRP2 caused persistent negative excess stock returns. The negative excess stock returns were especially conspicuous in the NIRP1.

Figure 5: Excess Stock Returns of Japan's Finance Sector



NIRP = negative interest rate policy, QQE = quantitative and qualitative monetary easing.

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

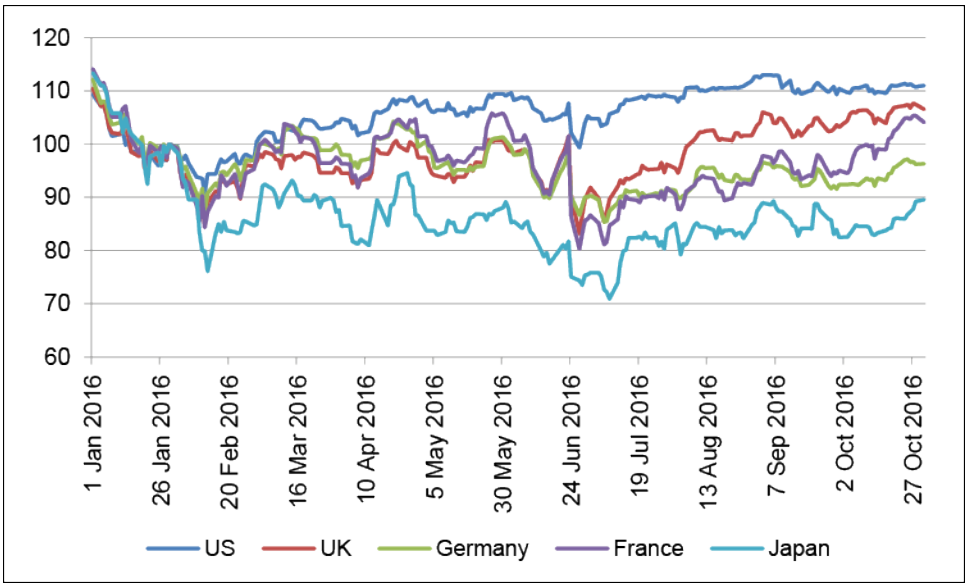
Source: Datastream.

The negative excess stock returns reflect the fact that negative long-term interest rates in the NIRP raised a serious concern about profitability of 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 policy holders. Negative long-term interest rates thus squeezed their profits significantly. The introduction of the NIRPs led to substantial stock price declines in various financial institutions in Japan.

Figure 6 depicts daily stock price indexes of the finance sector in Japan, four advanced countries (the US, the United Kingdom [UK], Germany, and France), and nine economies in Asia (the People's Republic of China [PRC]; Hong Kong, China; the Republic of Korea; Singapore; Taipei,China; Thailand; Malaysia; Indonesia; and the Philippines). It normalized the stock price indexes on 29 January 2016 to be 100 and depicted how the normalized indexes changed from 29 January 2016 to 31 October 2016. The figure shows that the stock price index of Japan's finance sector declined by nearly 20% after the introduction of NIRP1 and remained low throughout the period. Reflecting the referendum on Brexit (withdrawal of the UK from the European Union), the finance sector's stock price indexes in Europe declined in late June. But none of them had a larger decline than Japan. More importantly, no Asian economies experienced significant decline in their finance sector's stock price index during the sample period. Instead, many of Asia's finance sectors experienced steady increases in their stock prices during the period.

Figure 6: Daily Stock Price Indexes of the Finance Sector

(1) Advanced Countries

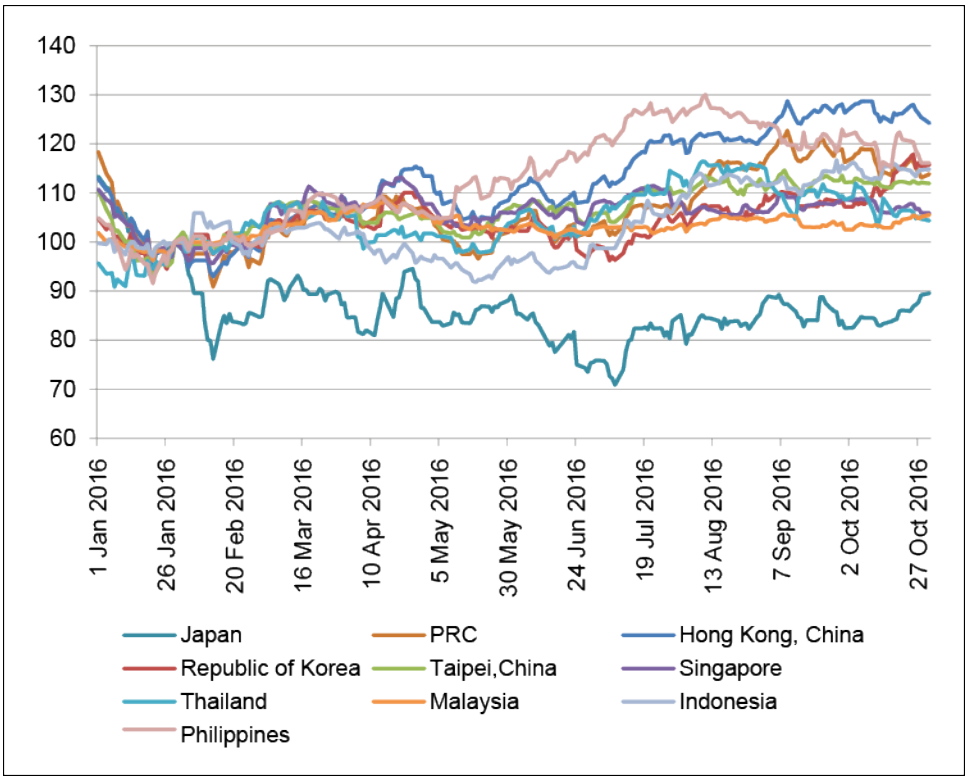


UK = United Kingdom, US = United States.

Source: Datastream.

Figure 6 *continued*

(2) Emerging Asia



PRC = People's Republic of China.

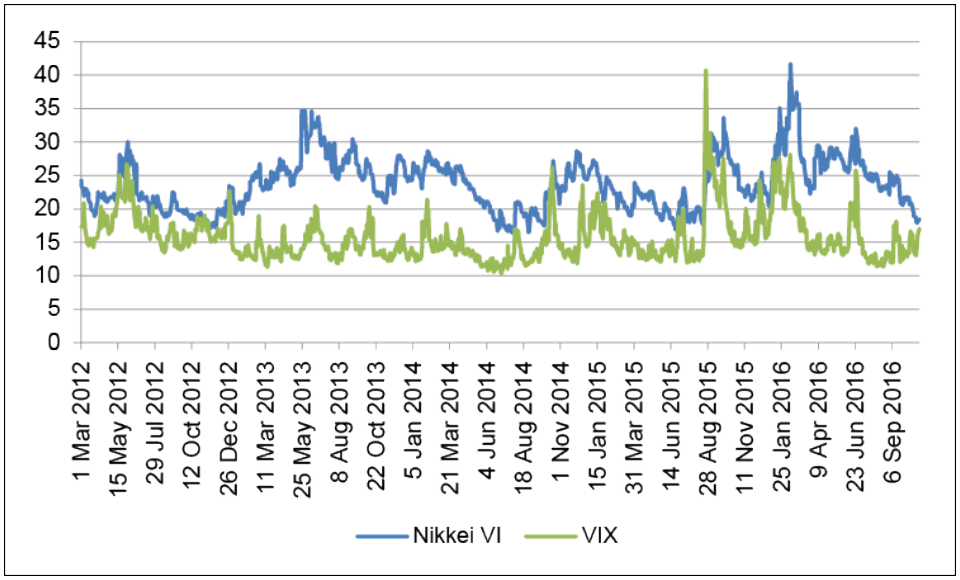
Source: Datastream.

