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Cross-country Spillover Through Government Bond Market in Emerging East Asia: The Effect of Covid-19

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ABSTRACT
This paper showed evidence of the effect of covid-19 on changes in the structure and time-varying pattern of bond yield spillover across the country through the government bond market in emerging East Asia. We used daily 10-year government bond yield for China, Hong Kong, Japan, South Korea, Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam. We employed the VAR-variance decomposition framework developed by Diebold-Yilmaz 2012, which performed both static and dynamic impact to quantify the spillover shock transmission from one country to another. The static Total Spillover Index in the Covid-19 period was higher than the entire sample period. Over 10-years, the spillover effects come from the own-stressed country. In contrast, spillover effects emanating from other countries have significant roles in the Covid-19 period. It indicated that domestic factors turn to regional factors that explained shock transmission across-country in the Covid-19 Era. The dynamic Total Spillover Index reached the highest point in the Covid-19 period. In particular, the first quarter of 2020 showed the peak point of spillover effect across the country. Hong Kong and Thailand showed their impact on the East Asia markets within 10-years and the covid-19 period. Our findings matter to regional government policies seeking to achieve financial stability.

Keywords: *Spillover, Government bond, COVID-19, Emerging East Asia, VAR-variance decomposition.*

1. INTRODUCTION

The outbreak of coronavirus disease 2019 (Covid-19) has brought a severe challenge to the global bond market. The emerging market economies were generally more vulnerable to capital outflows than advanced economies, while sovereign bond yield was affected more heavily than the stock or foreign exchange market[1]. As reported in Asia Bond Monitor in June 2020[1], the outbreak of Covid-19 soured investment sentiment in emerging East Asia. Global investors flocked to safe-haven assets, pushing down foreign holding in the most region local-currency (LCY) bond market. Government bonds outstanding, which dominate the region's bond market, rose to USD 9.9 trillion, accounting for 60.6% of the region's aggregate bond stock at the end of March 2020. Local currency government bonds have become an increasingly important source of government financing, given the Covid-19. The government has issued bonds to finance its large fiscal stimulus package[2].

Fundamental conditions in domestic economies and the influence of global factors are related to the movement in the bond yield across the region[3]. The prior studies showed that the behavior of bond yield could represent the measurement of country risk[4], the response to government monetary policies[5], and changes in investor risk preference[6]. In the Covid-19 period, a study showed the long-term behavior of sovereign bond yield in the emerging market is divergent[1].

Several studies on relationships across the market focused on measuring integration. Bond market integration examined in regional[7][8][9][10] [11], and international [12][13][14], both in the tranquil and turmoil period[7][9][13][14]. The result confirmed that the bond market in Asia become more integrated after the Asian financial crisis period, even though the

[1] Details are available at https://asianbondsonline.adb.org/abm.php.

process was slow. However, an integrated financial market may facilitate the shock transmission from one economy to another. During the crisis period, the shock transmission may have consequences to financial stability[12]. A few studies in the Asian bond market examined the shocks transmission showed about shock transmission direction[15][14][3][2].

Several studies also tested the effects of the natural disaster on the Asian financial market. After a Tsunami earthquake[16] and several outbreaks as SARS in China[17], Avian Influenza[18], and Animal Foot-Mouth Disease in Korea[19]. During the Covid-19 period, existing studies examined shock transmission across the country[20], across China's financial market[21] and on the global financial market[22][23].

The previous studies on financial shock transmission focused on the stock markets [20][21][23][22]. In contrast, the impact on debt markets was relatively scant. To the best of our knowledge, research in the bond market contributed to topics of flight quality[24], liquidity[25], the role of government policy response on volatility[26] and behavior of long-term sovereign bond[1].

We investigated cross-country spillover direction and intensities of bond yield. We performed analysis on the static and the dynamic impact to quantify the spillover shock transmission. We used high-frequency data, which are less affected by macroeconomics fundamentals, allow for better analysis of the spillovers' time variations and detect sudden changes in transmission magnitude. We divided the period into the whole sample period and the Covid-19 period. We used a generalized VAR variance decomposition developed by Diebold Yilmaz 2012. The Total Spillovers Index (TSI) represented the static impact of one country on others. The dynamic used rolling regression to give information about time variations of spillover intensities. The result showed that TSI index increase in the Covid-19. The magnitude of spillovers varied substantially over time across countries. The source of spillover effects exhibited that domestic factors turn to regional factors in the Covid-19 Era.

