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Dynamic Correlations and Spillovers among the East Asian Currencies

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Abstract

This paper uses the Diebold and Yilmaz (2012) spillover indices to examine the exchange rate volatility. Weekly return data from January 2002 to April 2022 from nine East Asian currencies and four major currencies are investigated to determine how the currencies are linked. The results show that the Singaporean dollar has the highest volatility spillover to (and from) other currencies. During the full sample periods, the currency spillover is coming from its own shock. The East Asian currencies were the net volatility recipients except for the Singaporean dollar and Taiwanese dollar. Moreover, during the COVID-19 pandemic period, the volatility spillover increased, which highlighted the need for policymakers to intervene to maintain currency stability. This research also includes COVID-19 factors such as the confirmed cases, deaths, vaccinations, and the government response policy to see how COVID-19 affects the exchange rate volatility. The results from the panel regression with fixed effect show that the strength of the government's response policy and widespread vaccination rate decrease the degree of spillover in the Asian foreign exchange markets.

Keywords: Currency Volatility, Financial Contagion, Spillover Index, COVID-19

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Background and Significance of the Research Problem

Decades ago, currency crises leading to recessions spread to neighboring nations, such as the 1994 Mexico peso crisis, the 1997 financial crisis in the Asian region, the 1998 financial crisis in Russia, and the 2002 economic crisis in Argentina, resulting in the abandonment of the fixed exchange rate system. The term "financial contagion" became familiar to the public, referring to the direct or indirect transmission of financial market turmoil across countries, especially within the same region (Claessens & Forbes, 2001).

Forbes and Rigobon (2001) introduced two sets of theories explaining how shocks spread. The first theory, called crisis-contingent, suggests that shocks are internationally transmitted through three channels. The first channel is grounded in the psychology of investors or multiple equilibria. The second channel is based on shocks that trigger investors to recompose their portfolios or endogenous liquidity. The third channel is based on policymakers who influence foreign exchange regimes or the political economy. The second theory, called non-crisis contingent, proposes insignificant changes when shocks are spread before or after a crisis. There is a strong correlation across markets after shocks due to the continuation of "real linkages" through economic fundamentals such as trade, coordinated policy, country reassessment, and random macroeconomic shocks. Abdoh, Yusuf, Zulkifli, Bulot, and Ibrahim (2016) investigated factors like exports, interest rates, and inflation rates that may influence the fluctuation of selected ASEAN currencies, concluding that only the export factor is significant.

Currency-crisis-related theories include the first-generation model, second-generation model, and third-generation model. First-generation models suggest that an unsustainable fiscal policy causes the collapse of the fixed exchange rate regime. Second-generation models, initiated by Obstfeld (1984) paper, state that self-fulfilling prophecies can be the source of currency crises through speculative attacks. Lastly, the third-generation model developed after the 1997 currency crisis in Asia, as none of the prior models could explain the situation. Moral hazard was proposed as a major problem (Krugman, 1999) when there were enormous foreign investment fund flows protected from default risks by governments, leading to the rapid spread of the crisis across the region.

Due to the risk of currency crises and contagion, exchange rate volatility can impact financial assets such as stocks and bonds, as well as fund flows from international markets. A currency's dynamic relationship in foreign exchange markets can influence households, private investors, and corporate and government decisions, leading to a complex global connection. A variation in currency value will be adjusted to another currency's relative price, as stated in the law of one price and purchasing power parity (PPP) theories. However, real exchange rate adjustment to the PPP theory is likely to happen in the very long run (Rogoff, 1996). Short-run deviations from PPP are significant and unpredictable. While most exchange rate regime theories assume rational behavior and attribute exchange rate volatility to fundamental shocks, some policymakers believe that exchange rate volatility also comes from non-fundamental factors (Jeanne & Rose, 2002), especially under the floating exchange regime, such as noise traders and speculators who create forex spillovers describing currency volatility's transmission to another currency volatility. Barroso and Santa-Clara (2015) stated that carry trade gives good returns without any fundamental economic explanation.

Volatility spillovers and “crash risk” can reflect the systemic risk (Greenwood-Nimmo, Nguyen, & Rafferty, 2016). The two main components are a starting random shock and the contagion mechanism that spreads negative effects to one or more institutions in the system (Martínez-Jaramillo, Pérez, Embriz, & Dey, 2010). Empirical research, including exchange rate interdependencies and exchange rate correlations, that measures currency volatility and spillover from one currency to another includes Engle III, Ito, and Lin (1988); Baillie and Bollerslev (1991); Melvin and Melvin (2003); Cai, Howorka, and Wongswan (2008); Lahaye and Neely (2020) and Huynh, Nasir, and Nguyen (2023).

When the World Health Organization announced COVID-19 as a pandemic in March 2020, the world economy faced instabilities and unforeseeable losses. These affected various societal sectors, including production, travel limitations, lockdowns, etc. (Feng, Yang, Gong, & Chang, 2021) eventually leading to a crisis that spread to various financial sectors, such as stock returns volatility (Kusumahadi & Permana, 2021) and exchange rate devaluations (Hoshikawa & Yoshimi, 2021).

This research is inspired by Yilmaz (2010), who employed variance decomposition vector autoregression and discovered that East Asian equity markets exhibit different patterns in returns and volatility over time, responding significantly during major crises. Additionally, using this methodology, Prukumpai, Dacuycuy, and Sethapramote (2023) examined the connectedness between major world stock markets and ASEAN stock markets, finding that during the COVID-19 pandemic, ASEAN markets had larger spillovers from global equity markets than during normal times.

This research provides valuable insights to regulators and policymakers on how to utilize policy instruments and surveillance procedures to mitigate negative consequences resulting from severe return spillovers in exchange rates. Investors and traders, particularly those in East

Asian exchange rate markets, can use these findings to improve their trading decisions and risk management strategies during periods of extremely favorable and extremely negative market conditions, such as the current COVID-19 crisis.

