Spillover Effects of Asian Financial Markets on the Global Markets*

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Abstract

This paper aims to find out how much stronger the spillover effects of a shock in Asian financial markets on the global financial markets have become since the GFC (Global Financial Crisis). In the first half of the analysis, the paper analyzes spillover effects in stock markets. An estimation based on a GVAR model shows that the impacts of a shock in Asian emerging economies have become stronger since the GFC. However, the increase in Asian impacts is attributable to a shock in the manufacturing sector, rather than in the financial sector. This suggests that the increase in the spillover effects since the GFC reflects an increase in the impacts of a shock in the manufacturing sector in Asian emerging economies. In the second half of the analysis, the paper examines spillover effects across foreign exchange rates, focusing on effects originating from the Chinese Yuan. Based on the data on changes in the Chinese Yuan's exchange rate between 1 AM and 2 AM GMT, this analysis reveals that exchange rate policy changes made by the People's Bank of China (PBC) have had positive spillover effects on many developed countries since the summer of 2015. The results of this empirical analysis suggest that amid the growth in Asia's presence in the global economy, Asia's impacts are increasing in the global financial markets as well.

Keywords: emerging economies, cross-border spillover effects, Asian financial market
JEL: F10, F32, E52

I. Introduction

During the past quarter-century, the share of emerging market economies in global GDP has risen substantially. Until the early 1990s, emerging market and developing economies had accounted for less than 40% of global GDP. However, their share in global GDP increased dramatically in the 2000s and is expected to exceed 60% in 2020. In particular, a rise of emerging and developing Asia has been dramatic. The share of emerging and developing Asia in global GDP, which was 16.7% in 2000, is expected to increase to 37.8% in

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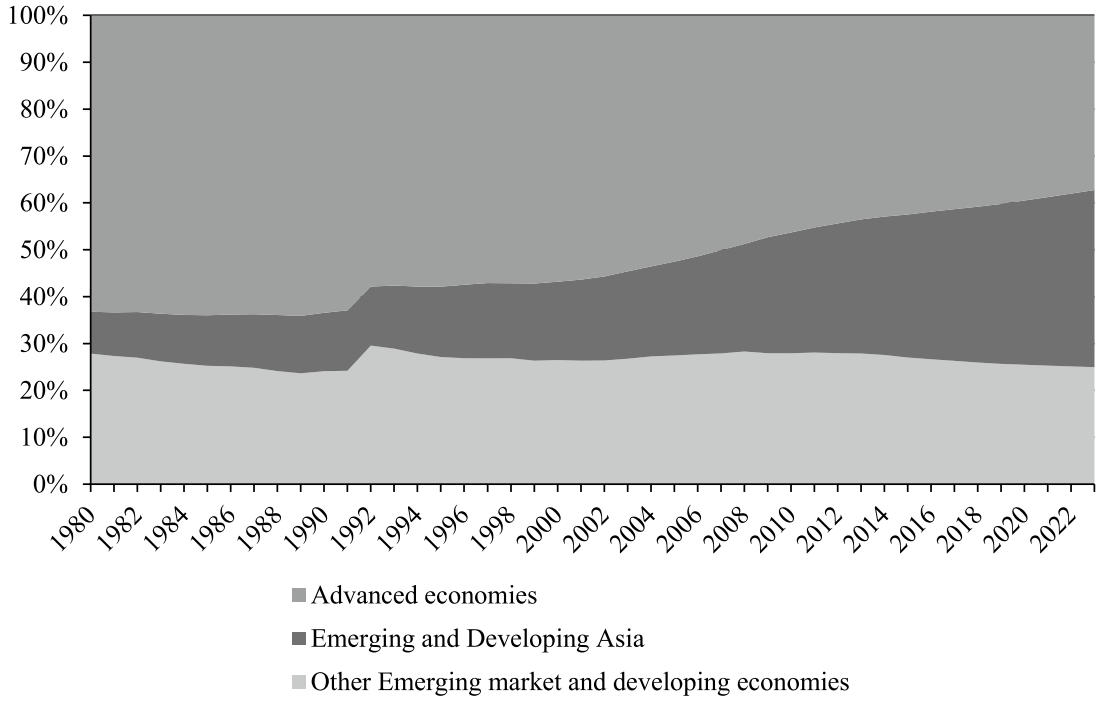
2023 (see Figure 1). Macroeconomic shocks in emerging economies now have greater impacts on advanced economies (see, for example, Comin et al. (2014) and Huidrom et al. (2017)). However, despite a large increase in output and trade, there are no doubts about many so-called frictions existing in emerging financial markets. Less liquidity, a higher degree of information asymmetry problems, a need for better and more transparent regulations, and better monitoring and regulatory mechanisms all are the need of the hour.

Figure 1. The Share of World GDP



Note: GDP based on PPP (Purchasing Power Parity).
Source: IMF, World Economic Outlook (October 2018).

The purpose of this paper is to investigate whether such a view is correct by exploring to what extent the spillovers from Asian financial markets have risen in the 2000s. In the analysis, we first investigate the spillovers of stock markets between advanced countries and Asian emerging markets. Estimating the GVAR (Global Vector Autoregression) model, we show that the spillover from Asia to Europe and the USA became large after the GFC, although it was small before the GFC. This suggests that the presence of Asia has increased even in the stock markets in the post-GFC period. However, we also show that most of the significant spillovers are from the manufacturing sector, rather than from the financial sector. This implies that a rise of the Asian manufacturing sector in the global market played a key role for enhancing stock market spillovers from emerging Asia in the post-GFC period. In the second part of this paper, we explore the spillovers among foreign exchange markets. In the analysis, we estimate spillovers from the Chinese Yuan (CNY) on several major cur-

rencies in the time zone during which the People's Bank of China (PBC) reports its official fixing exchange rate. We find that an exchange rate policy change by the PBC had significant spillover effects on most of the advanced currencies after the summer of 2015 when the variance of the CNY was widened[1].

This paper focuses on emerging Asia for the following three reasons. Firstly, emerging East Asian economies have achieved high growth rates by promoting investment, nurturing human capital and opening up to export manufacturing. This growth, including China's miracle in the 2000s, contributes to a dramatic increase in the share of emerging Asia in the world economy[2]. Secondly, despite the rapid growth, several emerging East Asian economies still manipulated and repressed their financial markets until recently. In Asian emerging economies, the dramatic increase in the influence of neo-liberal thinking and laissez-faire governance led to serious capital market reform in the 2000s. However, in spite of such a reform, the development of Asian financial markets is far from that of developed countries (See Fukuda (2013), for example). Thirdly, because of substantial time differences across the regions, we can identify direction of spillover effects without serious simultaneous biases by using daily data in each region. The rapid evolution into a 24h society challenges individuals' ability to conciliate work schedules. However, most financial markets are open from Monday through Friday and closed on Saturday and Sunday in their respective local time zones. This allows us to identify from which financial markets the shocks were originated.