Compared to existing studies, this paper contributed in several distinct ways. First, we examined the shock transmission intensities. Second, the recent outbreak Covid-19 Era. Third, we analyzed the government bond market. Last, we tested on the emerging East Asia region.

This study builds on research about spillover transmission in the financial market. The spillovers and contagion are the financial terminologies that defined the shock transmission with different intensities. We followed Rigobon (2019) used the words contagion and spillovers very loosely to describe the phenomenon in which a shock from one country has transmitted to another[27]. A few studies in the Asian bond market examined the shocks transmissions, such as volatility transmission[15], return spillover[14], including advanced economies' factors [3][2]. The shock transmission examined in the financial crisis period. The previous research showed that shock transmission also existed in the natural disaster period. After a Tsunami earthquake in Southeast Asia in December 2014, the foreign market in some Asian countries suffered from shock transmission (contagion)[16]. In the preceding period, several outbreaks already affected the financial market, such as SARS in China[17], Avian Influenza in Hong Kong[18], and Animal Foot-Mouth Disease in Korea[19]. Recently, we faced another natural disaster, the Covid-19 outbreak.

During the Covid-19 period, existing studies examined shock transmission across the country, between China and G7 advanced economies countries, through the stock market. The empirical results indicated financial contagion transmission occurred[20]. The study across China's financial market revealed that the volatility relationship between China's stock market and bitcoin significantly grown[21]. In the global financial market, the connectedness across various assets exhibited a change in the structure and time-varying patterns of return connectedness[22]. The study using network analysis revealed structural changes in the global financial market and a contagion effect found in global emerging markets[23]. The shock transmission induced changes in the relationship, the connectedness, or the network structure.

The previous studies on financial shock transmission focused on the stock markets [20][21][23] and across the financial market[22]. In contrast, the impact of Covid-19 on debt markets was relatively scant. To the best of our knowledge, research in the bond market during Covid-19 contributed to topics of flight quality [24], liquidity on emerging market bonds [25], the role of government policy response on international sovereign bond markets volatility[26] and behavior of long-term sovereign bond yields across emerging market economies[1]. Accordingly, we examined the impact of Covid-19 on changes in the structure and time-varying pattern of bond yield spillover across the country through the government bond market.

2. MATERIAL AND METHODS

2.1. Data

We used daily 10-year government bond yield for China, Hong Kong, Japan, South Korea, Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam. The data collected from

Eikon Data Stream. We divided the period into the whole sample period (18 March 2011 to 8 February 2021) and the Covid-19 period (2 December 2019 to 8 February 2021). We followed the empirical approach developed by Diebold and Yilmaz (2012) based on VAR variance decomposition.

2.2 Summary Statistics

The descriptive statistic over 10-years (Table 1) showed that Indonesia has the highest average (7.26%) government bond yield. Japan has the lowest bond yield over two sample periods. The Covid-19 period (Table 2) exhibited that most countries have a lower bond yield than over 10-years. Interestingly, some countries experienced the lowest bond yield with almost nearly zero

Table 1. Descriptive statistic of 10-years government bond yield for the whole sample period

	China	Hong Kong	Japan	South Korea	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Mean	3.50	1.59	0.34	2.56	7.26	3.74	4.79	1.98	2.76	6.92
Median	3.50	1.60	0.13	2.41	7.30	3.87	4.53	2.12	2.72	6.76
Maximum	4.71	3.03	1.34	4.53	9.77	4.45	8.19	2.88	4.41	12.53
Minimum	2.50	0.42	-0.29	1.17	5.02	2.50	2.57	0.70	0.86	2.06
Std. Dev.	0.44	0.55	0.40	0.83	0.94	0.41	1.13	0.50	0.83	2.72
Skewness	0.34	-0.11	0.54	0.39	-0.29	-1.12	0.49	-0.70	-0.26	0.31
Kurtosis	2.91	2.38	2.00	2.13	2.42	3.80	2.71	2.61	2.13	2.20
Observations	2581	2581	2581	2581	2581	2581	2581	2581	2581	2581