2.4 Effects on Volatility Indexes

The QQE without a negative interest rate brought dramatic recovery of stock prices in Japan but the NIRP did not. However, both of them increased stock market volatility substantially in Japan. Figure 7 depicts daily data of the Nikkei 225 VI Futures Index (Nikkei VI) and the Chicago Board Options Exchange Volatility Index (VIX) from 1 March 2012 to 31 October 2016. The VIX, which is a popular measure of the implied volatility of the Standard & Poor's (S&P) 500 index options and is often referred to as the fear index, represents a measure of the global market's expectation of volatility over the next 30-day period. The Nikkei VI is its Japanese version. It is designed to reflect the daily price fluctuation of a position that combines the near-term and the next-term Nikkei Stock Average Volatility Index Future (Nikkei 225 VI Future) prices at specified weights. It indicates how market participants expect the Nikkei 225 to fluctuate.

The daily data, which is downloaded from Datastream, shows that the Nikkei VI became larger than the VIX not only after the introduction of the QQE1 on 4 April 2013 but also after the announcement of the NIRP1 on 29 January 2016. This implies that both of the two unconventional monetary policies increased stock market volatility substantially in Japan. However, while the increased volatility after the QQE1 was accompanied by dramatic stock price recovery, the increased volatility after the NIRP1 did not.

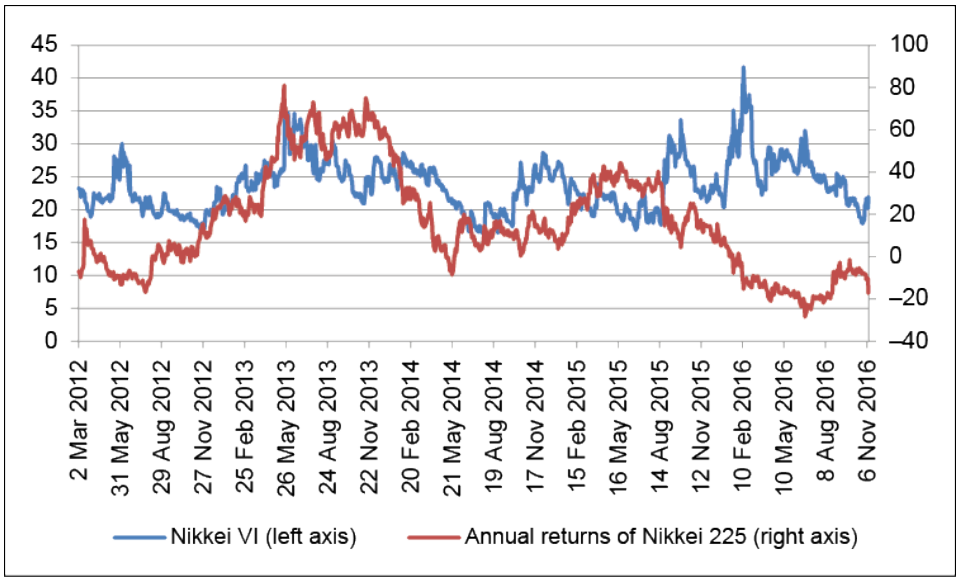
Figure 7: The Nikkei VI and the Volatility Index



VIX = volatility index.
Source: Datastream.

Figure 8 depicts daily data of the Nikkei VI and annual returns of the Nikkei 225 indexes. In summer of 2012 when the global market risk increased, the two data showed opposite movements. But the Nikkei VI had shown very strong positive correlation with annual returns of the Nikkei 225 index from the end of 2012 to the end of 2015. This implies that both QQE1 and QQE2 not only brought dramatic recovery of stock prices but also increased stock market volatility in Japan. In contrast, the Nikkei VI had very strong negative correlation with annual returns of the Nikkei 225 index after the announcement of the NIRP1. Unlike the QQE without a negative interest rate, the NIRP not only had negative impacts on the stock price but also increased its volatility in Japan.

Figure 8: The Nikkei VI and Annual Returns of Nikkei 225



Source: Datastream.

3. EMPIRICAL METHODOLOGY

Unlike the QQE without a negative interest rate, the NIRP had limited contributions to recovery of Japan's economy but reduced long-term interest rates significantly. In particular, it raised a serious concern about profitability of local financial institutions in Japan and had negative impacts on stock prices of Japan's finance sector. It is thus likely that its spillover effects are very different from those of the QQE without a negative interest rate. The purpose of the following sections is to explore to what spillover effects different from Japan's unconventional monetary policies had on Asian financial markets.

To investigate spillover effects on Asian financial markets, we explore how daily stock prices in Asian emerging economies reacted to financial shocks in Japan, especially changes of long-term interest rates, for alternative monetary policy regimes. For alternative subsample periods, we estimate the GARCH (1,1) model in order to capture daily financial spillovers across advanced and emerging market economies in Asia.

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

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

where Y_t^i is stock returns in Asia's economy *i* (*i* = Republic of Korea; Singapore; Taipei,China; and Thailand), X_t^h is Japan's financial variable *h*, Z_t^k is stock returns in Asian economy *k* (*k* = the PRC and Hong Kong, China), and Z_t^l is a financial variable in Europe or in the US.

Since our main interest is to explore spillover effects to Asian stock markets, we chose stock returns in the Republic of Korea; Singapore; Taipei,China; and Thailand as a dependent variable. We chose these four Asian economies partly because they have a developed stock market but 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, the Seoul Composite Index; Singapore (SES) Strait Times Index; TWII, Tapei,China's weighted index; and Thailand SET-Index.

The set of explanatory variables consists of three subsets. The first subset (X_t^h) is Japan's financial variables: daily change of 10-year Japanese government bond (JGB) yields, daily returns of the Nikkei 225 stock price index, and daily change of the dollar-denominated yen's exchange rate. Unlike QQE1 and QQE2, the NIRP had a limited impact on the Nikkei 225 stock price index and the yen–dollar exchange rate but large impacts on long-term interest rates. It is 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 the PRC (i.e., Shanghai SSEC) and (i.e., Hang Seng Stock Index). Because of its remarkable development, the PRC now plays a critical role in Asian economies. It is thus likely that spillovers from stock prices in China to those in the other Asian economies have increased dramatically in 2000s, especially after the GFC. In addition, from December 2014 to February 2016, stock returns in China became highly volatile reflecting growth slowdown of the Chinese economy. Including the second subset of variables captures the increasing role of the PRC in Asian financial markets.

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

The estimation of the GARCH model is done with the number of lags set to one.[1] The sample starts in 5 October 2010 when the BOJ started Comprehensive Monetary Easing and ends in 20 September 2016 after which the BOJ announced the QQE with yield curve control. We split the sample into four subsample periods: pre-QQE period (i.e., 5 October 2010 to 3 April 2013), the QQE1 period (i.e., 4 April 2013 to 30 October 2014), the QQE2 period (i.e., 31 October 2014 to 28 January 2016), and the NIRP1 period (i.e., 29 January 2016 to 20 September 2016). All daily data were downloaded from Datastream.