Many previous studies have pointed out that movements in the prices of different assets are likely to directly influence one another in advanced countries. A number of authors found that financial market shocks in advanced countries had large spillover effects on emerging market economies (EMEs) (see, for example, Rogers, Scotti, and Wright (2014), Gauvin, McLoughlin, and Reinhardt (2014), Neely (2015), Bowman, Londono, and Sapriza, (2015), Aizenman, Chinn, and Ito (2017), Anaya, Hachula, and Offermanns (2017)). In particular, the introduction of unconventional monetary policies and the eventual exit from these policies by advanced economies have sparked a vigorous, ongoing debate among policy-makers and academics about the spillover effects on EMEs. Several authors pointed out that this was true even on emerging Asian economies which are now a global leader in manufacturing and trade in the world economy (see, for example, Morgan (2011), Park and Um (2016), Tillmann (2016), Chen, Filardo, He, and Zhu (2016), Belke, Dubova, and Volz, (2018), and Fukuda (2019)). However, relatively limited previous studies explored how large spillovers financial market shocks in emerging economies had on advanced economies. Exceptional studies such as Gelos and Surti (2016) and Huidrom, Kose, and Ohnsorge (2016) showed the growing importance of financial spillovers from emerging market economies. However, these studies do not focus on Asian emerging markets. Except for Fukuda and Tanaka (2017), few studies explored the spillovers from Asian financial markets to ad-

[1] See Ito and Kawai (2016) and Ito (2017) for the increasing role of the CNY.
[2] See Aizenman and Fukuda (2017) and Didier, Llovet, and Schmukler (2017) for the role of emerging economies in the pacific region.

vanced countries after the GFC. It is thus important to examine to what extent spillovers from Asian financial market shocks have risen in global financial markets during the past two decades.

Our empirical results suggest that the spillover effects from Asian emerging economies to advanced economies exceed those from advanced economies to Asian emerging economies even in the post-GFC period. However, at the same time, this paper shows that the spillover effects increased in the post-GFC period because of increased manufacturing sector's shocks in emerging Asia. This implies that even if Asian financial markets are underdeveloped, the spillovers of Asian stock market shocks have larger impacts on the global financial markets due to an increase in macroeconomic fundamentals of East Asia. Moreover, utilizing high frequency data of foreign exchange markets, we show that changes of the currency exchange policy by the PBC have had positive spillovers to many advanced economies after the summer of 2015. This suggests that the impact of China increases even in foreign exchange markets from the increasing presence of China in the world economy. Deep trade and investment linkages could drive a phase of rapid financial market development and integration in the world economy.

This paper is a straightforward extension of Fukuda and Tanaka (2017, 2019). Using long time-series data, Fukuda and Tanaka (2017) explored to what extent spillovers from Asian financial market shocks have risen during the past two decades and found that the spillovers increased in the post-GFC period because of manufacturing sector's shocks. Using principal component analysis (PCA), Fukuda and Tanaka (2019) examined financial spillovers between emerging Asia and advanced economies and found that stock market spillovers from emerging Asia became significant in the post-GFC period but bond market spillovers from emerging Asia remained small even after the GFC. This paper is similar to these studies in that we explore the degree of financial spillovers from emerging Asia in the 2000s. However, it has two critical differences. First, this paper allows interaction of stock market shocks and bond market shocks to examine financial spillovers between emerging Asia and advanced economies. Given financial market integration in Asia, it is important to see how the interaction of the two financial market shocks affected spillovers from emerging Asia. Second, this paper investigates the effects of China's exchange rate reform to examine exchange rate spillovers among different currencies. Because of the growing role of China in the world market, it is important to explore how China's official exchange rate policy affected exchange rates of the other major currencies before and after China's exchange rate reform.

The paper proceeds as follows. Section 2 explains our empirical methodology to examine financial spillovers across the regions. Section 3 investigates stock market spillovers between emerging Asia and advanced economies using the variance decomposition. Section 4 reports how the results change when we allow industry-level effects. Section 5 examines hourly spillovers among major currencies. Section 6 summarizes our main results and discusses their implications.

II. Empirical Methodology

In this paper, we first investigate the spillovers of stock markets between emerging Asia and advanced economies. Specifically, we explore how stock markets in Japan, Europe and the USA and those in six Asian economies (that is, China, Hong Kong, Korea, Singapore, Taiwan, and Thailand) have reacted with each other. The stock market indexes used in the following analysis are Nikkei 225, Shanghai SSEC, Hang Seng Stock Index, Seoul Composite Index, Singapore (SES) Strait Times Index, Taiwan Weighted Price, and Thailand SET-Index, FTSE 100, DAX 30, and Dow Jones Industrials. We take their daily rates (the log-difference of the closing time price from the previous day's closing price). To control the effects of interest rates, we also use daily differences of 5-year or 10-year government bond yields of the six Asian economies and advanced economies (that is, Japan, the UK, Germany, and the USA).

The sample period starts in January 2003 and ends in April 2018. We split the sample periods into three subsample periods: January 3, 2003 to June 29, 2007 (i.e. pre-GFC period), July 1, 2009 to May 20, 2013 (i.e. post-GFC and pre-tapering period), and May 21, 2013 to April 27, 2018 (i.e. tapering period). The subsample periods did not include July 1, 2007 to June 30, 2009 to exclude the effects of the GFC. We split the post-GFC period into the two to allow different monetary policy regimes in the USA. The break point is the date when Federal Reserve Chairman Ben Bernanke first mentioned the idea of gradually reducing or "tapering" the Federal Reserve Board's monetary expansion. We downloaded the data from *Datastream*.

To capture total (common) stock market and bond market shocks in Asia, we use principal component analysis (PCA), which reduces data by geometrically projecting them onto lower dimensions called principal components (PCs), with the goal of finding the best summary of the data using a limited number of PCs. Its central idea is to reduce the dimensionality of a data set consisting of a large number of interrelated variables while retaining as much as possible of the variation present in the data set. This is achieved by transforming to a new set of variables, the PCs, which are uncorrelated, and which are ordered so that the first few retain most of the variation present in all of the original variables. The extracted PCs in Asia allow us to investigate how large regional spillovers Asian common financial shocks had before and after the GFC. Given financial integration in Asia, it deserves to estimate commons shocks' spillovers.

The first PC is chosen to minimize the total distance between the data and their projection onto the PC. By minimizing this distance, we also maximize the variance of the projected points. Table 1 reports how the first PC of Asian stock market returns and that of changes in Asian bond yields are correlated with individual returns in Asia for the three alternative subsample periods respectively. The table shows that in both cases, the first PC has a large positive correlation with individual returns in Asia. In case of the stock market returns, the correlation with China's stock market returns is small for the first subsample period. However, the correlation lies almost between 0.3 and 0.5 for the other Asian returns. This implies

that the first PC is a weighted average of all Asian stock market returns throughout the sample periods. In case of the bond yields changes, the first PC is positively correlated with each Asian long-term interest rate except for China's long-term rates. The correlation with Thailand's long-term rate was relatively small in the first and second subsample periods. However, putting aside these outliers, the other correlation exceeded 0.4 in 5-year government bond yields. They also tend to lie between 0.37 and 0.60 in 10-year government bond yields. This implies that the first PC is a weighted average of Asian long-term interest rates.