Source : Data Processed

Table 2. Descriptive statistic of 10-years government bond yield for the Covid-19 period

	China	Hong Kong	Japan	South Korea	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Mean	3.01	0.85	0.01	1.53	6.93	2.91	3.53	1.11	1.31	2.85
Median	3.09	0.71	0.02	1.53	6.90	2.80	3.14	0.94	1.32	2.90
Maximum	3.34	1.82	0.10	1.81	8.32	3.57	5.49	1.79	1.82	3.62
Minimum	2.50	0.42	-0.15	1.28	5.95	2.50	2.57	0.70	0.86	2.06
Std. Dev.	0.23	0.40	0.04	0.14	0.57	0.28	0.76	0.34	0.14	0.36
Skewness	-0.64	1.18	-1.66	0.03	0.51	0.76	0.70	1.01	0.17	-0.03
Kurtosis	2.22	2.97	7.57	1.84	2.66	2.35	1.95	2.37	3.59	2.23
Observations	311	311	311	311	311	311	311	311	311	311

Source : Data Processed

2.3 VAR-variance decomposition by Diebold Yilmaz 2012

According to Augmented-Dickey Fuller (ADF) test, a raw series of bond yields was non-stationary. We transformed data into stationary series with percentage deviation using Hodrick-Prescott (HP) Filter Trends[2].

We estimated the VAR(p)5 model:

$$x_{t=\sum_{i=1}^{p}\Phi_i\, x_{t-1}+\varepsilon_i} \qquad (1)$$

Where $\varepsilon \in (0,\Sigma)$ is the i.i.d error vector.

According to the Schwarz-information criterion [28], we chose the lag length of 2 for the whole sample period and the lag length of 1 for the Covid-19 period.

The further analysis relied on variance decompositions, which allowed assessing the fraction of the H-step-ahead error variance in forecasting x_i is due to shocks *to* x_j. We used the generalized VAR framework to produce variance decompositions invariant to ordering choice to deal with contemporaneous correlations of VAR shock transmissions. This method relied on historical patterns to identify directionality.

The H-step-ahead forecast error variance decomposition calculated as:

$$\theta_{ij}^{g}(H) = \frac{\sigma_{jj}^{-1}\sum_{h=0}^{H-1}(e'_i\, A_h\ \Sigma e_j\ )2}{\sum_{h=0}^{H-1}(e'_i\, A'_h\ \Sigma e_i\ )} \qquad (2)$$

where Σ is the variance matrix for the error vector ε, σ_{jj} is the standard deviation of the errors term for the

*j*th equation and e_i is the selection vector, with one as the *i*th element and zeros otherwise.

The Total Spillovers Index (TSI) constructed as:

$$TSI^g(H) = \frac{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}.100 = \frac{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}{N}.100 \quad (3)$$

where $\tilde{\theta}_{ij}^g(H)$ is normalized value for $\theta_{ij}^g(H)$, so that $\tilde{\theta}_{ij}^g(H) = \frac{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}$.

TSI measured the contribution of spillovers of shocks across variables under consideration to the total forecast error variance, therefore enabled us to understand shocks spillovers intensities. The dynamic TSI, we estimated using a 200-day rolling sample for the whole sampel period and a 20-day rolling samples data in the Covid-19 period.

The measurement of the gross directional spillovers received by market *i* from all others market *j* as:

$$GS_i^g(H) = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ij}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^g(H)}.100 = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ij}^g(H)}{N}.100 \quad (4)$$

Similarly, the measurement of the gross directional spillovers transmitted by market *i* to all others market *j* as:

$$GS_i^g(H) = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ji}^g(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ji}^g(H)}.100 = \frac{\sum_{j=1}^{N} \tilde{\theta}_{ji}^g(H)}{N}.100 \quad (5)$$

The set of directional spillovers as providing a decomposition of the Total Spillovers to those coming from (or to) a particular source.

The Net Spillovers is the difference between the shocks transmitted to and those received from all other markets. The Net Spillovers from market *i* to all other market *j* as:

$$NS_i^g(H) = DS_i^g(H) - DS_i^g(H) \quad (6)$$

3. RESULT AND DISCUSSION

3.1 The Static Total Spillovers Index

Table 3 showed that the value of the total spillover index is 22.60%. It indicated that 22.60% of the total variance of the forecast error over 10-years was explained by shocks across countries, whereas the remaining 77.40% explained by idiosyncratic shocks. Table 4 the TSI value achieved 42.20%, which means that almost half of the variation in bond yield explained by shocks to bond's yield in other countries in the Covid-19 period. We summarized that the magnitude of spillover effect increased during the Covid-19 period.