4. EMPIRICAL RESULTS: STOCK PRICE SPILLOVERS

Table 2 reports the estimation results for the four alternative subsample periods. Most of the variables in the second subset were statistically significant. In particular, although the Shanghai stock price index sometimes took a negative sign, the Hong Kong stock price index took large positive values in all of the estimated equations. This suggests that increased positive spillovers from the PRC economy might be reflected mainly in stock prices in the Hong Kong, China market. The effects of the variables in the third subset varied across the economies depending on the sample period. But the London and New York stock price indexes had a tendency to be positive. The VIX and 10-year US bond yields took a negative sign in several equations. This indicates that some of the common/systematic global factors had significant spillover effects on the Asian stock prices. However, even if we control these external effects, we still see that some of the three financial variables in Japan had significant spillover effects on the stock price index in each of the four Asian economies. The result was essentially the same even if we estimated by using alternative control variables or by adding more lagged variables.[2]

Among the three financial variables in Japan (i.e., the 10-year JGB yields, the Nikkei 225 stock price index, and the yen–dollar exchange rate), a shock in Japan's stock market had significantly positive impacts on the stock prices in Asian economies except in Thailand. In particular, the Nikkei stock price index took large positive values in the Republic of Korea throughout the subsample periods. This indicates a strong stock market linkage in the Asian region. However, the impacts of Japan's stock market shocks were different depending on the subsample period. They were largest in the pre-QQE period in Taipei,China and in the QQE2 period in Singapore. But they became modest in the NIRP1 period. This implies that Japan's stock market turbulence in the NIRP1 period had limited contagious effects on the Asian economies.

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

[2] We checked the robustness by using DAX 30, France CAC 40, and 5-year US government bond yields.

Table 2: Basic Estimation Results for Alternative Subsample Periods

(1) Pre-QQE Period

		Republic of Korea		Singapore	
Variable		**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–0.05	0.000	0.50
Japan financial shocks	JGB yields	0.007	0.35	0.003	0.19
	JGB yields(-1)	0.012	0.71	–0.013	–1.12
	Nikkei 225	0.188	6.32***	0.084	3.90***
	Nikkei 225(-1)	–0.006	–0.20	0.000	0.00
	Yen	0.016	0.33	0.020	0.55
	Yen(-1)	0.238	4.49***	0.009	0.26
Control variables	PRC Stock	–0.046	–1.59	–0.027	–1.30
	PRC Stock(-1)	–0.050	–1.93*	–0.057	–2.52**
	HK, C stock	0.466	13.00***	0.443	16.62***
	HK, C stock(-1)	0.010	0.29	0.070	2.85***
	London Stock(-1)	0.010	0.21	–0.048	–1.51
	NY stock(-1)	0.215	3.36***	0.028	0.62
	VIX(-1)	0.009	1.36	–0.002	–0.49
	US yields(-1)	0.006	0.92	0.011	2.22**
Variance equation	C	0.000	2.75***	0.000	2.63***
	RESID(-1)^2	0.127	4.41***	0.118	4.28***
	GARCH(-1)	0.836	26.02***	0.822	21.05***
	R-squared	0.504		0.564	
	Adjusted R-sq.	0.493		0.554	
		Taipei,China		**Thailand**	
Variable		**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	0.24	0.001	2.98***
Japan financial shocks	JGB yields	0.024	1.21	–0.013	–0.69
	JGB yields(-1)	0.009	0.47	–0.003	–0.17
	Nikkei 225	0.192	5.16***	0.025	0.83
	Nikkei 225(-1)	0.023	0.72	0.013	0.41
	Yen	0.071	1.47	0.014	0.25
	Yen(-1)	0.142	3.25***	0.001	0.01
Control variables	PRC Stock	0.030	1.06	–0.005	–0.17
	PRC Stock(-1)	–0.063	–2.40**	–0.019	–0.64
	HK, C stock	0.346	9.93***	0.428	11.98***
	HK, C stock(-1)	0.071	2.23**	0.058	1.62
	London Stock(-1)	0.013	0.29	–0.085	–1.98**
	NY stock(-1)	0.149	2.51**	0.107	1.51
	VIX(-1)	0.008	1.17	0.003	0.42
	US yields(-1)	–0.002	–0.24	0.000	0.07
Variance equation	C	0.000	2.03**	0.000	3.11***
	RESID(-1)^2	0.057	4.29***	0.195	5.93***
	GARCH(-1)	0.925	59.67***	0.736	16.07***
	R-squared	0.475		0.345	
	Adjusted R-sq.	0.463		0.331	

continued on next page

Table 2 *continued*

(2) QQE1 Period

Variable		Republic of Korea		Singapore	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–0.22	0.000	–0.99
Japan financial shocks	JGB yields	–0.040	–2.56**	–0.015	–0.87
	JGB yields(-1)	0.035	1.82*	0.000	0.01
	Nikkei 225	0.117	4.27***	0.079	3.55***
	Nikkei 225(-1)	–0.038	–1.48	–0.002	–0.13
	Yen	0.014	0.30	–0.106	–2.78***
	Yen(-1)	0.124	2.33**	0.031	0.54
Control variables	PRC Stock	0.052	1.46	–0.015	–0.55
	PRC Stock(-1)	0.003	0.09	–0.043	–1.53
	HK, C stock	0.268	6.93***	0.256	8.10***
	HK, C stock(-1)	0.062	1.64	0.012	0.35
	London Stock(-1)	0.114	2.27**	0.035	0.88
	NY stock(-1)	0.156	1.89*	0.199	3.20***
	VIX(-1)	0.001	0.15	0.007	1.37
	US yields(-1)	0.002	0.32	–0.005	–0.83
Variance equation	C	0.000	1.24	0.000	1.44
	RESID(-1)^2	0.072	1.34	0.052	1.83*
	GARCH(-1)	0.696	3.04	0.894	17.50***
	R-squared	0.423		0.414	
	Adjusted R-sq.	0.403		0.394	
Variable		**Taipei,China**		**Thailand**	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	0.81	0.001	1.42
Japan financial shocks	JGB yields	–0.010	–0.44	–0.010	–0.40
	JGB yields(-1)	0.004	0.23	0.037	1.25
	Nikkei 225	0.091	3.52***	0.057	1.34
	Nikkei 225(-1)	0.020	0.78	–0.009	–0.27
	Yen	–0.004	–0.08	–0.121	–1.57
	Yen(-1)	0.145	2.04**	0.256	3.06***
Control variables	PRC Stock	0.048	1.42	0.002	0.03
	PRC Stock(-1)	–0.046	–1.34	–0.038	–0.66
	HK, C stock	0.254	6.72***	0.233	4.09***
	HK, C stock(-1)	0.083	1.91*	0.062	0.83
	London Stock(-1)	0.122	2.39**	0.052	0.57
	NY stock(-1)	0.160	1.69*	0.050	0.38
	VIX(-1)	0.006	0.76	–0.009	–0.66
	US yields(-1)	–0.006	–0.88	–0.017	–1.37
Variance equation	C	0.000	1.66*	0.000	1.91*
	RESID(-1)^2	0.082	1.94*	0.082	3.72***
	GARCH(-1)	0.779	6.95***	0.909	45.13***
	R-squared	0.337		0.191	
	Adjusted R-sq.	0.314		0.162	