Table 1. The Correlation of the 1st PC with Individual Economy's Returns

(1) Stock market index returns

	pre-GFC	post-GFC, pre-tapering	post-tapering
Korea	0.476	0.430	0.431
Hong Kong	0.489	0.466	0.483
China	0.109	0.310	0.300
Taiwan	0.445	0.425	0.432
Singapore	0.475	0.441	0.440
Thailand	0.315	0.354	0.331

(2-1) 5-year bond yields

	pre-GFC	post-GFC, pre-tapering	post-tapering
Korea	0.446	0.476	0.462
Hong Kong	0.614	0.521	0.490
China	0.066	0.145	0.006
Taiwan	0.158	0.408	0.398
Singapore	0.607	0.474	0.463
Thailand	0.162	0.299	0.416

(2-2) 10-year bond yields

	pre-GFC	post-GFC, pre-tapering	post-tapering
Korea	0.374	0.439	0.457
Hong Kong	0.583	0.503	0.493
China	−0.056	0.071	0.057
Taiwan	0.419	0.442	0.390
Singapore	0.570	0.532	0.488
Thailand	0.125	0.265	0.394

Using the first PCs in Asian stock prices and government bond yields, we estimate the GVAR model to capture stock market spillovers across advanced countries and six emerging Asian market economies. Specifically, we estimate the following equation:

$$Y_t = \alpha + \sum_{j=1}^{p} \beta_j Y_{t-j} + \sum_{j=1}^{p} \gamma x_{t-j} + u_t, \quad (1)$$

where Y_t is a vector of endogenous variables and x_t is an exogenous variable. The vector of endogenous variables is composed of stock market returns and interest rate changes in Japan, Asia, the UK, Europe, and the USA. The exogenous variable is daily log-difference of VIX. We use VIX as an exogenous variable to account for common/systematic global factors. We downloaded the data from *Datastream*. The estimation of the GVAR model is done recursively, with the number of lags set to two.

The order of the Cholesky decomposition is the interest rate changes and the stock market returns. The order of the countries is Japan, Asia, the UK, Europe, and the USA. We chose the order because Asian financial markets are open when European and New York markets are closed. Strictly speaking, our identified spillovers do not necessarily mean "true" causality from Asian financial markets to European and US markets. For example, if some event happened in the USA after the NY stock market was closed, the shock is regarded to have happened in Asia. However, since Japan is ordered first in the Cholesky decomposition, such a shock is identified as a shock in Japan, which is one of advanced economies, not as a shock in Asian emerging economies. Hence, although there is a possibility that we overestimate the impact of shocks in Japan, it is unlikely to overestimate the impacts of shocks in Asian emerging economies.

Besides, since stock prices reflect anticipation of future shocks, if some event is expected to happen in the USA when Asian stock markets are open, stock prices in Asia would respond earlier in anticipation of the shock in the USA. In this case, the identified Granger causality is from Asia to the USA, although the true causality is from the USA to Asia. However, noting that most of the country-specific shocks tend to occur when its local market is open, large US-specific events are less likely to happen when Asian markets are open. In the following analysis, we thus suppose that our GVARs approximately identify true spillovers from Asian financial shocks to European and US markets.

III. Variance Decompositions

This section reports the variance decompositions of the estimated GVARs. Table 2 reports the variance decomposition of various stock returns over 10 business days. It shows how many percentages of the stock price fluctuations were explained by their own shocks, other stock market shocks, and bond market shocks over 10 business days. Our main interest is to see spillover effects between Asian stock markets and those in advanced economies when we allow interaction of stock market shocks and bond market shocks. Table 2-(1) reports how many percentages of the first PC of Asian stock returns were explained by its own shocks, stock market shocks in advanced countries, and bond market shocks, while Table 2-(2) reports how many percentages of stock prices in Japan, two European countries, and the USA were explained by the first PC of Asian stock returns, stock market shocks in advanced countries, and bond market shocks. In both of the tables, we include either 5-year or

10-year bond yields of each country in the GVAR model to control the impacts of long-term interest rates on stock markets. We downloaded the data from *Datastream*.

Table 2-(1) indicates that the first PC of Asian stock returns was largely explained by stock price shocks in the advanced economies throughout the three subsample periods. When we use 5-year bond yields, more than 38% of the first PC was explained by stock market shocks in the advanced economies in the first and second subsample periods and more than 35% in the third subsample periods. This implies that there have been large positive spillovers from stock markets in advanced economies to Asian stock markets before and after the GFC, although the spillover effects declined significantly in the tapering period. Among the advanced economies, shocks in Japan explained most in the first and the third subsample periods, while so did shocks in the UK in the second subsample period. Shocks in the USA also explained more than 8% in the first and 10% in the third subsample periods. The only exception was shocks in Germany which only explained 1.25% in the second subsample period and 1.00% in the third subsample period. This may have happened because of the Euro crisis in these periods. Bond market shocks in the advanced economies also explained the first PC of Asian stock returns in the first and second subsample periods. When we use 5-year bond yields, bond market shocks in the advanced economies explained more than 4% of the first PC in the first subsample period and more than 6% of the first PC in the second subsample period. The results are essentially the same even when we use 10-year bond yields.

In contrast, Table 2-(2) shows that the first PC of Asian stock returns explained only limited percentages of the stock price fluctuations in the advanced economies throughout the subsample periods. In particular, the first PC of Asian stock returns hardly explained stock price fluctuations in Japan in the first and the second subsample periods. This implies that the stock price spillovers are asymmetric between Asia and advanced economies. However, Table 2-(2) also indicates that after the GFC, the first PC of Asian stock returns came to explain significant percentages of stock price fluctuations in two European countries and the USA. In the second subsample period (i.e. post-GFC and pre-tapering period), it explained 13.67% and 14.35% in the UK, 10.37% and 10.81% in Germany, and 6.64% and 7.12% in the USA when we include 5-year and 10-year bond yields respectively. In the third subsample period (i.e. tapering period), it explained 11.31% and 11.21% in the UK, 9.69% and 9.49% in Germany, and 5.93% and 6.06% in the USA when we include 5-year and 10-year bond yields respectively. These percentages were much larger than those in the first subsample period (i.e. pre-GFC period). This implies that stock market spillovers from emerging Asia to Europe and the USA, which were small before the GFC, became significantly positive after the GFC. The stock market spillovers from Asia to advanced economies became far from negligible even though they were still smaller than those from advanced economies to Asia. However, the first PC of Asian bond market shocks explained stock price fluctuations in advanced economies even after the GFC. Throughout the subsample periods, the first PC of Asian bond market shocks never explained more than 1% of stock price fluctuations in the advanced countries.

Table 2-(1). Variance Decomposition of the First PC in Asian Stock Prices

(a) Case of 5-year interest rates

	stock market shocks						interest rate shocks	
	Asian 1st	advanced countries					advanced	Asian 1st
	PC shock	total	Japan	the UK	Germany	the USA	countries	PC shock
pre-GFC period	56.19	38.21	21.42	5.46	3.04	8.28	4.16	0.37
post-GFC, pre-tapering	54.48	38.08	14.61	16.19	1.25	6.02	6.06	1.33
tapering period	61.45	35.46	15.72	8.11	1.00	10.62	0.96	0.82

(b) Case of 10-year interest rates

	stock market shocks						interest rate shocks	
	Asian 1st	advanced countries					advanced	Asian 1st
	PC shock	total	Japan	the UK	Germany	the USA	countries	PC shock
pre-GFC period	56.10	38.55	21.72	5.52	3.05	8.26	3.47	0.77
post-GFC, pre-tapering	55.86	34.68	13.81	14.51	1.35	5.01	8.75	0.66
tapering period	61.76	35.12	15.44	8.19	0.96	10.53	1.50	0.31