The main objective of this paper is to examine the spillover and dynamic connectedness of currencies in East Asian countries. The research explicitly aims to investigate if the increase in COVID-19 cases, deaths, and government reaction policies have an impact on exchange rate volatility. To achieve that aim, the degree to which a currency is interlinked with other regional currencies is investigated and the regional and global interdependence of forex is quantified.

Research Objectives

This research aims to answer the following questions:

1. How interconnected are currencies, and in what manner does this connectivity change during disease outbreaks?
2. How do COVID-19 disease outbreaks and government response policies affect spillover patterns in the foreign exchange rate market?

Data and Methodology

Data

This paper utilizes weekly return data from January 2002 to April 2022 obtained from Pacific Exchange Rate Services by the University of British Columbia. The analysis focuses on nine East Asian currencies: Indonesian rupiah (IDR), Philippine peso (PHP), Malaysian ringgit (MYR), Singapore dollar (SGD), Japanese yen (JPY), Korean won (KRW), Hong Kong dollar (HKD), Taiwan dollar (TWD), and Thai baht (THB), all quoted against the US dollar. These East Asian markets, being small open economies, heavily rely on exports of goods, tourism revenue, and foreign investment as crucial sources of economic growth. Furthermore, the "surge" in net capital flows to Asia and the rapidly rising growth rate in these markets significantly influence the world's markets All of the currencies are quoted against the US dollar (Yilmaz, 2010). The selection of these nine currencies is based on their importance in international trade and capital flow.

The data are divided into two periods: pre-COVID-19 (March 2017 to March 2020) and post-COVID-19 (March 2020 to April 2022), marking the beginning of the latter when the World Health Organization declared COVID-19 a pandemic in March 2020. This division allows the examination of the pandemic's impact on correlation and spillover among East Asian currencies.

Additionally, major currencies such as the Euro (EUR), Australian dollar (AUD), New Zealand dollar (NZD), and the dollar index serve as the proxy for the U.S. exchange rate (Bouri, Cepni, Gabauer, & Gupta, 2021; Q. Feng, Sun, Liu, & Li, 2021; Wei & Han, 2021) are included to explore correlations and spillover between regions.

COVID-19 indicators, namely confirmed cases, deaths, vaccination rates, and the stringency index, are employed to assess the impact of the pandemic and government intervention on exchange rate volatility. Recent empirical studies, like Benzid and Chebbi (2020) and Bouhali, Dahbani, and Dinar (2021), have demonstrated the influence of COVID-19 cases, deaths, and vaccinations on exchange rate volatility. The stringency index, calculated by The Oxford Coronavirus Government Response Tracker (OxCGRT), incorporates nine metrics, including school and workplace closures, public transportation suspensions, cancellation of public events, restrictions on public gathering and internal movement, stay-at-home requirements, controls on international travel, and public information campaigns. A higher index value indicates a stricter response. Beckmann and Czudaj (2022) utilized the stringency index as a measure of COVID-19 policy responses, demonstrating strong effects on exchange rate returns.

Methodology

1. Volatility Spillovers and Directional Spillovers Index in Foreign Exchange Rate Markets: Dynamic Connectedness Index (Diebold-Yilmaz)

The measurement of directional spillovers was introduced by Diebold and Yilmaz (2009) to explain the timing and magnitude of financial contagion in international financial markets. The spillover index is a tool applied to elucidate the patterns of spillover between markets, providing insights into the interconnections among distinct variables. Moreover, the directional spillover, net spillover, and pairwise spillover index offers more details on the patterns of spillover between markets. While studies on currency linkages during the pandemic have used various methodologies such as vector error correction models and wavelet analysis (Shahrier, 2022), the volatility spillovers and directional spillovers models are deemed more appropriate for the objectives of this research.

The Diebold and Yilmaz (2012) model operates under the Vector Autoregressive (VAR) framework, utilizing the prediction of error variance decomposition. Let currency volatility be the sample series of a Var(p) model with N variables, expressed as:

$$x_t = \sum_{t=1}^{n} \psi_i x_{t-i} + \varepsilon_t \quad (1)$$

Here, Σ is a variance-covariance matrix. And ε represents independent and identically distributed (i.i.d.) errors. The Var(p) is the presented model of average movement expressed as $x_t = \sum_{t=1}^{\infty} A_i \varepsilon_{t-i}$, denoted that A_i is the N×N matrix coefficient and is written as $A_i = \psi_1 A_{i-1} + \psi_2 A_{i-2} + \ldots + \psi_p A_{i-p}$; note that, A_0 is a N×N matrix and $A_i=0$ for $i<0$. The residual variance fraction for the H-step-ahead for predicting y_i to shocks to x_j for all $i \neq j$ for each measurement of i can be examined under the variance decomposition. The calculation of H-step-ahead error decomposition prediction under Koop, Pesaran, and Potter (1996) and Pesaran and Shin (1998) framework can be written as:

$$\theta_{ij}(H) = \frac{\sigma_{ii}^{-1} \sum_{h=0}^{H-1} (e_i' h_h e_j)^2}{\sum_{h=0}^{H-1} (e_i' h_h e_j)} \tag{2}$$

Note that σ_{ii} is element i on the diagonal Σ principle. Because summing each $\theta_{ij}(H)$ row is not equal to one, each matrix element is normalized by adding up $\tilde{\theta}_{ij}(H) = \frac{\theta_{ij}(H)}{\sum_{j=1}^{N}(\theta_{ij}(H))}$ row and, hence, $\sum_{j=1}^{N}\left(\theta_{ij}(H)\right) = 1$ also the overall market net decomposition is summing up to N. Therefore, Diebold and Yilmaz (2012) total spillover index is specified as:

$$S(H) = \frac{\sum_{j=1, i \neq j}^{N} \tilde{\theta}_{ij}(H)}{N} \times 100 \tag{3}$$