continued on next page

Table 2 *continued*

(3) QQE2 Period

Variable		Republic of Korea		Singapore	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	0.25	0.000	–1.20
Japan financial shocks	JGB yields	0.010	0.45	0.022	1.15
	JGB yields(-1)	0.013	0.58	0.015	0.78
	Nikkei 225	0.198	5.69***	0.116	3.16***
	Nikkei 225(-1)	–0.016	–0.55	–0.003	–0.08
	Yen	–0.012	–0.16	–0.161	–2.69***
	Yen(-1)	0.156	1.91*	0.037	0.50
Control variables	PRC Stock	–0.026	–1.76*	–0.003	–0.22
	PRC Stock(-1)	–0.034	–2.06**	–0.025	–1.73*
	HK, C stock	0.187	5.95***	0.264	7.96***
	HK, C stock(-1)	0.027	0.71	0.054	1.81*
	London Stock(-1)	0.080	1.89*	–0.081	–1.89*
	NY stock(-1)	–0.078	–1.09	0.205	2.71***
	VIX(-1)	–0.021	–2.73***	0.007	0.98
	US yields(-1)	0.003	0.36	–0.003	–0.31
Variance equation	C	0.000	0.83	0.000	1.38
	RESID(-1)^2	0.043	0.93	0.089	1.91*
	GARCH(-1)	0.891	7.50***	0.833	9.31***
	R-squared	0.428		0.478	
	Adjusted R-sq.	0.402		0.454	

Variable		Taipei,China		Thailand	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–0.53	–0.001	–1.41
Japan financial shocks	JGB yields	–0.016	–0.69	–0.040	–2.01**
	JGB yields(-1)	–0.002	–0.09	0.030	1.31
	Nikkei 225	0.166	3.61***	0.063	1.28
	Nikkei 225(-1)	0.004	0.10	–0.049	–1.14
	Yen	–0.054	–0.68	–0.230	–2.90***
	Yen(-1)	–0.022	–0.19	–0.023	–0.23
Control variables	PRC Stock	–0.021	–1.01	0.003	0.15
	PRC Stock(-1)	0.006	0.30	–0.016	–0.76
	HK, C stock	0.287	6.77***	0.211	4.15***
	HK, C stock(-1)	0.063	1.41	–0.027	–0.53
	London Stock(-1)	–0.017	–0.32	–0.085	–1.53
	NY stock(-1)	0.013	0.12	0.033	0.36
	VIX(-1)	–0.008	–0.74	–0.011	–1.25
	US yields(-1)	–0.001	–0.11	0.011	1.07
Variance equation	C	0.000	1.70*	0.000	1.15
	RESID(-1)^2	0.169	2.90***	0.036	1.05
	GARCH(-1)	0.522	2.40**	0.892	10.82***
	R-squared	0.389		0.273	
	Adjusted R-sq.	0.361		0.240	

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Table 2 *continued*

(4) NIRP1 Period

Variable		Republic of Korea		Singapore	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–0.41	0.000	–0.87
Japan financial shocks	JGB yields	0.001	0.29	–0.049	–2.41**
	JGB yields(-1)	–0.009	–0.49	–0.009	–0.30
	Nikkei 225	0.172	5.52***	0.095	2.06**
	Nikkei 225(-1)	0.027	0.78	0.068	1.48
	Yen	0.120	2.27**	0.027	0.35
	Yen(-1)	0.015	0.22	0.186	2.26**
Control variables	PRC Stock	–0.036	–1.40	–0.054	–1.11
	PRC Stock(-1)	0.061	1.86*	0.058	1.44
	HK, C stock	0.359	8.62***	0.506	7.55***
	HK, C stock(-1)	0.052	1.11	0.030	0.50
	London Stock(-1)	–0.074	–1.68*	–0.006	–0.10
	NY stock(-1)	0.054	0.53	–0.052	–0.37
	VIX(-1)	–0.006	–0.71	–0.010	–0.91
	US yields(-1)	–0.021	–1.95*	0.000	0.00
Variance equation	C	0.000	1.52	0.000	1.03
	RESID(-1)^2	–0.084	–3.92***	0.058	1.26
	GARCH(-1)	1.039	27.72***	0.894	13.34***
	R-squared	0.615		0.547	
	Adjusted R-sq.	0.580		0.505	
Variable		**Taipei,China**		**Thailand**	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	0.55	0.001	1.56
Japan financial shocks	JGB yields	–0.035	–2.72***	–0.014	–0.67
	JGB yields(-1)	–0.035	–1.66*	–0.039	–1.79*
	Nikkei 225	0.058	1.85*	0.048	1.07
	Nikkei 225(-1)	0.041	1.10	–0.004	–0.09
	Yen	–0.026	–0.43	–0.136	–2.07**
	Yen(-1)	0.073	0.98	0.111	1.19
Control variables	PRC Stock	0.009	0.22	–0.048	–0.93
	PRC Stock(-1)	–0.015	–0.37	–0.013	–0.31
	HK, C stock	0.305	5.33***	0.285	4.63***
	HK, C stock(-1)	0.087	1.66*	0.090	1.52
	London Stock(-1)	–0.020	–0.32	–0.142	–2.35**
	NY stock(-1)	–0.105	–0.84	0.034	0.22
	VIX(-1)	–0.023	–2.36**	–0.007	–0.49
	US yields(-1)	–0.006	–0.42	–0.028	–1.79*
Variance equation	C	0.000	2.34**	0.000	0.90
	RESID(-1)^2	–0.097	–4.07***	0.153	2.82***
	GARCH(-1)	1.037	34.46***	0.823	11.05***
	R-squared	0.432		0.319	
	Adjusted R-sq.	0.380		0.257	

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

HK, C = Hong Kong, China, JGB = Japanese government bonds, PRC = People's Republic of China, US = United States, and VIX = volatility index.

Nikkei 225 ≡ daily returns of the Nikkei 225 stock price index, yen ≡ daily change of the dollar-denominated yen's exchange rate, JGB yields ≡ daily change of 10-year Japanese government bond (JGB) yields, PRC stock ≡ daily stock returns of Shanghai SSEC, HK, C stock ≡ daily stock returns of Hang Seng Stock Index, London stock ≡ daily stock returns of FTSE 100, NY stock ≡ daily stock returns of Dow Jones Industrials, VIX ≡ daily log-difference of the VIX, US yields ≡ daily change of the 10-year US government bond yields, RESID(-1)^2 ≡ squared lagged residual, and GARCH ≡ contemporary variance.

Source: Author's calculation.

The yen–dollar exchange rate took large positive values in the Republic of Korea throughout the subsample periods. This indicates that reflecting export competition between the two countries, the yen's depreciation might have had a beggar-thy-neighbor effect on the Republic of Korea's economy. Similar significant negative spillover effects were observed in Taipei,China before the QQE2 period, in Singapore in the NIRP1 period, and in Thailand in the QQE1 period. But the yen's depreciation had significant positive spillover effects in Singapore in the QQE1 and QQE2 periods and in Thailand in the QQE2 and NIRP1 periods. This implies that beggar-thy-neighbor effects on stock prices were, if any, limited in the Southeast Asian economies even if the yen depreciated dramatically.