Table 2-(2). Variance Decomposition of the Stock Price in the Advanced Countries

(a) Japanese stock price

	stock market shocks			5-year interest rate shocks		
	shocks in Japan	other adv. countries	Asian 1st PC shock	shocks in Japan	other adv. countries	Asian 1st PC shock
pre-GFC period	71.02	13.80	1.22	11.58	1.01	0.02
post-GFC, pre-tapering	66.20	19.25	0.18	3.27	10.07	0.86
tapering period	72.27	19.07	2.60	1.37	3.88	0.16

	stock market shocks			10-year interest rate shocks		
	shocks in Japan	other adv. countries	Asian 1st PC shock	shocks in Japan	other adv. countries	Asian 1st PC shock
pre-GFC period	70.54	13.52	1.25	12.05	1.21	0.02
post-GFC, pre-tapering	63.67	17.27	0.23	5.93	11.64	1.08
tapering period	71.13	18.97	2.63	2.50	3.87	0.19

(b) UK stock price

	stock market shocks			5-year interest rate shocks		
	shocks in the UK	other adv. countries	Asian 1st PC shock	shocks in the UK	other adv. countries	Asian 1st PC shock
pre-GFC period	76.80	13.58	4.42	2.83	1.79	0.15
post-GFC, pre-tapering	63.22	7.67	13.67	10.66	3.25	1.49
tapering period	68.92	14.34	11.31	2.07	5.82	0.55

	stock market shocks			10-year interest rate shocks		
	shocks in the UK	other adv. countries	Asian 1st PC shock	shocks in the UK	other adv. countries	Asian 1st PC shock
pre-GFC period	76.55	13.53	4.40	3.24	1.47	0.32
post-GFC, pre-tapering	58.68	6.34	14.35	14.85	4.70	1.04
tapering period	68.81	14.26	11.21	2.59	0.77	0.32

Table 2-(2). Variance Decomposition of the Stock Price in the Advanced Countries (continued)

(c) German stock price

	stock market shocks			5-year interest rate shocks		
	shocks in Germany	other adv. countries	Asian 1st PC shock	shocks in Germany	other adv. countries	Asian 1st PC shock
pre-GFC period	35.41	50.22	5.76	0.50	7.04	0.60
post-GFC, pre-tapering	21.13	51.63	10.37	0.74	10.94	1.73
tapering period	33.66	50.04	9.69	0.36	5.53	0.17

	stock market shocks			10-year interest rate shocks		
	shocks in Germany	other adv. countries	Asian 1st PC shock	shocks in Germany	other adv. countries	Asian 1st PC shock
pre-GFC period	35.10	50.06	5.77	0.42	7.25	0.86
post-GFC, pre-tapering	20.42	44.74	10.81	0.66	22.37	0.94
tapering period	34.16	49.86	9.49	0.56	5.29	0.08

(d) US stock price

	stock market shocks			5-year interest rate shocks		
	shocks in the USA	other adv. countries	Asian 1st PC shock	shocks in the USA	other adv. countries	Asian 1st PC shock
pre-GFC period	62.03	30.53	2.58	0.15	4.36	0.09
post-GFC, pre-tapering	37.83	39.70	6.64	2.88	10.94	1.73
tapering period	62.47	25.96	5.93	1.27	4.02	0.08

	stock market shocks			10-year interest rate shocks		
	shocks in the USA	other adv. countries	Asian 1st PC shock	shocks in the USA	other adv. countries	Asian 1st PC shock
pre-GFC period	62.11	36.57	2.60	0.15	4.47	0.14
post-GFC, pre-tapering	35.86	36.57	7.12	5.36	13.80	1.00
tapering period	61.45	25.40	6.06	2.28	4.40	0.14

IV. Industry-level Estimations

In the last section, we found that stock market spillovers from the first PC in emerging Asia to those in Europe and the USA became significant in the post-GFC period. The result indicates that even in the stock markets, common shocks in emerging Asia came to have substantial spillover effects on advanced countries after the GFC. However, stock market spillovers could increase because real linkages had been tightened. If this is the case, the spillovers do not necessarily suggest direct financial linkages from emerging Asia to advanced countries in the post-GFC period.

In this section, we investigate whether the significant stock market spillovers in the post-GFC period were originated from the Asian financial sector or from the Asian manufacturing sector. Using daily industry-level stock market returns in emerging Asia, we examine

which sector's shocks had larger impacts on the stock prices in advanced countries. In the analysis, we use PCA to extract common stock price shocks of the manufacturing sector and those of the financial sector in the five emerging Asian economies for the three subsample periods.

Table 3 reports how the first PC of Asian industry-level stock returns was correlated with each industry-level stock market returns in Asia. Comparing the two sectors, the positive correlation in the manufacturing sector tended to be slightly larger than that in the financial sector. However, both in the manufacturing sector and in the financial sector, the first PC is positively correlated with the industry-level stock market returns in all Asian economies. The correlation is relatively small in Thailand. However, except for a couple of cases in Thailand, the correlation lies between 0.3 and 0.5 for each industry-level Asian returns. This implies that the first PC is a weighted average of all Asian industry-level stock market returns.

Table 3. Correlation of the Industry-level First PC with Individual Economy's Returns

(1) The first PC in the Asian manufacturing sector

	pre-GFC	post-GFC, pre-tapering	post-tapering
Korea	0.461	0.410	0.389
Hong Kong	0.485	0.448	0.464
China	0.316	0.463	0.457
Taiwan	0.434	0.374	0.401
Singapore	0.441	0.425	0.410
Thailand	0.264	0.310	0.310

(2) The first PC in the Asian financial sector

	pre-GFC	post-GFC, pre-tapering	post-tapering
Korea	0.435	0.385	0.314
Hong Kong	0.491	0.460	0.489
China	0.348	0.454	0.477
Taiwan	0.379	0.383	0.392
Singapore	0.453	0.420	0.439
Thailand	0.316	0.334	0.297

In the following analysis, we estimate the GVAR model by focusing especially on the first PC. Except for the use of the first PCs in the manufacturing and financial sectors for emerging Asia, the set of endogenous variables, the exogenous variable, and their order are the same as those in the last section. We estimate GVARs for three alternative subsample periods: January 3, 2003 to June 29, 2007, July 1, 2009 to May 20, 2013, and May 21, 2013 to April 27, 2018. As in the last section, we also include either 5-year or 10-year bond yields in the GVAR model to control the impacts of long-term interest rates on stock markets.

Table 4-(1) reports how many percentages of the first PCs of stock market shocks in Asian manufacturing and financial sectors were explained by their own shocks, other stock market shocks, and bond market shocks, while Table 4-(2) reports how many percentages of stock returns in Japan, two European countries, and the USA were explained by the first PCs in Asian stock returns, stock market shocks in advanced countries, and bond market shocks. As in the last section, we find large spillovers from advanced countries to the first PCs of Asian stock returns throughout the subsample periods. Table 4-(1) indicates that the first PC of stock market shocks in the Asian manufacturing sector not only explains about 60% of its own fluctuations but also about 40% of stock price fluctuations in the Asian financial sector. However, in both the manufacturing and financial sectors, shocks in advanced economies also explained more than 30% of the first PC of Asian stock returns in the first and third subsample periods and more than 40% in the second subsample period. This implies that there have been large spillovers of stock markets from advanced economies to Asian emerging economies in both the manufacturing and financial sectors throughout the 2000s.