The directional measurement introduced by Diebold and Yilmaz (2012) is expressed through equation (4) and (5), interpreting spillovers that asset i receives from all other asset j (equation 4) and spillovers that asset i gives to all other asset j (equation 5):

$$S_{N,i\leftarrow\bullet}^{H} = \frac{\sum_{j=1, i \neq j}^{N} \tilde{\theta}_{ij}(H)}{\sum_{j=1}^{N} \tilde{\theta}_{ij}(H)} \times 100 \tag{4}$$

$$S_{N,i\rightarrow\bullet}^{H} = \frac{\sum_{j=1, i \neq j}^{N} \tilde{\theta}_{ij}(H)}{\sum_{j=1}^{N} \tilde{\theta}_{ij}(H)} \times 100 \tag{5}$$

The net asset volatility that each asset transmits to the others is calculated as:

$$S_i(H) = S_{N,i\rightarrow\bullet}^{H} - S_{N,i\leftarrow\bullet}^{H} \tag{6}$$

2. Determinants of Spillover in Foreign Exchange Rate Markets During covid-19 Pandemic: Panel Data Regressions

A pooled regression model, characterized by constant coefficients for intercepts and slopes, is employed in this study and is expressed as:

$$FR_{it} = \beta_{0,i} + \beta_1 case_{it} + \beta_2 death_{it} + \beta_3 vac_{it} + \beta_4 stringency_{it} + \mu_{it} \quad (7)$$

Here, FR_{it} represents the risk of spillovers received from other countries, obtained from equation (4) where the forecast error variance of country i receiving shocks from country j. The variables $case_{it}$, $death_{it}$, vac_{it}, and $stringency_{it}$ correspond to correspond to the confirmed COVID-19 cases, the number of death cases from COVID-19, COVID vaccination doses, and the stringency index representing government response policy during the pandemic, respectively. Including country-specific effects ($\beta_{0,i}$) aims to capture the impact of domestic factors during the crisis.

Results

Table 1 illustrates that 61.1% of exchange rate shocks result from the spillover of shocks from other currencies. Over the period from January 2002 to April 2022, Singapore, a key port and financial center, exhibited the highest degree of spillover to other markets (126.4%) and received spillover from other markets (75.8%). The Korean won transmitted 85.3% of risks to other currencies and received the shocks from others at a rate of 71.5%. The Euro received risks from other currencies (70.2%) more than it contributed volatility to other currencies (66.5%). Examining each currency in the columns reveals how each currency transfers risks to others. For instance, the Singaporean dollar transmitted 10.9% of the Euro's volatility and 13.1% of the Korean won's volatility. Each row can be interpreted as the Singaporean dollar receiving 11.9% of risks from the Australian dollar and 10.4% from the Korean won. The currencies that received the most shocks from others were the Singaporean dollar (75.8%), Australian dollar (74.7%), and New Zealand dollar (73.3%).

Table 1 Spillover from January 2002 -April 2022

Spillover (Connectedness)	R_ IDR	R_ PHP	R_ MYR	R_ SGD	R_ JYP	R_ KRW	R_ HKD	R_ TWD	R_ THB	R_ AUD	R_ NZD	R_ EUR	R_USD_ INDEX	From Others
R_IDR	41.3	6.6	1.4	9.9	0.2	8.1	0.5	5.2	4.7	10.4	8.3	1.9	1.5	58.7
R_PHP	5.7	41.8	3.3	8.7	0.1	8.8	0.8	5.9	5.1	7.6	6.8	2.9	2.7	58.2
R_MYR	3.4	5.1	48.1	9.9	1.2	5.7	0.7	4.3	3.8	6.1	5	3.6	3.1	51.9
R_SGD	5.1	4.7	1.9	24.2	3	10.4	1.6	10.3	5.6	11.9	9.7	5.9	5.8	75.8
R_JPY	1.2	0.3	0.2	8.7	71.3	0.7	0.3	4.5	2.8	0.5	0.7	3.1	5.8	28.7
R_KRW	4.3	5.9	1.7	13.1	0.4	28.5	1.5	12.3	3.8	11.1	9.3	4	4	71.5
R_HKD	0.5	1.5	0.4	4.4	0.8	2.9	70	4.2	1.9	4.3	3.8	2.7	2.5	30
R_TWD	3.4	4	1.3	14.2	2.2	12.9	2.3	30.9	4.8	8.6	7	4.2	4.2	69.1
R_THB	5.2	5.8	1.7	11	1.8	6.1	1	7.1	39	7.5	7.7	3.2	3	61
R_AUD	5.1	4.5	1.6	13	0.1	10.3	1.7	6.6	4	25.3	17.8	5.4	4.4	74.7
R_NZD	4.4	4.3	1.5	11.6	0.2	9.3	1.6	6	4.6	19.2	26.7	5.6	5	73.3
R_EUR	1.6	1.9	1.5	10.9	2.8	5.1	1.2	4.7	2.8	7.4	6.8	29.8	23.5	70.2
R_USD_INDEX	1.9	1.9	1.3	10.9	4.4	4.9	1.2	4.9	2.7	6.9	6.5	24	28.6	71.4
Contribution to others	41.7	46.6	17.7	126.4	17.1	85.3	14.4	76.2	46.5	101.6	89.3	66.5	65.4	794.6
Contribution including own	83	88.4	65.8	150.5	88.4	113.8	84.3	107.1	85.5	126.8	116	96.2	94.1	61.10%