Our finding was in line with a few studies on linkages across countries. The previous study exhibited that the long-run relationship in international integration changed after the Asian financial crisis in 1997[12]. After Global Financial Crisis in 2008, intra-regional spillovers in Asia through the bond market improved[14]. Likewise, studies that included the Global financial crisis and European Debt Crisis showed that the bond market integration based on bond yield increased little[13]. The previous studies did not examine the magnitude of change in linkages, but they showed that the bond market increased in different intensities during the turmoil period. In the Covid-19 period, a study showed a dramatic change in the structure and time-varying of return connectedness across various assets[22].

Furthermore, the main diagonal of the TSI Table exhibited the own-country stressed spillovers. Table 3 the forecast error variance in the ranging from 57.9% (Hong Kong) to 97.6% (Vietnam). Over 10-years, domestic factors were a primary part of the bond yield. All countries showed the own-country stressed index reached more than 55%. We confirmed the result of earlier studies that the domestic influence was a significant factor in explaining movement in Asian bond yield[15][12][8][13].

The Covid-19 period (Table 4) has a range of 38.2% for Singapore to a 84.2% for Vietnam. This evidence denoted that the tensions from other countries increased. Most countries in emerging East Asia were affected by regional shocks. Even though Indonesia, the Philippines, and Vietnam remain experienced the own-country stressed spillover. In contrast with our result, previous studies considered two crisis periods, the Global Financial Crisis, and the European Debt Crisis. Their evidence showed that own-country shocks explained the main fraction of its variance both in the short and long run. Moreover, it suggested domestic monetary shocks are a primary driver of the Asian Bond Market [5]. Hence, the uniqueness of spillover effects in the Covid-19 period was a role of regional factors increased.

(Table 3) the spillovers from Hong Kong explained a significant proportion of the variation in bond yields. Approximately 56% of the variation in emerging East Asia was attributable to the spillovers emanating from Hong Kong. On the other hand, those who are the primary transmitters are the countries as receivers too. Hong Kong and South Korea received spillovers of nearly 42% and 38%, respectively. These results were not surprising for us. After the 1997 Asian Financial Crisis, Hong Kong, Singapore, and South Korea have developed

bond markets in Asia. Earlier studies showed that they have a role in the regional bond markets and international financial integration[15][7][12][8][13]

Table 4 showed the spillover within the Covid-19 period. Thailand was the highest contributor to other markets. Japan and Thailand were receivers of spillovers. Compared to a previous study, Thailand exhibited a higher sensitivity to the regional market since the 2008 Global Financial Crises. Hong Kong and Singapore more sensitives to the regional market than the global market after the GFC[13]. Hence, we concluded that during the Covid-19 period, the sensitivity to the regional market was higher than in the previous crisis.

In the last row of the TSI Table, we presented the Net Spillovers that indicated stability in the country's financial system [22]. Over 10-years (Table 3), Hong Kong has a magnitude of net spillovers, which indicated the least vulnerable markets. However, in the Covid-19 era, Thailand was the least prone market. Indonesia and Malaysia the most prone market in both periods.

3.2 The Dynamic Total Spillovers Index

Many changes took place with their background of financial market evolution and turbulence within 10-years. In the Covid-19 period, the evidence showed the government bond market conditions influenced by monetary policies[29], government policy responses[30], investors' behavior[24], and the role of fundamental growth[1].

The spillover index within 10-years (Figure 3) fluctuated considerably over time. During the Covid-19 was the highest point within 10-years. Several studies used the dynamic modeling of conditional correlations to understand the time-varying movements. The research covered 1997-2005 showed the estimation DCC's was indeed time varying, but the mean-spillover was limited in terms of size and impact[7]. Another study covered from 2001 to 2012, in most Asian countries, the DCCs did not exhibit any clear upward trend and still limited volatility effects over the sample period[13]. We summarized that the spillover effect in the Asian bond was no longer limited and increased to its highest point in the Covid-19 period.