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. They were, if any, limited in most of the Asian economies before the NIRP was announced.[3] This means that a change of low but still positive long-term interest rate in Japan had limited spillover effects on the Asian economies. However, except in the Republic of Korea, the 10-year JGB yields took a significantly negative sign in the NIRP1 period. This means that a decline of the long-term interest rate might have benefited Asian economies after the 10-year JGB yields fell below zero.

One notable consequence of the NIRP was that not only short-term but also long-term interest rates became negative. The prevailing negative long-term interest rates raised a serious concern about profitability of local financial institutions in Japan. Local commercial banks experienced substantial decline in the margin between domestic lending rates and deposit rates. Local institutional investors, such as insurance companies, trust funds, and pension funds, lost their profit opportunities in domestic markets. Many of them thus needed to explore a new profit opportunity outside Japan. Financial markets in emerging Asia were their natural choices. They are still risky but potentially highly profitable investment destinations. It is likely that their changed investment behavior benefited Asian economies, especially their finance sector.

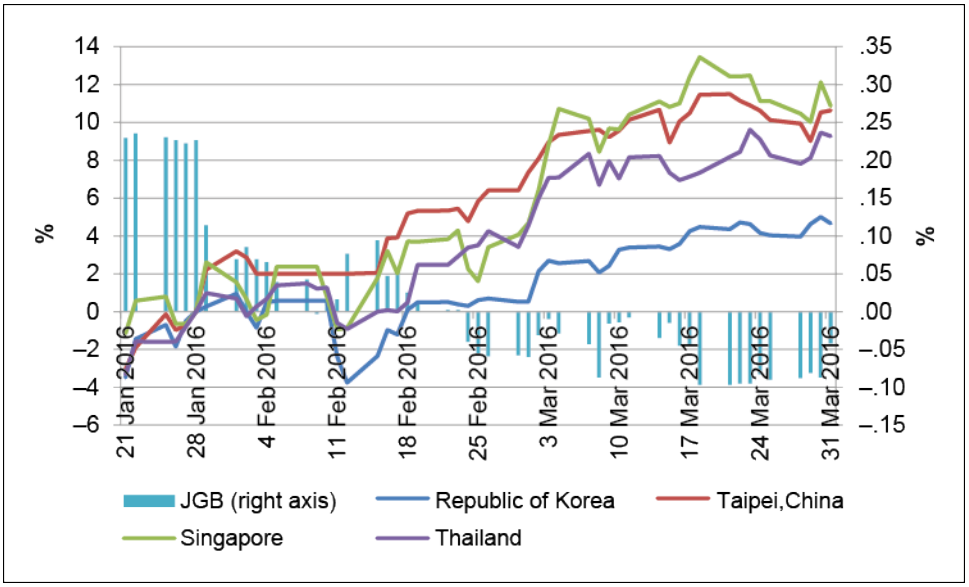
The exception was the Republic of Korea. In the Republic of Korea, the 10-year JGB yields were not statistically significant in the NIRP1 period, while both the Nikkei 225 stock price index and the yen–dollar exchange rate took a significantly positive sign in the NIRP1 period. This might have happened because of strong trade linkage but weak financial market linkage between the two countries. Because of its economic development, further growth potential in the Republic of Korea's economy might be more limited than those in other emerging Asian countries. It is thus likely that Japanese financial institutions did not explore a new profit opportunity in the Republic of Korea.

Figure 9 depicts accumulated returns of the stock price indexes in the Republic of Korea; Singapore; Taipei,China; and Thailand before and after the NIRP1 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 NIRP1 announcement. In the figure, the accumulated returns increased only modestly soon after the NIRP1 announcement even though the 10-year JGB yields dropped sharply to almost zero.

[3] The simultaneous effect of 10-year JGB yields on the stock price was significantly negative in the Republic of Korea in the QQE1 period and in Thailand in the QQE2 period. But since the lagged effect was positive in both cases, the total effect was never significant before the NIRP1 period.

However, they started to increase substantially after the 20th business day when the 10-year JGB yields fell below zero persistently. The increased accumulated returns were very modest in the Republic of Korea. But the increased accumulated returns amounted to nearly 10% in the other three Asian economies.[4] They are consistent with the view that Asian stock prices welcomed negative long-term interest rates in Japan.

Figure 9: Accumulated Returns in the Four Asian Economies and Japanese Government Bond Yields



JGB = Japanese government bond.

Note: Left axis shows the unit of accumulated returns and the right axis shows the unit of 10-year JGB yields.

Source: Datastream.

5. ESTIMATION RESULTS USING EXCESS STOCK RETURNS OF JAPAN'S FINANCE SECTOR

In the last section, we found that except in the Republic of Korea, the 10-year JGB yields, which had shown no significant impacts before the announcement of the NIRP, took significantly negative effects on Asian stock prices in the NIRP1 period. This means that lowering long-term interest rates below zero in Japan might have benefited Asian economies except the Republic of Korea. We conjectured that this might have happened because local financial institutions who lost their profit opportunities in domestic markets explored new profit opportunities in emerging Asia after the NIRP announcement.

[4] During the same period, stock prices in the PRC and in Hong Kong, China showed no persistent changes. This indicates that we cannot attribute the dramatic increases in accumulated returns to the effects of the PRC's economy.

The purpose of this section is to examine the validity of this conjecture through exploring whether the NIRP benefited Asian economies because of its negative impact on Japan's finance sector. Specifically, using excess stock returns of Japan's finance sector, which was explained by the JGB yields as a new explanatory variable, we investigate how daily responses of the Asian sector's stock prices changed before and after the introduction of the NIRP.

In the analysis, we define excess stock returns of Japan's finance sector, ER_t, by daily stock returns of Japan's finance sector minus daily stock returns of Nikkei 225. To calculate how the JGB yields explain the excess stock returns, we then run OLS, which regresses ER_t on current and lagged value of the 10-year JGB yields, JGB_t, as follows:

$$ER_t = \theta + \sum_{j=0}^{J} \mu_h JGB_{t-j} + \nu_t, \quad (2)$$

Excess stock returns of Japan's finance sector, which are explained by the JGB yields, are the fitted value of ER_t in the four alternative subsample periods: the pre-QQE period, the QQE1 period, the QQE2 period, and the NIRP1 period. That is, denoting the estimated coefficients by $\widehat{\theta}$ and $\widehat{\mu_h}$, we calculate the excess stock returns explained by the NIRP as $\widehat{ER}_t \equiv \widehat{\theta} + \sum_{j=0}^{J} \widehat{\mu_h} JGB_{t-j}$ for each alternative subsample period. Except that we replace the 10-year JGB yields by $\widehat{ER}_t$ in the explanatory variables, the estimated GARCH (1,1) equations are the same as those in previous sections. We estimate the model for the four alternative subsample periods. Comparing the estimation results across different monetary policy regimes, we examine how the introduction of the NIRP changed stock price responses in the Asian economies.

As in the last section, all of the data were downloaded from *Datastream*. Table 3 reports the estimation results. Except for the excess returns, the estimated coefficients were essentially the same as those in the last section. That is, many of the control variables were statistically significant. Among the three financial variables in Japan, the Nikkei stock price index took significantly positive values except in Thailand. The yen–dollar exchange rate took large positive values in the Republic of Korea in most of the subsample periods.