Source: Authors' Study

Table 2 Spillover Pre- Covid March 2017 to March 2020

Spillover (Connectedness)	R_ IDR	R_ PHP	R_ MYR	R_ SGD	R_ JYP	R_ KRW	R_ HKD	R_ TWD	R_ THB	R_ AUD	R_ NZD	R_ EUR	R_USD_ INDEX	From Others
R_IDR	31.9	5.8	0.8	10.3	0.6	8.1	1.1	4.2	6.1	14.1	8.2	4.6	4.1	68.1
R_PHP	9.5	52.7	0.6	6	0.8	10	1.7	3.9	1.7	5.5	5.3	1.4	0.9	47.3
R_MYR	9.6	2.3	20.2	15.8	1.5	11.7	3.9	11	7.5	8.1	5.2	0.8	2.5	79.8
R_SGD	7.6	2.4	0.8	21.2	3.1	12.2	2.7	12	11.1	13.5	9.8	1.5	2.2	78.8
R_JPY	1.1	1.4	0.5	8.2	55.6	1.6	5.4	3.3	10.3	5.2	5.8	0.6	0.9	44.4
R_KRW	5.5	4.2	0.6	14	1.3	27.5	4.5	17.5	8.4	9.2	6	0.6	0.7	72.5
R_HKD	1.6	1.8	4.9	3.4	1.7	6.2	67.4	6	1	2.2	2.4	0.4	1.2	32.6
R_TWD	4.1	2.3	0.6	14.8	1.4	17.4	3.9	31.7	9.1	7.5	5.3	1.2	0.9	68.3
R_THB	5.3	1.1	0.5	14.4	4.4	10.4	5	10.9	27.5	10.2	8.2	0.7	1.4	72.5
R_AUD	11.9	2.5	0.4	14.2	2.4	9	1.7	7.8	8.6	22.2	14.2	2.4	2.7	77.8
R_NZD	10	2.7	0.4	13.6	2.7	7.4	1.7	6.4	9.4	17.4	23.7	2.1	2.6	76.3
R_EUR	2.3	0.7	1.1	18.2	4.2	8.7	3.1	12.1	9.2	10.2	7.9	13.8	8.6	86.2
R_USD_INDEX	3.4	0.6	0.9	17.8	5.7	7.7	2.4	10	11.2	12.9	9.7	5.8	11.9	88.1
Contribution to others	71.8	27.8	12.1	150.6	29.6	110.3	37.1	105	93.5	115.9	88	22.2	28.7	892.8
Contribution including own	103.8	80.5	32.2	171.9	85.2	137.8	104.5	136.7	120.9	138.2	111.7	36	40.6	68.70%

Source: Authors' Study

Table 3 Spillover Covid March 2020 to April 2022

Spillover (Connectedness)	R_IDR	R_PHP	R_MYR	R_SGD	R_JYP	R_KRW	R_HKD	R_TWD	R_THB	R_AUD	R_NZD	R_EUR	R_USD_INDEX	From Others
R_IDR	43.2	7.2	1.7	8.8	1.8	5.3	1.9	2.2	9.2	11.5	6.1	0.4	0.6	56.8
R_PHP	1.5	45.9	1.9	5.9	1.3	6.9	2.6	5.5	7.5	5.3	4.2	5.9	5.5	54.1
R_MYR	2.8	5.6	17.7	16.9	3	8.4	4.3	6.1	5.6	11.8	11.5	3.6	2.6	82.3
R_SGD	4.7	4.9	0.2	23.8	2.9	11.9	6.4	7.6	7.1	13.3	13.1	2.8	1.2	76.2
R_JPY	1.2	1.8	0.7	8.1	49	8.8	6.1	11.2	1.7	2	3.3	3.8	2.2	51
R_KRW	4	4.5	0.4	15.1	1.5	29.7	6.4	11.1	6.5	8.1	9	2.4	1.1	70.3
R_HKD	2.2	1.7	0.9	14	3.8	9.8	40.7	8.4	3.5	6.3	6.4	1	1.3	59.3
R_TWD	2.5	3.7	0.5	13.7	7.2	12.8	9.4	28.5	3.6	5.3	8.8	2.8	1.1	71.5
R_THB	6.2	8.7	0.3	12.7	2.3	8	2.8	4.2	32.3	9.2	7.2	3.4	2.6	67.7
R_AUD	5.2	5.3	0.5	14.1	0.5	7.8	2.4	3.9	6.9	29.1	20.5	2.6	1.2	70.9
R_NZD	3.3	3.9	0.2	14.8	1.4	8.3	2.5	5.7	6.5	22.1	27.9	2.6	0.8	72.1
R_EUR	2.4	4	0.2	17.7	4.2	10.5	5	7.1	4.5	11.6	11.8	13.9	7	86.1
R_USD_INDEX	2.9	3.5	0.2	17.9	5.2	11	6	6.4	3.7	11.9	12.8	9.1	9.5	90.5
Contribution to others	38.9	54.9	7.8	159.9	35.2	109.3	56	79.6	66.2	118.5	114.7	40.3	27.3	908.6
Contribution including own	82.2	100.8	25.5	183.7	84.2	139	96.7	108.1	98.6	147.6	142.6	54.2	36.8	69.90%

Source: Authors' Study

Table 2 presents data from the pre-COVID period, from March 2017 to March 2020. The degrees of spillover are higher than those of the full sample (68.7%). Three years before the World Health Organization officially announced the COVID-19 pandemic, the currencies that contributed the most volatility to others were SGD (150.6%), AUD (115.9%), and TWD (105%). In contrast, the currencies that absorbed volatility from others were the dollar index, Euro, and Malaysian ringgit, respectively.