Figure 4 showed the spillover index reached around March 2020. After that, it fluctuated considerably over time. These findings were like the study on total connectedness across various assets during Covid-19. The study revealed that pronounced connectedness is evident around mid-March. It coincided with the onset of the new infectious disease all over and sparking fears of the possible second wave of infections[22]

Figure 3. The Dynamic Total Spillover Index- plot (The whole period)

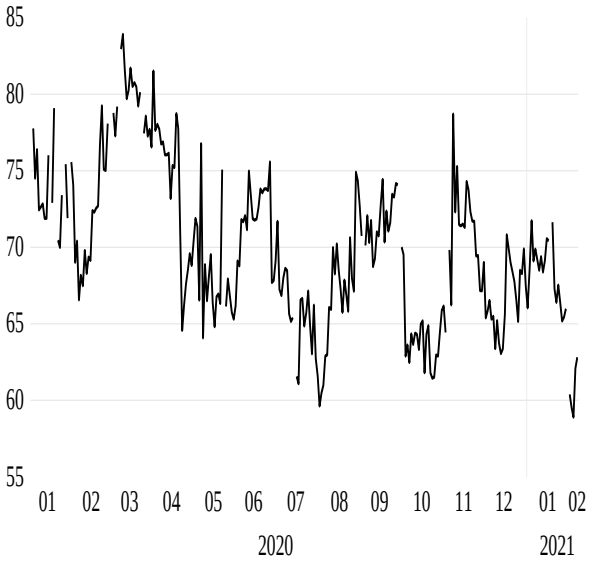

Figure 4. The Dynamic Total Spillover Index- plot (The whole period)

Table 3 The Static Total Spillovers Index – The whole sample period

	From										
To others	**China**	**Hong Kong**	**Japan**	**South Korea**	**Indonesia**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**	**Vietnam**	***From Others***
China	92.9	1.2	1.2	1.4	0	0.2	0.1	0.8	2	0.1	7.1
Hong Kong	0.2	57.9	7.5	11.5	0.3	2.4	0.5	11.8	8	0	42.1
Japan	0.3	9.7	70.9	9.6	0	0.8	0.3	5.2	3.1	0.1	29.1
South Korea	0.1	13.1	9.6	62	0	2	0.6	7	5.4	0	38
Indonesia	0.1	2.7	0.2	1.1	87.7	4.1	0.1	2	1.8	0.2	12.3
Malaysia	0.1	5.9	1.3	3.4	3.5	75.2	0.5	4.8	4.7	0.6	24.8
Philippines	0.1	1.1	0.6	1	0.2	0.2	95.5	0.6	0.6	0.1	4.5
Singapore	0.3	13.6	5.1	7.5	0.7	3.3	0.1	62.4	6.9	0.1	37.6
Thailand	0.9	8.5	2.3	4.8	1.1	3.4	0.1	7.2	71.7	0	28.3
Vietnam	0.1	0.3	0.1	0.2	0.2	0.9	0.1	0.4	0.1	97.6	2.4
Contribution to others	2.2	56	27.9	40.6	6.2	17.3	2.4	39.8	32.7	1.3	226.3
Contribution including own	95.1	113.9	98.7	102.6	93.8	92.5	97.9	102.1	104.4	98.9	22.60%
Net Spillover	-4.9	13.9	-1.2	2.6	-6.1	-7.5	-2.1	2.2	4.4	-1.1	TSI