The most noteworthy result is the effects of $\widehat{ER}_t$ before and after the NIRP period. As did the 10-year JGB yields, they had contrasting features before and after the NIRP period. In the pre-NIRP periods, they were small and insignificant in all of the Asian economies except in the Republic of Korea in the QQE1 period. This means that a change of excess stock returns of Japan's finance sector had no spillover effect on the Asian finance sectors when long-term interest rates were low but still positive in Japan. In contrast, except for the Republic of Korea, its spillover effects on the Asian economies became larger and more significant in the NIRP1 period. In particular, they were significantly negative. This means that when negative long-term rates reduced excess stock returns of Japan's finance sector in Japan, the Asian stock prices increased except in the Republic of Korea. It is likely that the changed behavior of Japanese financial institutions in the NIRP might have benefited the finance sectors of most Asian economies.

Table 3: Estimation Results by Using Excess Returns

(1) Pre-QQE Period

		Republic of Korea		Singapore	
Variable		**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–0.53	0.000	0.45
Japan financial shocks	Excess Returns	0.494	0.73	–0.117	–0.23
	Nikkei 225	0.187	6.56***	0.084	3.89***
	Nikkei 225(-1)	–0.003	–0.11	–0.004	–0.20
	Yen	0.017	0.36	0.021	0.57
	Yen(-1)	0.254	4.76***	0.031	0.74
Control variables	PRC Stock	–0.042	–1.37	–0.032	–1.57
	PRC Stock(-1)	–0.047	–1.62	–0.051	–2.26**
	HK, C stock	0.460	12.45***	0.435	15.40***
	HK, C stock(-1)	0.013	0.37	0.055	2.03**
	London Stock(-1)	0.017	0.35	–0.027	–0.80
	NY stock(-1)	0.213	3.21***	0.043	0.92
	VIX(-1)	0.009	1.33	–0.001	–0.18
	US yields(-1)	0.005	0.78	0.011	2.17**
Variance equation	C	0.000	–1.77*	0.000	–1.77*
	RESID(-1)^2	0.111	3.40***	0.118	2.61***
	GARCH(-1)	0.796	15.03***	0.511	3.00***
	VIX(-1)	0.000	2.43**	0.000	2.32**
	R-squared	0.505		0.562	
	Adjusted R-sq.	0.495		0.553	
		Taipei,China		**Thailand**	
Variable		**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–0.86	0.001	3.15***
Japan financial shocks	Excess Returns	1.041	1.41	–0.464	–0.67
	Nikkei 225	0.188	5.25***	0.025	0.85
	Nikkei 225(-1)	0.013	0.46	0.014	0.46
	Yen	0.082	1.73*	0.012	0.21
	Yen(-1)	0.126	2.48**	0.002	0.04
Control variables	PRC Stock	0.034	1.19	–0.003	–0.09
	PRC Stock(-1)	–0.068	–2.51**	–0.022	–0.71
	HK, C stock	0.345	9.46***	0.430	11.44***
	HK, C stock(-1)	0.077	2.16**	0.059	1.55
	London Stock(-1)	0.026	0.55	–0.080	–1.76*
	NY stock(-1)	0.155	2.36**	0.102	1.37
	VIX(-1)	0.010	1.37	0.003	0.37
	US yields(-1)	–0.003	–0.43	0.001	0.13
Variance equation	C	0.000	–2.13**	0.000	0.56
	RESID(-1)^2	0.097	1.81*	0.191	5.42***
	GARCH(-1)	0.307	1.14	0.709	12.99***
	VIX(-1)	0.000	2.41**	0.000	1.35
	R-squared	0.476		0.346	
	Adjusted R-sq.	0.465		0.333	

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Table 3 *continued*

(2) QQE1 Period

Variable		Republic of Korea		Singapore	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–1.384	0.000	–1.423
Japan financial shocks	Excess Returns	–0.929	–3.185***	–0.397	–1.291
	Nikkei 225	0.119	4.213***	0.083	3.535***
	Nikkei 225(-1)	–0.033	–1.322	–0.004	–0.186
	Yen	0.016	0.332	–0.091	–2.173**
	Yen(-1)	0.122	2.310**	0.023	0.378
Control variables	PRC Stock	0.050	1.385	–0.022	–0.819
	PRC Stock(-1)	0.001	0.031	–0.045	–1.590
	HK, C stock	0.268	6.996***	0.263	8.547***
	HK, C stock(-1)	0.060	1.475	0.028	0.848
	London Stock(-1)	0.116	2.243**	0.002	0.051
	NY stock(-1)	0.152	1.825*	0.212	3.262***
	VIX(-1)	0.001	0.181	0.008	1.299
	US yields(-1)	0.003	0.441	–0.010	–1.856*
Variance equation	C	0.000	0.703	0.000	–1.594
	RESID(-1)^2	0.073	1.370	–0.030	–1.044
	GARCH(-1)	0.682	3.037***	0.668	3.032***
	VIX(-1)	0.000	0.560	0.000	1.629
	R-squared	0.421		0.413	
	Adjusted R-sq.	0.402		0.394	
Variable		**Taipei,China**		**Thailand**	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	0.052	0.000	0.920
Japan financial shocks	Excess Returns	–0.499	–1.285	–0.543	–1.290
	Nikkei 225	0.097	3.415***	0.059	1.385
	Nikkei 225(-1)	0.008	0.303	0.003	0.081
	Yen	–0.007	–0.121	–0.127	–1.783*
	Yen(-1)	0.120	1.742*	0.269	3.253***
Control variables	PRC Stock	0.043	1.179	0.006	0.101
	PRC Stock(-1)	–0.052	–1.407	–0.041	–0.718
	HK, C stock	0.257	6.209***	0.223	3.931***
	HK, C stock(-1)	0.069	1.492	0.046	0.614
	London Stock(-1)	0.108	2.003**	0.068	0.825
	NY stock(-1)	0.147	1.508	0.040	0.322
	VIX(-1)	0.006	0.763	–0.009	–0.706
	US yields(-1)	–0.006	–0.827	–0.013	–1.065
Variance equation	C	0.000	–2.125**	0.000	1.477
	RESID(-1)^2	0.026	0.593	0.076	3.640***
	GARCH(-1)	0.618	4.689***	0.920	52.606***
	VIX(-1)	0.000	2.933***	0.000	–1.248
	R-squared	0.330		0.195	
	Adjusted R-sq.	0.308		0.164	