Next, we examine the results during the pandemic, The exchange rate volatility transmission is slightly higher during the pandemic at 69.9%, as shown in table 3. It is observed that the volatility spillover from all the periods studied originates from its own shock. During COVID-19, the volatilities of all the currencies explained by their own shocks ranged between 9.5% (dollar index) to 49% (JPY). Additionally, the currencies most vulnerable to shocks from other currencies are the dollar index, Euro, and Malaysian ringgit. Furthermore, the currencies that contribute the most to volatility in other currencies are SGD (159.9%), AUD (118.5%) and NZD (114.7%).

The spillover index of 69.90% indicates that shocks across currency pairs explain more than half of the total variance of forecast errors during COVID-19, while the currency's own shocks explain the remaining 30.1%. Both total and directional spillover indices are notably high, suggesting the presence of return spillovers between major currency pairs.

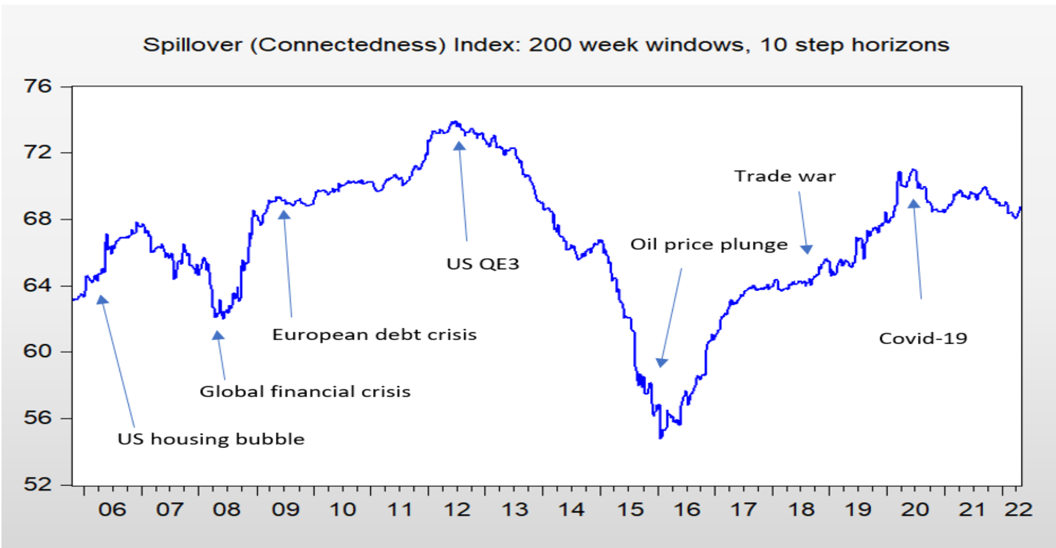
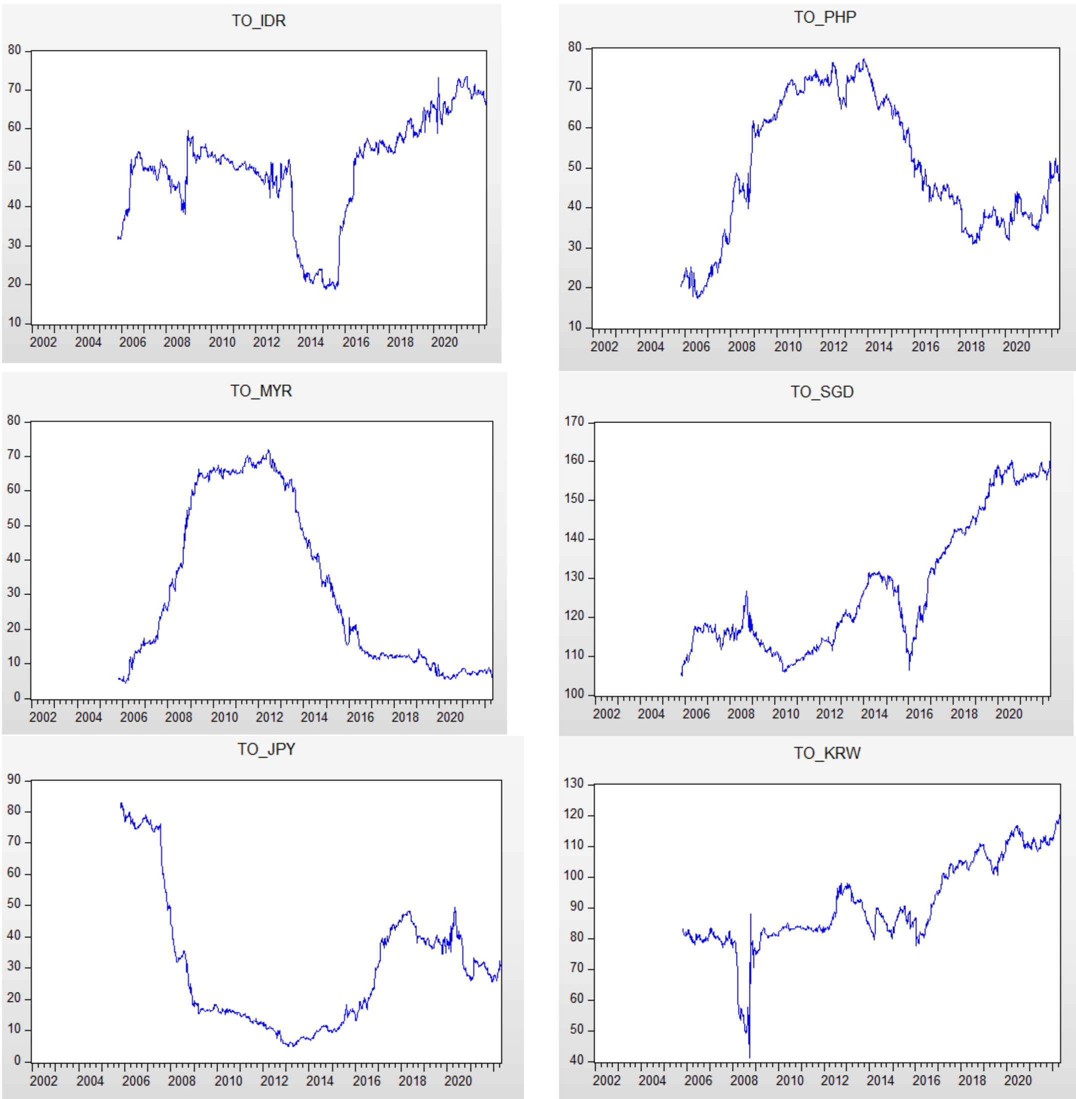