Table 4 The Static Total Spillovers Index – The Covid-19 sample period

	From										
To	**China**	**Hong Kong**	**Japan**	**South Korea**	**Indonesia**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**	**Vietnam**	***From Others***
China	72	4.9	4.2	0.6	1.7	3	2.2	3.7	5.9	1.7	28
Hong Kong	1.9	50.1	8.3	5.9	0.3	1.4	2.9	15.4	13.3	0.5	49.9
Japan	3.1	11.9	47.5	6.9	0.4	2.3	0.5	14.2	12	1.2	52.5
South Korea	0.4	7.4	11.1	54.2	0.2	1.2	2.3	12	10.9	0.3	45.8
Indonesia	1.3	4.7	2.9	3.9	65.4	7	0.2	3.9	10.4	0.3	34.6
Malaysia	0.4	8.5	8.1	2.6	6.2	53	1	7.1	9.4	3.7	47
Philippines	3.8	2.7	6	3.1	0.7	0.6	63.3	3.9	8.3	7.5	36.7
Singapore	3.4	17.9	13.3	5.7	0.5	2.1	1.3	38.2	17.1	0.6	61.8
Thailand	3.4	13.4	7	4	1.5	2.1	1.1	17.2	49.5	0.9	50.5
Vietnam	1.2	1	0.2	2.3	0.2	2	3.6	2.6	2.7	84.2	15.8
Contribution to others	18.8	72.4	61	35.1	11.6	21.7	15	80.1	90.1	16.6	422.5
Contribution including own	90.9	122.5	108.5	89.3	77	74.7	78.3	118.4	139.7	100.8	42.20%
Net Spillover	-9.2	22.5	8.5	-10.7	-23	-25.3	-21.7	18.3	39.6	0.8	TSI

3.3 The Net Spillover Plots

Figure 9 showed Hong Kong and Singapore have strong financial stability. Hong Kong and Singapore acted as net transmitters in most periods. The role of Thailand has increased substantially since 2016. China, Indonesia, Malaysia, the Philippines, and Vietnam are net receivers from others, which indicated their financial vulnerability. In contrast, China has net spillovers in the 1997 and 2008 financial crises[31].

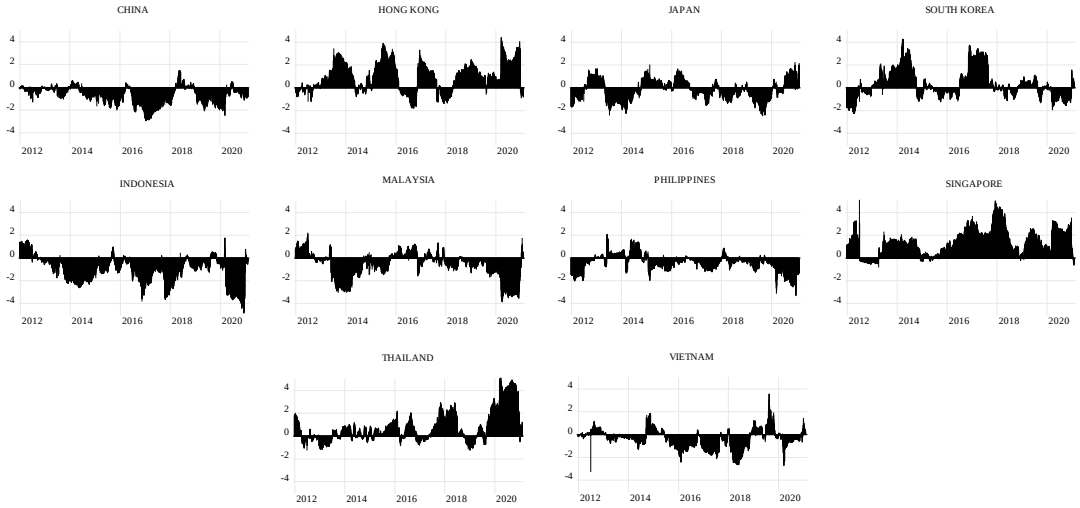

Figure 9 The Net Spillovers' (The whole sample)