continued on next page

Table 3 *continued*

(3) QQE2 Period

Variable		Republic of Korea		Singapore	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	0.05	0.000	–1.09
Japan financial shocks	Excess Returns	0.441	0.51	0.588	0.82
	Nikkei 225	0.203	5.81***	0.134	3.41***
	Nikkei 225(-1)	–0.008	–0.25	–0.011	–0.27
	Yen	–0.005	–0.07	–0.162	–2.35**
	Yen(-1)	0.185	2.32**	0.089	1.09
Control variables	PRC Stock	–0.015	–0.88	0.013	0.79
	PRC Stock(-1)	–0.024	–1.44	–0.024	–1.53
	HK, C stock	0.166	5.17***	0.231	6.79***
	HK, C stock(-1)	0.025	0.66	0.077	2.32**
	London Stock(-1)	0.091	1.97**	–0.075	–1.65*
	NY stock(-1)	–0.067	–0.91	0.201	2.70***
	VIX(-1)	–0.019	–2.46**	0.007	0.97
	US yields(-1)	0.007	0.88	0.002	0.21
Variance equation	C	0.000	0.15	0.000	–0.38
	RESID(-1)^2	–0.002	–0.03	0.197	2.45**
	GARCH(-1)	–0.094	–0.07	–0.220	–1.31
	VIX(-1)	0.000	0.95	0.000	2.37**
	R-squared	0.426		0.471	
	Adjusted R-sq.	0.402		0.449	
Variable		**Taipei,China**		**Thailand**	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–0.55	–0.001	–1.31
Japan financial shocks	Excess Returns	–0.048	–0.05	1.292	1.60
	Nikkei 225	0.167	3.56***	0.059	1.15
	Nikkei 225(-1)	0.004	0.11	–0.033	–0.72
	Yen	–0.049	–0.61	–0.192	–2.09**
	Yen(-1)	–0.030	–0.25	–0.051	–0.47
Control variables	PRC Stock	–0.021	–1.02	0.009	0.45
	PRC Stock(-1)	0.007	0.35	–0.034	–1.48
	HK, C stock	0.285	6.66***	0.190	3.67***
	HK, C stock(-1)	0.063	1.35	–0.015	–0.29
	London Stock(-1)	–0.017	–0.32	–0.056	–0.90
	NY stock(-1)	0.020	0.19	0.046	0.45
	VIX(-1)	–0.008	–0.70	–0.008	–0.79
	US yields(-1)	–0.004	–0.43	0.003	0.30
Variance equation	C	0.000	1.24	0.000	–0.68
	RESID(-1)^2	0.169	2.77***	–0.037	–0.63
	GARCH(-1)	0.502	2.24**	0.127	0.21
	VIX(-1)	0.000	0.29	0.000	1.49
	R-squared	0.388		0.264	
	Adjusted R-sq.	0.363		0.233	

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Table 3 *continued*

(4) NIRP1 Period

Variable		Republic of Korea		Singapore	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–0.85	–0.001	–1.14
Japan financial shocks	Excess Returns	–0.019	–0.19	–0.302	–1.99**
	Nikkei 225	0.183	5.84***	0.102	2.28**
	Nikkei 225(-1)	0.024	0.75	0.091	2.41**
	Yen	0.106	1.86*	0.036	0.55
	Yen(-1)	0.031	0.48	0.194	2.18**
Control variables	PRC Stock	0.002	0.08	–0.040	–0.90
	PRC Stock(-1)	0.061	1.90*	0.062	1.68*
	HK, C stock	0.335	9.56***	0.509	8.25***
	HK, C stock(-1)	0.028	0.60	0.024	0.42
	London Stock(-1)	–0.061	–1.42	0.020	0.37
	NY stock(-1)	0.077	0.78	–0.073	–0.58
	VIX(-1)	–0.010	–1.22	–0.013	–1.16
	US yields(-1)	–0.018	–1.72*	–0.006	–0.43
Variance equation	C	0.000	–0.71	0.000	3.24***
	RESID(-1)^2	–0.116	–5.73***	–0.051	–2.15**
	GARCH(-1)	1.011	32.72***	1.029	41.27***
	VIX(-1)	0.000	20.67***	0.000	–2.31**
	R-squared	0.603		0.537	
	Adjusted R-sq.	0.570		0.498	
Variable		**Taipei,China**		**Thailand**	
		Coef.	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.000	–0.09	0.001	1.49
Japan financial shocks	Excess Returns	–0.386	–2.48**	–0.313	–2.45**
	Nikkei 225	0.064	1.46	0.063	1.35
	Nikkei 225(-1)	0.040	0.89	0.008	0.15
	Yen	–0.025	–0.32	–0.140	–2.26**
	Yen(-1)	0.075	0.91	0.110	1.33
Control variables	PRC Stock	0.025	0.59	–0.021	–0.44
	PRC Stock(-1)	–0.017	–0.38	–0.035	–0.93
	HK, C stock	0.322	5.06***	0.244	4.15***
	HK, C stock(-1)	0.093	1.39	0.097	1.50
	London Stock(-1)	–0.014	–0.20	–0.146	–2.65***
	NY stock(-1)	–0.086	–0.55	0.111	0.78
	VIX(-1)	–0.025	–2.10**	–0.003	–0.20
	US yields(-1)	–0.010	–0.56	–0.035	–2.64***
Variance equation	C	0.000	0.35	0.000	2.43**
	RESID(-1)^2	–0.086	–17.84***	0.113	2.55**
	GARCH(-1)	1.007	27.12***	0.903	19.88***
	VIX(-1)	0.000	1.94*	0.000	–2.56**
	R-squared	0.431		0.302	
	Adjusted R-sq.	0.383		0.243	

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

HK, C = Hong Kong, China, JGB = Japanese government bonds, PRC = People's Republic of China, US = United States, and VIX = volatility index.

Nikkei 225 ≡ daily returns of the Nikkei 225 stock price index, yen ≡ daily change of the dollar-denominated yen's exchange rate, JGB yields ≡ daily change of 10-year Japanese government bond (JGB) yields, PRC stock ≡ daily stock returns of Shanghai SSEC, HK, C stock ≡ daily stock returns of Hang Seng Stock Index, London stock ≡ daily stock returns of FTSE 100, NY stock ≡ daily stock returns of Dow Jones Industrials, VIX ≡ daily log-difference of the VIX, US yields ≡ daily change of the 10-year US government bond yields, RESID(-1)^2 ≡ squared lagged residual, and GARCH ≡ contemporary variance.

Source: Author's calculation.

6. EFFECTS OF THE NEGATIVE INTEREST RATE POLICY ON ADVANCED ECONOMIES

Until the last section, we found that except in the Republic of Korea, the 10-year JGB yields, which had shown no significant impact in the pre-NIRP period, had significantly negative effects on Asian stock prices in the NIRP1 period. We conjectured that this might have happened because Japanese financial institutions explored a new profit opportunity in emerging Asia after the announcement of the NIRP.

The purpose of this section is to investigate whether the NIRP in Japan had similar spillover effects on stock prices in advanced economies. Specifically, using daily stock price data in the UK, Germany, and the US, we examine how the stock prices responded to Japan's financial shocks in the NIRP period. In the estimation, we use daily returns of the FTSE 100 in the UK, the DAX 30 in Germany, and the Dow Jones Industrial in the US as a dependent variable. Except for the dependent variable, the estimated equations are essentially the same as those in previous sections. But we dropped the second subset of control variables, that is, those in the PRC, in the regressions because they were not significant. We also allowed some simultaneous feedback across advanced economies. All daily data were downloaded from *Datastream*.