Figure 1 Total Spillover

Source: Authors' Study

Figure 1 illustrates the total spillover plot, providing a visual representation of the dynamics of spillover. The spillovers initiated with a value of approximately 63% in 2005. Over time, the total spillover fluctuates between 54% and 74%, exhibiting occasional dips and surges. The pronounced rises and falls in the graph align with economic incidents, reflecting the decentralized nature of the foreign exchange market, globalization trends, and capital mobility.

The graph reached its peak around the time of the U.S. third round of quantitative easing in 2012, and a gradual decline followed during the oil price plunge from 2014 to 2016. Notably, with the onset of the COVID-19 pandemic in 2020, there was a slight increase in spillover. These patterns underscore the interconnected and responsive nature of the foreign exchange market to major economic events and global shifts.



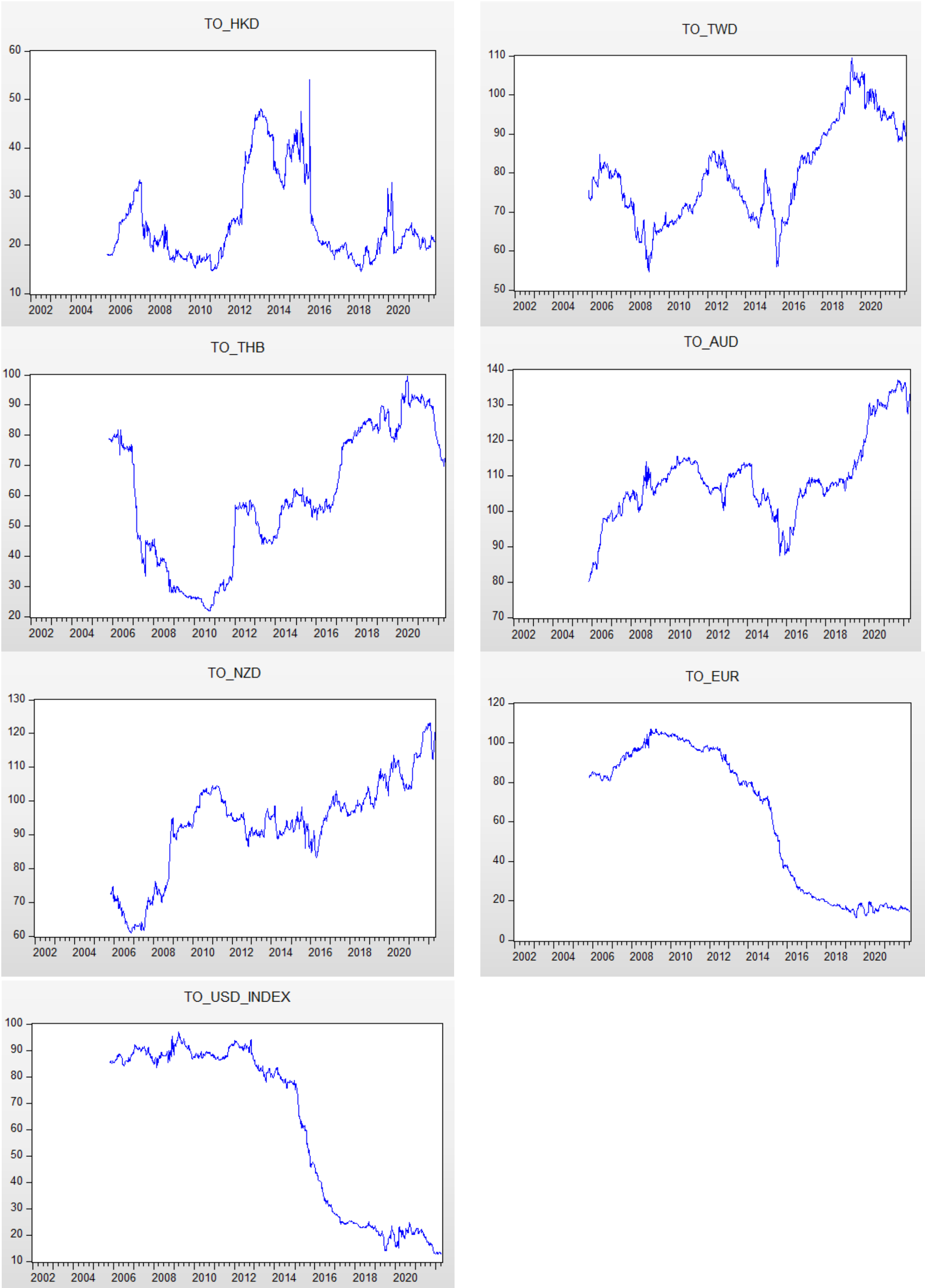
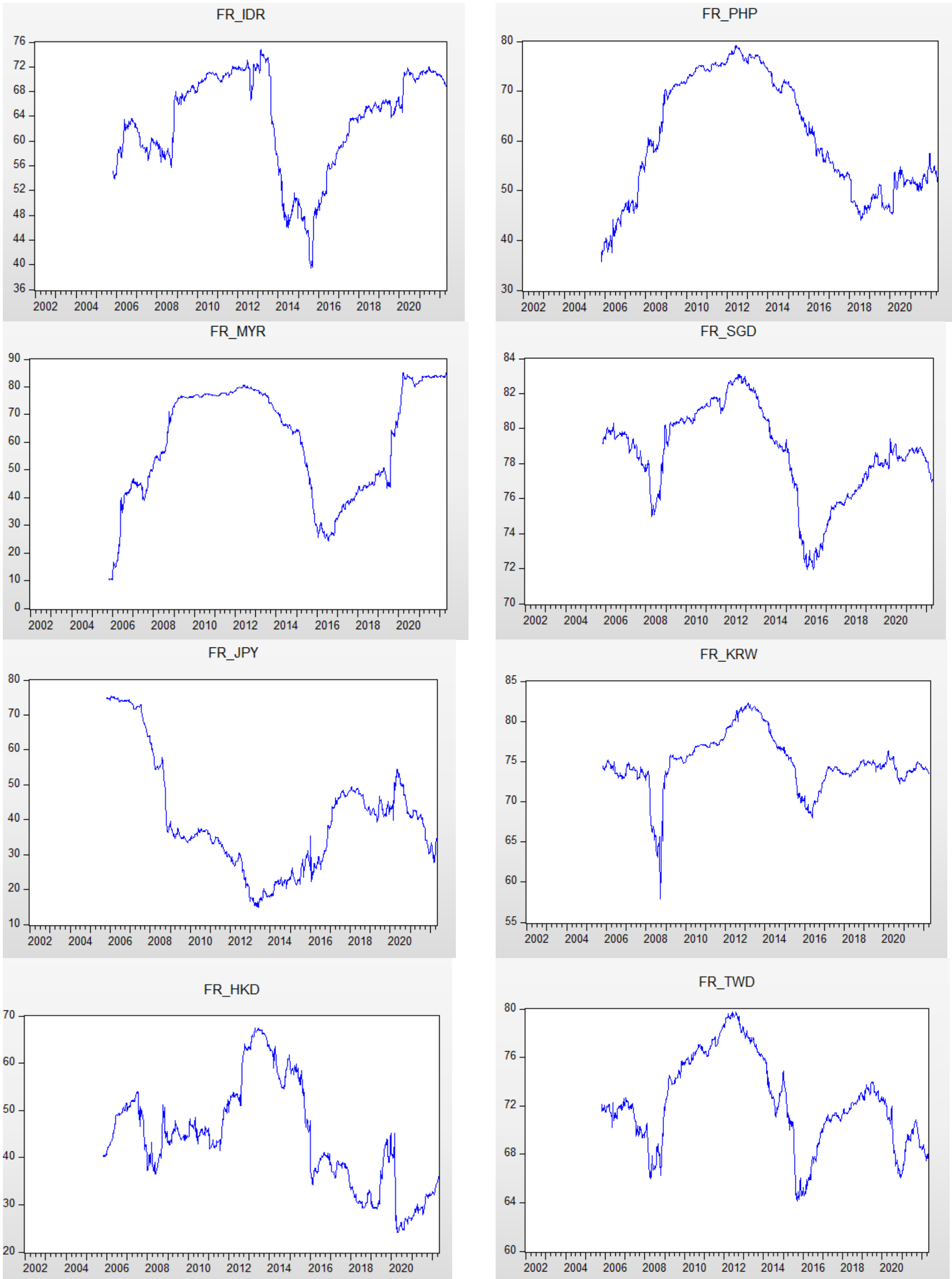