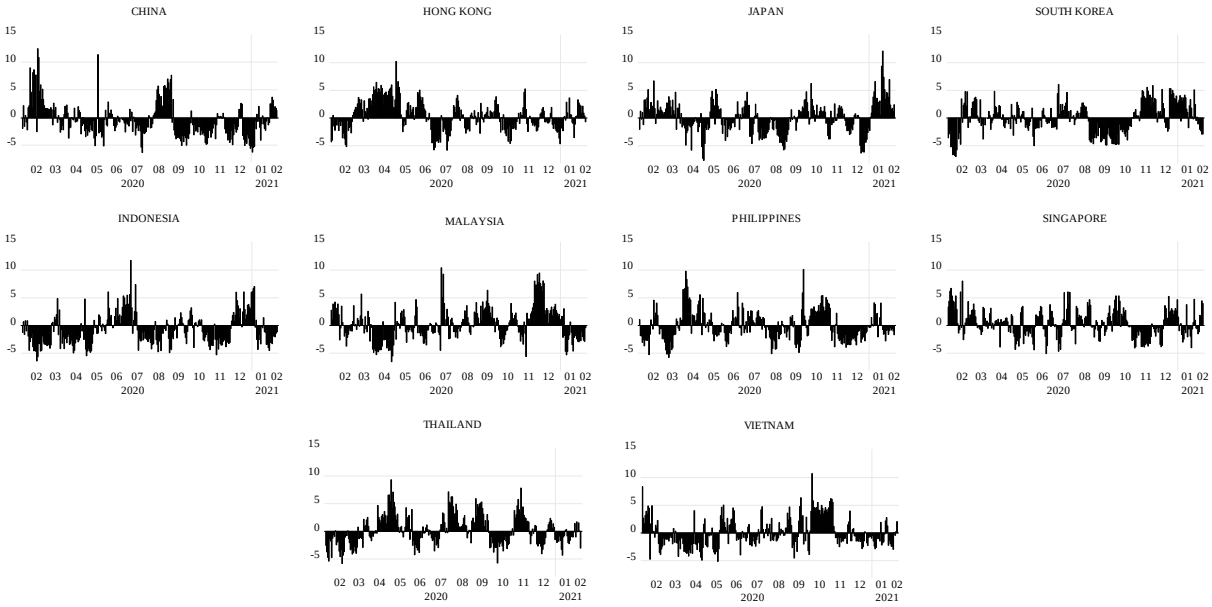

Figure 10 The Net Spillovers' (The Covid-19 sample)

A previous study showed China's financial market acted physically and financially as an epicenter of contagion during the Covid-19 period [21]. Similarly, Figure 10 showed China was the primary transmitter of spillover in the first quarter of 2020. The net spillover during the Covid-19 period fluctuated considerably over time. The previous showed that sovereign bonds are directly affected by government policies [26].

3.4 Discussion

We discussed some striking features of our empirical result in this section. First, spillover intensities increased during the covid-19 period. An increased intensity could present market reaction speed to government policies was increased. Second, the role of other countries or regional factors was the primary influence during the Covid-19 period. These findings showed that individual government policies were not enough to mitigate the impact of Covid-19. Our result suggests that regional policies were needed to limit the spillover effect during the pandemic era. Third, the net spillover could present whether the country can resist shocks and hold on to financial market stability. After the 1997 Asian Financial Crisis, Hong Kong has focused on bond market development and showed its role in Asia bond market establishment. A higher bond market development could bring higher financial stability. Several governments have utilized fiscal stimulus and monetary measures to stabilize the financial market. Last, the total dynamic spillover can help policymakers to evaluate government policies over time. It denoted market responses to government policies which time dependent.

4. CONCLUSION

This study explored the effect of the Covid-19 pandemic on cross-country bond yield transmission through the government bond market in emerging East Asia. Our findings showed The Total spillovers index increased in the Covid-19 period. Interestingly, the tensions from other countries increased in the time of Covid. It indicated that regional factors have a significant role in bond yield spillover across-country. In the Covid-19 Era, the source of spillover was different from the previous crisis period.

Over 10-years, the dynamic spillover index reached the highest point in the Covid-19 period, especially in the first quarter of 2020. Our result showed that within 10-years, Hong Kong was a driver in the region and seemed to be the least vulnerable, while Thailand in the Covid-19 period. Indonesia and Malaysia were most prone within ten years and in the time of Covid-19.

We provided another empirical evidence for theoretical development in cross-country linkages. Our evidence confirmed that the source of spillovers could be different for each crisis or unprecedented period. Furthermore, we showed cross-country spillovers both direction and intensities in the region. The information about directions, intensities, and sources of spillover can helps investors to manage the country's risk. Regional factors were a primary source of bond yield spillover in the Covid-19 era, hence regional policies needed to achieve financial stability. Since the Covid-19 era, the policy coordination has not yet in regional. We recommend that Asian policymakers strengthen greater regional policy coordination to limit spillovers such as policy coordination in monetary factors.

Further research about the behavior of the government bond markets could be conducted by including other factors such as monetary policies in the region.

AUTHORS' CONTRIBUTIONS:

Ardiani Rachmasyaputri: conceptualization, writing-original draft, data curation, software.

Viverita: conceptualization, writing, analysis, editing, supervision.

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