Table 4: Estimation Results for Stock Prices in Advanced Economies

		UK		Germany		US	
Variable		**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**	**Coef.**	**z-Statistic**
	Constant	0.001	0.80	0.001	0.76	0.001	1.49
Japan financial shocks	JGB yields	–0.013	–0.39	0.004	0.09	0.017	0.98
	JGB yields(-1)	–0.004	–0.12	0.029	0.76	–0.002	–0.15
	Nikkei 225	0.116	1.94*	0.255	3.85***	–0.020	–0.82
	Nikkei 225(-1)	0.045	0.76	0.164	2.21**	0.037	1.23
	Yen	–0.139	–1.30	–0.367	–2.93***	–0.205	–4.91***
	Yen(-1)	0.090	0.86	0.133	0.87	0.020	0.35
Control variables	London Stock					0.416	11.23***
	London Stock(-1)	–0.077	–0.55	–0.007	–0.04	0.083	1.36
	German Stock(-1)	–0.342	–1.82*	–0.495	–2.00**		
	French Stock(-1)	0.278	1.24	0.319	1.25		
	NY stock(-1)	0.255	1.30	0.508	2.10**	–0.200	–1.71*
	VIX(-1)	–0.020	–1.17	0.002	0.10	0.006	0.70
	US yields(-1)	–0.032	–1.78*	–0.038	–1.40	–0.008	–0.82
Variance equation	C	0.000	1.43	0.000	0.80	0.000	1.29
	RESID(-1)^2	0.184	1.67*	0.090	1.47	0.253	1.96*
	GARCH(-1)	0.715	5.21***	0.850	8.42***	0.670	4.32***
	R-squared	0.215		0.290		0.523	
	Adjusted R-sq.	0.154		0.235		0.489	

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

JGB = Japanese government bond, UK = United Kingdom, US = United States, VIX = volatility index.

JGB yields ≡ daily change of 10-year Japanese government bond (JGB) yields, Nikkei 225 ≡ daily returns of the Nikkei 225 stock price index, yen ≡ daily change of the dollar-denominated yen's exchange rate, London stock ≡ daily stock returns of FTSE 100, German stock ≡ daily stock returns of DAX 30 in Germany, French stock ≡ daily stock returns of CAC 40 in France, NY stock ≡ daily stock returns of Dow Jones Industrials, VIX ≡ daily log-difference of the VIX, US yields ≡ daily change of the 10-year US government bond yields, RESID(-1)^2 ≡ squared lagged residual, and GARCH ≡ contemporary variance.

Source: Author's calculation.

We estimate the GARCH (1,1) model for the NIRP1 period. Table 4 reports the estimation results. As in the last section, many of the control variables were statistically significant. However, even if we control these external effects, we still see that the Nikkei stock price index and the yen–dollar exchange rate had significant spillover effects on the stock price responses in each of the three advanced economies. The Nikkei stock price index had a large positive effect on the Germany stock price index and a marginally significant positive effect on the UK stock price index. The yen–dollar exchange rate had a large negative effect both on the Germany stock price index and on the US stock price index. This indicates that a strong yen might have had a negative effect on stock prices in the two economies.

However, unlike in Asian stock markets, the 10-year JGB yields never had a significant effect on the stock prices in the advanced economies in the NIRP period. This means that unlike in Asia, a decline of long-term interest rates below zero in Japan did not benefit the advanced economies. In the NIRP period, the changed behavior of Japanese financial institutions might have benefited many Asian economies. But when exploring a new profit opportunity outside Japan, financial markets in advanced economies were not attractive investment destinations because their long-term interest rates had already fallen enough.

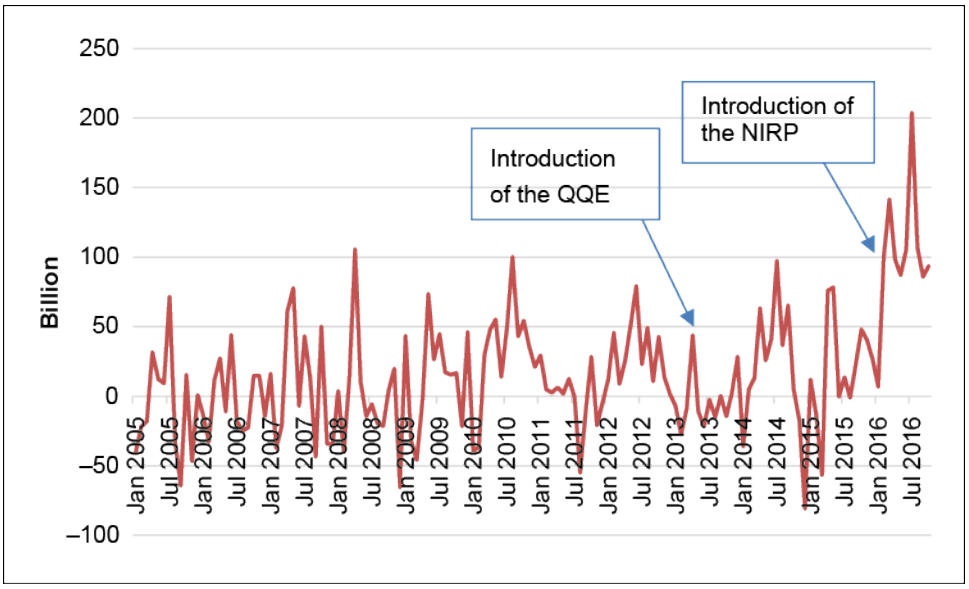
7. CONCLUDING REMARKS

In this paper, we explored what spillover effects Japan's negative interest rate policy (NIRP) had on Asian stock markets. Unlike the QQE without a negative interest rate, the QQE with a negative interest rate had limited impact on the Japanese economy. However, the NIRP brought various undesirable consequences to the Japanese economy, especially to its finance sector. It is thus likely that its spillover effects are very different from those of the QQE without a negative interest rate. Our empirical result suggested that spillovers from Japan's financial shocks to Asian stock markets had contrasting features in the NIRP period, which were not observed in the pre-QQE or the QQE periods. In particular, they showed that the NIRP might have benefited Asian economies through a decline of excess returns in Japan's finance sector.

One notable consequence of the NIRP was that not only short-term but also long-term interest rates became negative. Under prevailing negative long-term interest rates, most of the Japanese local financial institutions lost their profit opportunities in domestic markets. They thus needed to explore a new profit opportunity outside Japan. Figure 10 shows the amount of net purchases of foreign long-term securities by Japanese life insurance companies from 2005 to 2016. Until January 2016, the monthly amount had usually been less than ¥50 billion and rarely exceeded ¥100 billion. But the amount soared up dramatically in February 2016 and remained high. Such large and persistent net purchases never happened during the last decade. This implies that Japanese life insurance companies that lost investment opportunities in domestic markets expanded their investment to foreign markets after the announcement of the NIRP.

When exploring a new profit opportunity outside Japan, financial markets in emerging Asia, rather than those in advanced economies, were their natural choices. They are still risky but potentially highly profitable investment destinations. It is likely that their changed investment behavior benefited Asian economies, especially their finance sector. Our empirical results supported the view.

Figure 10: Net Purchases of Foreign Long-Term Securities by Life Insurance Companies



NIRP = negative interest rate policy, QQE = quantitative and qualitative monetary easing.

Source: Ministry of Finance, International Transactions in Securities.

However, it is worthwhile to note that the notable spillovers of the NIRP might have happened under a special environment in Japan. In order to mitigate a concern among local financial institutions, the BOJ introduced the QQE with yield curve control (NIRP2) on 21 September 2016. Even in the NIRP2, short-term interest rates remained significantly negative. But unlike in the NIRP1, long-term interest rates increased to zero in the NIRP2. Because of limited sample size, we could not estimate spillover effects in the NIRP2. But it is likely that in the NIRP2, we may no longer see beneficial spillover effects on Asian economies.

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