In contrast, Table 4-(2) shows that the first PC of the Asian financial sector never had significant spillover effects on advanced countries. Throughout the subsample periods, it never explained more than 2% of stock price fluctuations in each advanced country. This implies that the stock price spillovers are asymmetric between Asia and advanced economies. However, the first PC of the Asian manufacturing sector had significant spillover effects on stock prices in two European countries and the USA after the GFC. Both in the sec-

Table 4-(1). Variance Decomposition of the First PC in Asian Industry-level Stock Prices

(a) The first PC in the Asian manufacturing sector

	Asian 1st PC shock		stock market shocks in advanced countries					5-year
	mfg. sec.	fin. sec.	total	Japan	the UK	Germany	the USA	rate shock
pre-GFC period	60.39	0.45	37.20	20.13	4.91	2.87	6.59	3.56
post-GFC, pre-tapering	56.29	0.16	41.24	13.08	16.46	1.41	5.83	6.71
tapering period	65.11	0.03	30.48	14.53	7.24	1.25	8.71	2.20
	Asian 1st PC shock		stock market shocks in advanced countries					10-year
	mfg. sec.	fin. sec.	total	Japan	the UK	Germany	the USA	rate shock
pre-GFC period	60.24	0.43	37.20	19.93	5.03	2.91	6.60	3.71
post-GFC, pre-tapering	57.46	0.10	41.24	11.97	14.68	1.40	4.85	9.49
tapering period	65.66	0.04	30.48	14.11	7.37	1.20	8.52	2.21

(b) The first PC in the Asian financial sector

	Asian 1st PC shock		stock market shocks in advanced countries					5-year
	mfg. sec.	fin. sec.	total	Japan	the UK	Germany	the USA	rate shock
pre-GFC period	37.30	25.44	35.40	18.32	4.14	2.97	7.17	3.56
post-GFC, pre-tapering	43.96	12.92	41.12	13.86	15.22	1.61	5.74	6.62
tapering period	43.13	22.73	31.16	14.27	7.85	1.03	8.66	1.46
	Asian 1st PC shock		stock market shocks in advanced countries					10-year
	mfg. sec.	fin. sec.	total	Japan	the UK	Germany	the USA	rate shock
pre-GFC period	37.22	25.40	35.40	18.70	4.23	3.00	7.21	3.10
post-GFC, pre-tapering	45.05	12.99	41.12	13.04	13.63	1.66	4.75	8.79
tapering period	43.36	22.73	31.16	14.17	7.79	0.95	8.53	1.60

Note: "5-year rate shock" and "10-year rate shock" denote the total contributions of 5-year and 10-year interest rate shocks in Asia and the advanced countries respectively.

ond and third subsample periods, it explained more than 10% of UK stock price fluctuations, about 10% of German stock price fluctuations, and more than 5% of US stock price fluctuations. These features suggest that stock market spillovers from emerging Asia increased in the post-GFC period mainly because the common manufacturing sector's shocks in emerg-

Table 4-(2). Variance Decomposition of the Stock Price in the Advanced Countries

(a) Japanese stock price

	stock market shocks		Asian 1st PC shocks		5-year interest rate shocks		
	shocks in Japan	other adv. countries	mfg. sector	financial sector	shocks in Japan	other adv. countries	Asian 1st PC shock
pre-GFC period	70.64	13.53	1.13	0.67	11.63	1.07	0.02
post-GFC, pre-tapering	66.53	18.59	0.45	0.40	3.33	9.61	0.91
tapering period	72.29	19.24	2.29	0.16	1.40	3.81	0.16

	stock market shocks		Asian 1st PC shocks		10-year interest rate shocks		
	shocks in Japan	other adv. countries	mfg. sector	financial sector	shocks in Japan	other adv. countries	Asian 1st PC shock
pre-GFC period	70.23	13.25	1.15	0.72	12.05	1.22	0.02
post-GFC, pre-tapering	63.99	16.71	0.50	0.37	6.07	11.07	1.11
tapering period	71.08	19.19	2.35	0.16	2.56	3.76	0.19

(b) UK stock price

	stock market shocks		Asian 1st PC shocks		5-year interest rate shocks		
	shocks in the UK	other adv. countries	mfg. sector	financial sector	shocks in the UK	other adv. countries	Asian 1st PC shock
pre-GFC period	77.05	13.61	2.79	1.29	2.91	4.08	0.15
post-GFC, pre-tapering	62.81	7.79	13.94	0.60	9.88	3.30	1.64
tapering period	68.93	14.20	10.65	0.96	1.90	0.76	0.51

	stock market shocks		Asian 1st PC shocks		10-year interest rate shocks		
	shocks in the UK	other adv. countries	mfg. sector	financial sector	shocks in the UK	other adv. countries	Asian 1st PC shock
pre-GFC period	76.80	13.56	2.73	1.36	3.27	1.48	0.31
post-GFC, pre-tapering	58.60	6.45	14.42	0.69	13.85	4.82	1.12
tapering period	68.84	14.10	10.53	1.07	2.35	0.77	0.30

(c) German stock price

	stock market shocks		Asian 1st PC shocks		5-year interest rate shocks		
	shocks in Germany	other adv. countries	mfg. sector	financial sector	shocks in Germany	other adv. countries	Asian 1st PC shock
pre-GFC period	35.41	50.39	3.87	1.61	0.47	7.18	0.58
post-GFC, pre-tapering	21.07	51.44	10.33	1.03	1.18	13.42	1.45
tapering period	33.52	49.73	9.16	1.14	0.37	5.37	0.17

	stock market shocks		Asian 1st PC shocks		10-year interest rate shocks		
	shocks in Germany	other adv. countries	mfg. sector	financial sector	shocks in Germany	other adv. countries	Asian 1st PC shock
pre-GFC period	35.11	50.32	3.87	1.60	0.42	7.31	0.82
post-GFC, pre-tapering	20.36	44.94	10.61	1.13	0.65	21.24	1.01
tapering period	34.04	49.49	9.10	1.12	0.56	5.04	0.09

Table 4-(2). Variance Decomposition of the Stock Price in the Advanced Countries (continued)

(d) US stock price

	stock market shocks		Asian 1st PC shocks		5-year interest rate shocks		
	shocks in the USA	other adv. countries	mfg. sector	financial sector	shocks in the USA	other adv. countries	Asian 1st PC shock
pre-GFC period	61.82	30.72	1.47	1.03	0.16	4.44	0.09
post-GFC, pre-tapering	37.77	39.47	7.00	0.64	2.86	10.14	1.86
tapering period	62.52	26.56	5.03	0.30	1.29	3.95	0.07

	stock market shocks		Asian 1st PC shocks		10-year interest rate shocks		
	shocks in the USA	other adv. countries	mfg. sector	financial sector	shocks in the USA	other adv. countries	Asian 1st PC shock
pre-GFC period	61.92	30.46	1.47	1.08	0.15	4.52	0.14
post-GFC, pre-tapering	35.81	36.55	7.33	0.66	5.31	12.99	1.06
tapering period	61.58	26.03	5.15	0.31	2.26	4.24	0.14

Note: "5-year rate shock" and "10-year rate shock" denote the total contributions of 5-year and 10-year interest rate shocks in Asia and the advanced countries respectively.

ing Asia had significant impacts on advanced economies.

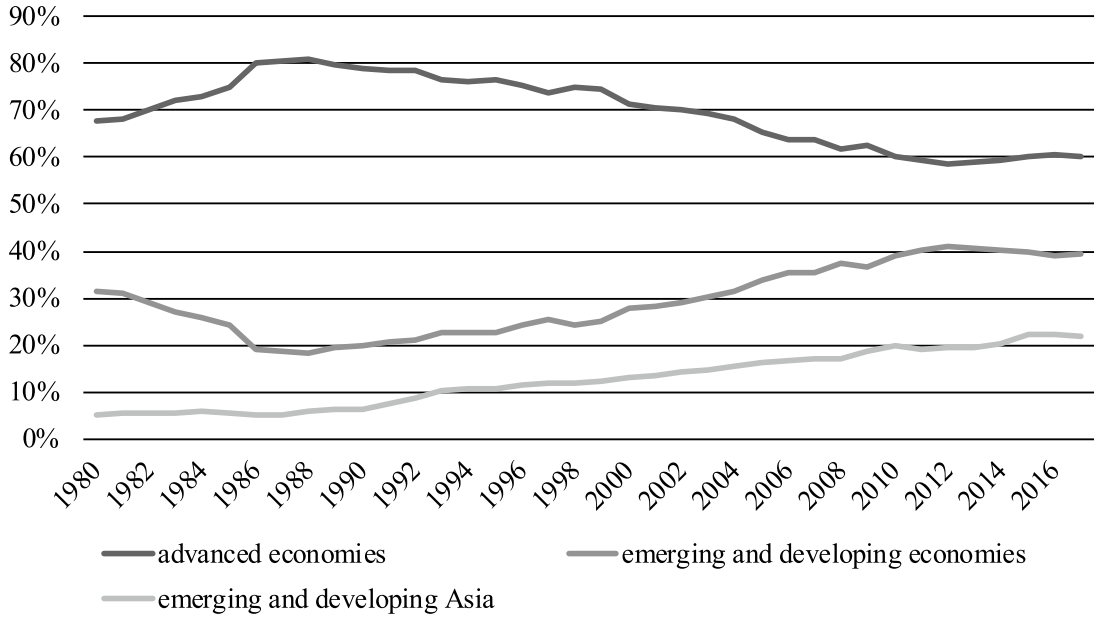
It is noteworthy that the share of emerging Asia in the global output and trading network has progressed steadily in the 2000s. For example, Figure 2 depicts how the share in the imports of advanced economies changed from 1980 to 2017. It shows that the imports from the other advanced economies had a dominant share in the early 1990s. However, their share, which had exceeded 80% in the late 1980s, steadily declined during the past quarter-century and fell below 60% in 2011. In contrast, the imports from emerging and developing economies increased their share dramatically in the 2000s. In particular, the share of emerging and developing Asia, which was 6.4% in 1990, exceeded 20% in 2014 in the imports of advanced economies.

Because Asian markets and institutional savings vehicles have long been underdeveloped relative to the region's economic output, the increased linkages in the manufacturing sector might have had limited impact on financial linkages until the post-GFC period. However, once the increased linkages had reached a threshold level, they tightened financial linkages significantly. As a result, even if direct financial market linkages from emerging Asia to advanced countries were, if any, limited even after the GFC, the increased real linkages in the manufacturing sector significantly increased the stock market spillovers.

V. Hourly Spillover Effects from the CNY

The previous sections showed that the spillover of Asian stock market shocks to the European and the US stock market has increased, reflecting the shocks in the Asian manufacturing sector in the post-GFC period. This section explores the spillover effects of another financial market, the foreign exchange markets. In the analysis, we focus on spillovers from the Chinese Yuan (CNY) to the major currencies because Fukuda and Tanaka (2017) showed

Figure 2. The Share in the Imports of Advanced Economies



Source: IMF, Direction of Trade Statistics.

that a shock in the Chinese currency increased its spillover effects dramatically in the post-GFC period. In July 2005, the People's Bank of China (PBC) reformed its official exchange rate to adopt the managed floating system (managed floating exchange rate system), and then the on-shore exchange rate of the CNY came to be determined by market rates reflecting the currency basket. However, even after the reform, the CNY was managed to vary within the range of the official fixing exchange rate. Although the range has been widened since August 11th, 2015, the predetermined official exchange rate has been the anchor of the CNY. Thus, it is important to see spillovers from the official exchange rate to the major currencies.

To measure spillovers across the currencies, we adopt the estimation method by Frankel and Wei (1994). Using the Swiss Franc as a benchmark currency, we estimate the following equation by using the log difference of hourly data of the exchange rates.

$$\Delta ln(z^{A}_{t}) = \text{constant} + a_1 \Delta ln(CNY_t) + \Sigma^{4}_{j=1} b_j \Delta ln(z^{j}_{t}), \quad (2)$$

where z^{A}_{t} is the major currency's exchange rate, CNY_t is the Chinese Yuan (CNY), and z^{j}_{t} is the exchange rate in the advanced country (that is, the US Dollar, the Euro, the UK Pound, and the Japanese Yen) respectively.

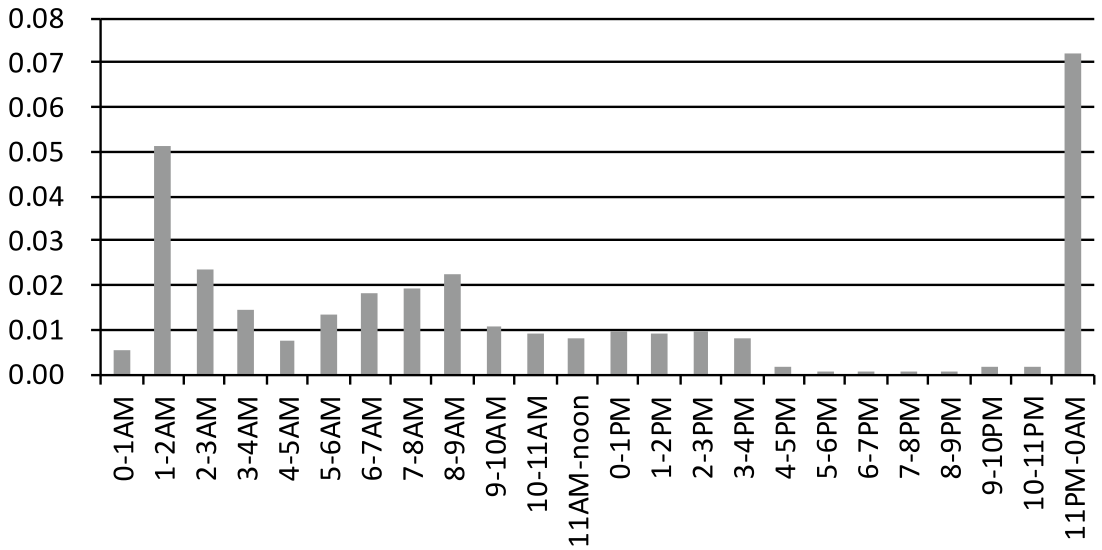
One possible problem with estimating equation (2) is that it may suffer from simultaneous biases and multicollinearity (see, for example, Fukuda and Ohno (2008) and Kawai and Pontines (2016)). Unlike in stock markets, the foreign exchange markets for major currencies are open for 24 hours a day. In addition, since the exchange rate is relative price be-

tween two currencies, the exchange rates are susceptible to currency-specific shocks of the numeraire currency. To avoid the problem, we use the exchange rates of specific time zone from Greenwich Mean Time (GMT) 1AM to 2AM and examine what spillovers we can observe from the Chinese Yuan (CNY) to several major currencies. Hourly data from GMT 1AM to 2AM, which is from 9AM to 10AM in China time, is useful for avoiding simultaneous biases in the following three respects.

First, the CNY's changes from GMT 1AM to 2AM are likely to reveal exchange rate policy changes by PBC. The PBC announces its predetermined official exchange rate, that is, the central parity of CNY at 9:15AM in China time every business day. To the extent that the predetermined official exchange rate has been the anchor of the CNY, exploring the impacts of the announcement on the other exchange rates would show spillovers from the CNY to the major currencies.

Second, reflecting the fact that the CNY was effectively controlled by the PBC, changes in the CNY during GMT 1AM to 2AM were highly heterogeneous from the other time zones. In particular, GMT 1AM to 2AM is one of the time zones when the CNY actually changed most in the post-GFC period. Figure 3 depicts the standard deviation of hourly changes of the CNY denominated in the US Dollar from April 7th, 2010 to August 31st, 2018. It indicates that the CNY changed little against the US Dollar except for the time zones from GMT 1AM to 2AM (9AM to 10AM in China time) and from GMT 11PM to 0AM (7AM to 8AM in China time). In other words, most of the daily changes in the CNY were attributable to hourly changes from GMT 1AM to 2AM[3].

Figure 3. The Standard Deviation of Hourly Changes of the CNY



Note: Horizontal axis is GMT.
Source: Authors' calculation.

[3] Changes from GMT 11PM to 0AM also contributed to the daily changes in the CNY because of infrequent large shocks.

Third, GMT 1AM to 2AM corresponds to the time zone from 2AM to 3AM (or from 3AM to 4AM in summer) in London time and from 9PM to 10PM (or from 10PM to 11PM in summer) in New York time. Noting that large local shocks are less likely to happen in the night time, this implies that most of the large exogenous shocks which affect the exchange rates are likely to be originated in East Asia in the time zone from GMT 1AM to 2AM. Thus, restricting our exchange rates to those from GMT 1AM to 2AM, it would be easier to identify the direction of exchange rate spillover effects from China to Europe and the USA.

In the following analysis, the dependent variables are five alternative major currencies: the US Dollar, the UK Pound, the Euro, the Norway Krone, and the Canadian Dollar, all of which are denominated in the Swiss Franc. The explanatory variables are the CNY, the US Dollar, the Euro, the UK Pound, and the Japanese Yen (JPY), all of which are also denominated in the Swiss Franc. Taking the log difference of hourly data, we investigate not only the instant spillover effects of the change of the CNY, but also the spillover effects with one-hour lag of the change of the CNY. All of the hourly data was downloaded from *Datastream*. The sample period is from April 7th, 2010 to August 31st, 2018. Since the exchange rate policy change in China caused a structural change in the movement of the CNY before and after August 11th, 2015, the sample period was split before and after August 11th, 2015. We explore how China's official exchange rate policy affected exchange rates of the other major currencies before and after China's policy change.

Table 5 summarizes the estimation results for the two subsamples when we took no lag of the explanatory variables. It reports the results with and without the lag dependent variable. In both subsample periods, the CNY had significant effects on the US Dollar. In particular, before August 11th, 2015, the CNY had large effects on the US Dollar. In contrast, before August 11th, 2015, the CNY had no significant impact on the major currencies except for the US Dollar. This may reflect the fact that the CNY was controlled to stabilize their values against the US Dollar before the exchange rate policy change. However, after August 11th, 2015, the CNY had significantly positive effect on the other advanced currencies except for the Euro. This implies that the exchange rate policy change by the PBC, which had widened the range of the CNY's changes, significantly increased the CNY's spillover effects on most of the major currencies in the world.

The results are essentially the same even when we took one-hour lag of the explanatory variables. Table 6 reports that estimation result for the two subsamples when we took one-hour lag of the explanatory variables. It shows that the spillovers with one-hour lag are overall less significant than instant spillovers. In particular, before August 11th, 2015, the CNY's effect became less significant even on the US Dollar and sometimes became negative on some currencies such as the Euro. However, the CNY had positive spillovers to all major currencies after August 11th, 2015, though with small significance. This result suggests that even when we take an hour lag, the CNY had positive spillovers to most of the major currencies after August 11th, 2015, when the policy change by the PBC widened the range of the CNY's changes.

Table 5. Hourly Spillover Effects of China's Exchange Policy without Lags

(1) before August 11th, 2015

	US Dollar		UK Pound		Euro	
Constant terms	0.001	0.002	−0.002	−0.002	−0.001	−0.001
	(0.001)**	(0.001)**	(0.001)***	(0.001)***	(0.001)	(0.001)
Variables with	−0.040		−0.029		−0.051	
one-hour lag	(0.015)***		(0.015)*		(0.020)**	
CNY	0.348	0.348	0.016	0.014	0.026	0.024
	(0.014)***	(0.014)***	(0.014)	(0.014)	(0.016)	(0.016)
US Dollar			0.414	0.417	−0.107	−0.101
			(0.020)***	(0.020)***	(0.026)***	(0.026)***
Euro	−0.104	−0.103	0.490	0.492		
	(0.027)***	(0.027)***	(0.019)***	(0.019)***		
UK Pound	0.551	0.553			0.641	0.640
	(0.027)***	(0.027)***			(0.025)***	(0.025)***
JPY	0.051	0.051	0.011	0.012	−0.023	−0.022
	(0.010)***	(0.010)***	(0.008)	(0.008)	(0.010)**	(0.010)**
Adj. R-squared	0.649	0.648	0.630	0.630	0.411	0.409
DW statistic	1.924	1.929	1.913	1.904	1.931	1.925

	Norway Krone		Canadian Dollar	
Constant terms	0.001	0.001	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Variables with	−0.020		−0.032	
one-hour lag	(0.017)		(0.017)*	
CNY	0.020	0.018	0.006	0.005
	(0.019)	(0.019)	(0.017)	(0.017)
US Dollar	−0.017	−0.015	0.304	0.309
	(0.031)	(0.030)	(0.028)***	(0.028)***
Euro	0.903	0.904	0.340	0.343
	(0.031)***	(0.031)***	(0.028)***	(0.028)***
UK Pound	0.133	0.135	0.398	0.395
	(0.035)***	(0.035)***	(0.032)***	(0.032)***
JPY	−0.063	−0.062	−0.022	−0.021
	(0.011)***	(0.011)***	(0.010)**	(0.010)**
Adj. R-squared	0.566	0.566	0.610	0.609
DW statistic	1.937	1.936	1.953	1.955

Table 5. Hourly Spillover Effects of China's Exchange Policy without Lags (continued)

(2) after August 11th, 2015

	US Dollar		UK Pound		Euro	
Constant terms	0.000	0.000	0.000	0.000	−0.002	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)***	(0.001)***
Variables with	−0.059		−0.004		−0.154	
one-hour lag	(0.031)*		(0.029)		(0.025)***	
CNY	0.110	0.114	0.039	0.039	0.015	0.018
	(0.015)***	(0.015)***	(0.016)**	(0.016)**	(0.0095)	(0.010)*
US Dollar			0.347	0.348	0.035	0.056
			(0.034)***	(0.034)***	(0.022)	(0.022)**
Euro	0.130	0.141	0.498	0.499		
	(0.057)**	(0.056)**	(0.055)***	(0.055)***		
UK Pound	0.329	0.330			0.188	0.187
	(0.033)***	(0.033)***			(0.020)***	(0.021)***
JPY	0.063	0.066	−0.178	−0.177	0.035	0.048
	(0.022)***	(0.022)***	(0.022)***	(0.022)***	(0.014)**	(0.014)***
Adj. R-squared	0.253	0.251	0.314	0.315	0.195	0.159
DW statistic	1.857	1.847	2.021	2.022	2.088	2.092

	Norway Krone		Canadian Dollar	
Constant terms	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)*	(0.001)	(0.001)
Variables with	−0.033		−0.063	
one-hour lag	(0.021)		(0.025)**	
CNY	0.034	0.034	0.082	0.081
	(0.011)***	(0.011)***	(0.014)***	(0.014)***
US Dollar	0.026	0.029	0.390	0.399
	(0.025)	(0.025)	(0.033)***	(0.033)***
Euro	0.737	0.744	0.237	0.245
	(0.040)***	(0.040)***	(0.053)***	(0.053)***
UK Pound	0.237	0.236	0.427	0.426
	(0.024)***	(0.024)***	(0.032)***	(0.032)***
JPY	−0.087	−0.085	−0.085	−0.083
	(0.016)***	(0.015)***	(0.020)***	(0.020)***
Adj. R-squared	0.523	0.522	0.552	0.549
DW statistic	2.119	2.112	2.135	2.149

Note: * = 10% significance level, ** = 5% significance level, and *** = 1% significance level.

Table 6. Spillover Effects of China's Exchange Policy with One-hour Lag

(1) before August 11th, 2015

	US Dollar		UK Pound		Euro	
Constant terms	0.001	0.001	−0.001	0.000	−0.003	−0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)***	(0.001)***
Variables with	0.060		−0.113		−0.007	
one-hour lag	(0.041)		(0.040)***		(0.031)	
CNY	0.018	0.039	0.006	0.004	−0.043	−0.043
	(0.025)	(0.021)*	(0.022)	(0.022)	(0.019)**	(0.019)**
US Dollar			0.003	−0.044	0.052	0.052
			(0.035)	(0.031)	(0.031)*	(0.031)*
Euro	0.019	0.012	0.036	−0.020		
	(0.042)	(0.041)	(0.035)	(0.029)		
UK Pound	−0.062	−0.029			−0.080	−0.084
	(0.047)	(0.042)			(0.035)**	(0.029)***
JPY	−0.083	−0.080	−0.015	−0.017	−0.034	−0.034
	(0.015)***	(0.015)***	(0.013)	(0.013)	(0.011)***	(0.011)***
Adj. R-squared	0.021	0.020	0.008	0.003	0.019	0.020
DW statistic	1.809	1.809	1.709	1.713	1.779	1.779

	Norway Krone		Canadian Dollar	
Constant terms	−0.002	−0.003	−0.001	−0.001
	(0.001)***	(0.001)***	(0.001)	(0.001)
Variables with	−0.266		−0.071	
one-hour lag	(0.034)***		(0.039)*	
CNY	−0.037	−0.042	−0.004	−0.005
	(0.024)	(0.025)*	(0.025)	(0.025)
US Dollar	−0.062	−0.058	0.094	0.072
	(0.040)	(0.040)	(0.042)**	(0.040)*
Euro	0.229	−0.011	0.065	0.041
	(0.051)***	(0.041)	(0.043)	(0.040)
UK Pound	0.007	−0.029	−0.011	−0.138
	(0.046)	(0.046)	(0.049)**	(0.046)***
JPY	−0.007	0.009	−0.043	−0.042
	(0.014)	(0.015)	(0.014)***	(0.014)***
Adj. R-squared	0.055	0.016	0.012	0.010
DW statistic	1.879	1.829	1.706	1.703

Table 6. Spillover Effects of China's Exchange Policy with One-hour Lag (continued)

(2) after August 11th, 2015

	US Dollar		UK Pound		Euro	
Constant terms	0.003	0.003	0.001	0.001	−0.002	−0.001
	(0.001)**	(0.001)**	(0.003)	(0.003)	(0.001)**	(0.001)
Variables with	0.158		0.794		−0.321	
one-hour lag	(0.040)***		(0.093)***		(0.050)***	
CNY	0.049	0.067	0.047	0.077	0.027	0.021
	(0.017)***	(0.017)***	(0.042)	(0.043)*	(0.014)*	(0.014)
US Dollar			−0.475	−0.198	−0.157	−0.175
			(0.096)***	(0.094)**	(0.031)***	(0.032)***
Euro	0.115	0.137	−0.772	−0.376		
	(0.064)*	(0.064)**	(0.153)***	(0.152)**		
UK Pound	−0.171	−0.118			0.170	0.110
	(0.039)***	(0.037)***			(0.030)***	(0.030)***
JPY	−0.047	−0.037	−0.134	−0.275	−0.040	−0.055
	(0.025)*	(0.025)	(0.059)**	(0.059)***	(0.019)**	(0.020)***
Adj. R-squared	0.044	0.026	0.120	0.041	0.100	0.054
DW statistic	1.999	2.009	1.943	2.000	1.952	2.018

	Norway Krone		Canadian Dollar	
Constant terms	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Variables with	0.162		0.213	
one-hour lag	(0.083)*		(0.050)***	
CNY	0.033	0.039	0.020	0.037
	(0.026)	(0.025)	(0.021)	(0.020)*
US Dollar	−0.181	−0.177	0.009	0.094
	(0.058)***	(0.059)***	(0.050)	(0.0470)**
Euro	−0.580	−0.459	−0.109	−0.056
	(0.111)***	(0.093)***	(0.075)	(0.075)
UK Pound	0.435	0.473	−0.009	0.082
	(0.060)***	(0.057)***	(0.050)	(0.046)*
JPY	−0.140	−0.153	−0.052	−0.069
	(0.037)***	(0.036)***	(0.029)*	(0.029)**
Adj. R-squared	0.140	0.137	0.053	0.032
DW statistic	2.023	2.040	1.954	1.970

Note: * = 10% significance level, ** = 5% significance level, and *** = 1% significance level.

VI. Concluding Remarks

This paper explores to what extent the spillovers from Asian financial market to international financial market have increased before and after the GFC. In stock markets, we found that although the spillovers from advanced countries to Asian emerging economies are larger than the spillovers of the opposite direction, the spillovers from Asian emerging economies have become non-negligible after the GFC. We also found that the stock market spillovers are mainly from the shocks of the manufacturing sector rather than of the financial sector. This implies that the shocks of the manufacturing sector of the Asian emerging economies increased the stock market spillovers. In contrast, in foreign exchange markets, the exchange rate policy change by the PBC have had positive spillovers to advanced economies since the summer of 2015. Both of the results imply that the impact of Asia is increasing in international financial markets and increasing the presence of Asia in the global economy.

While Asia may be a global leader in manufacturing and trade, the region's financial markets have been the least integrated and developed among the world's major economic regions. However, since the role of Asian emerging economies has been dramatically increasing over the two decades, their macroeconomic fundamental shocks came to have large spillovers to advanced economies. Our empirical results support the view that even though the financial market in emerging Asia has developed at a slower pace, the impact of emerging Asia has been rising in the global financial markets.

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