Figure 2 Directional Spillovers to Other Currencies

Source: Authors' Study

Figure 2 presents directional spillovers to other currencies, demonstrating that these spillovers increase by approximately 150% during periods of high volatility, while remaining below 5% during times of low volatility. This observation highlights the sensitivity of directional spillovers to the level of market volatility.



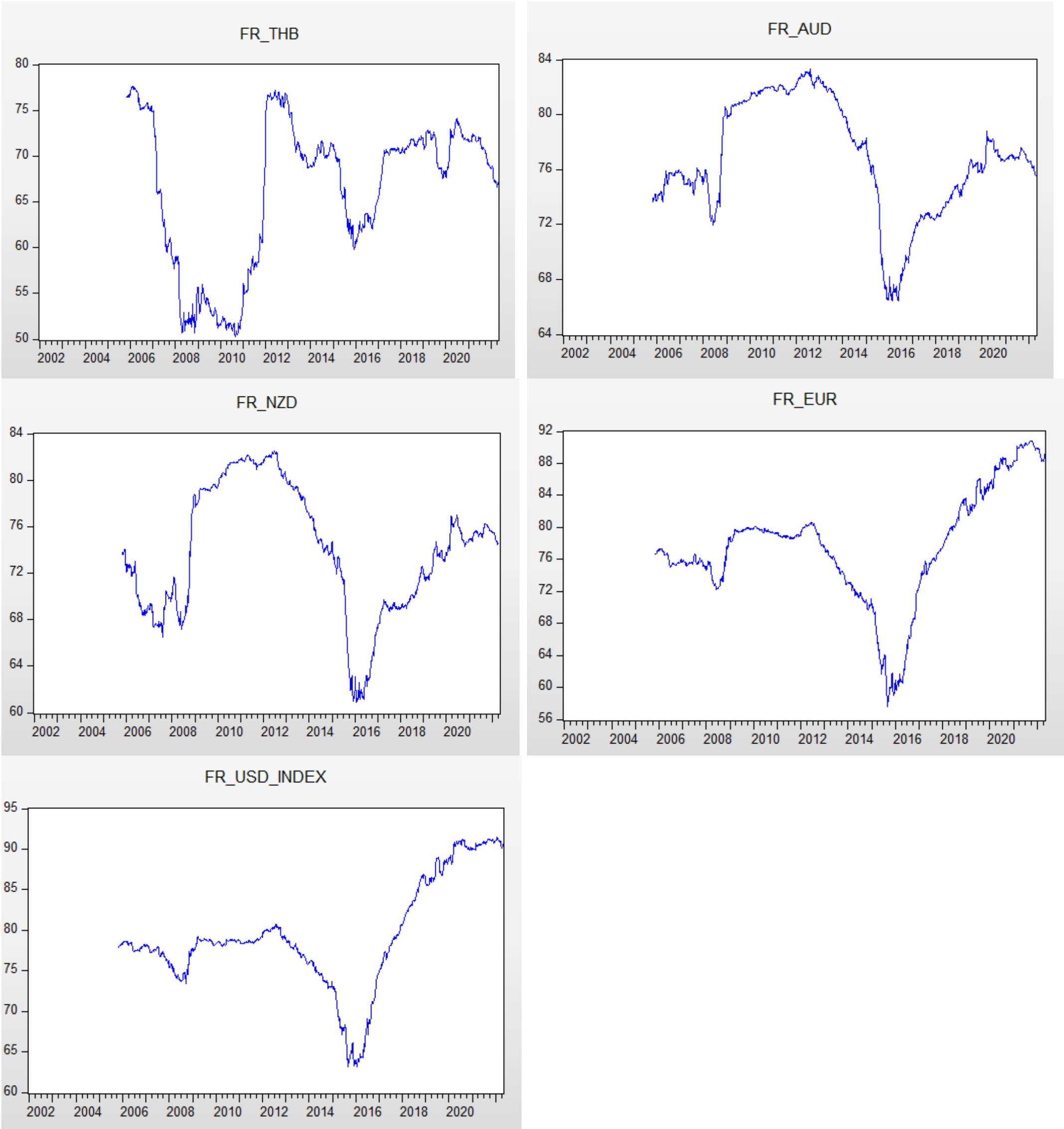


Figure 3 Directional Spillovers from Other Currencies

Source: Authors' Study

Figure 3 displays the directional spillovers from other currencies, revealing values ranging from 13% to 91%. During periods of high volatility, the Euro and the dollar index experience peak spillovers from other currencies, particularly in the year 2020. In contrast, the Japanese yen receives the least amount of spillover from other currencies, with a notable dip observed in 2012. These dynamics underscore the varying degrees of interaction and influence between specific currencies during different market conditions.

In Table 4, we delve into the factors influencing the degree of spillover to each country, employing COVID indicators such as confirmed cases, deaths, vaccination, and the Stringency index, which impact exchange rate volatility. The F-test results for the significance of cross-sectional specific effects indicate that incorporating fixed effects can elucidate the movement of the spillover index. The Hausman test, rejecting the null hypothesis of endogeneity in random effects, supports the estimation of the fixed effect model in the panel regression

The estimation results reveal that vaccination and government response policies significantly influence exchange rate volatility at the 10% level. Notably, an increase in vaccination is associated with a reduction in exchange rate volatility, indicating a pathway to restoring economic normalcy. This finding aligns with the conclusions of Bouhali et al. (2021). Moreover, stricter government response policies are found to decrease the risk of currencies receiving shocks from others, confirming the findings of Beckmann and Czudaj (2022). This underscores the role of government efforts in mitigating the volatility of exchange rates through measures aimed at preventing the spread of contagious diseases.

Table 4 Panel Regression Result

Independent Variables	Coefficient	t-Statistic
C	74.0438	110.0451
CASE	-3.84E-07	-1.08414
DEATH	1.48E-05	0.874508
VAC	-6.49E-09*	-1.93387
STRINGENCY	-0.0185*	-1.77108
R-squared	0.998078	
F-test	4250.646***	
Hausman test	2.99985**	
***, **, * indicates significance level: 1%, 5% and 10% respectively		

Note: Dependent Variable is FR

Source: Authors' Study

Conclusion

This research investigates exchange rate spillover and dynamic connectedness in East Asian countries and major currencies over three distinct periods: January 2002 to April 2022, pre-COVID from March 2017 to March 2020, and the COVID period from March 2020 to April 2022. Employing the Diebold and Yilmaz approach, the study explores total and directional spillovers, yielding the following key findings:

- Across the entire study period, 61.1% of exchange rate volatility stems from spillovers of shocks from other currencies, with Singapore exhibiting the most significant volatility spillover into and out of other currencies.
- In the pre-COVID sample, spillover levels are higher than those in the full sample (68.7%). The Singaporean dollar consistently stands out as the highest contributor and receiver among East Asian currencies.
- Throughout the pandemic, exchange rate volatility transmission slightly increases to 69.9%, with all currencies experiencing volatility explained by their own shocks (ranging from 9.5% to 49%). Certain currencies, such as the Indonesian rupiah, Malaysian ringgit, Japanese yen, Hong Kong dollar, and Thai baht, are particularly vulnerable to shocks from other currencies.
- The spillover index rises, reflecting the heightened influence of COVID-19 on exchange rate volatility globally. Vaccination and government response policy emerge as significant factors influencing exchange rate volatility.

The findings underscore the importance of government initiatives in mitigating uncertainty and panic induced by COVID-19, thereby positively impacting exchange rate volatility. Vaccination is identified as a significant contributor to lowering exchange rate volatility, emphasizing the need for careful consideration of the consequences of implementing various COVID-19 intervention measures.

This research highlights dynamic connectedness in foreign exchange rate markets during both crisis and non-crisis periods. Future research avenues could explore multivariate models in mean (Vector Auto Regression) and variance (Multivariate GARCH). A deeper understanding of returns and volatility spillovers in foreign exchange is crucial for policymakers to effectively manage the impact of external shocks. Additionally, further research may consider exploring diverse variables such as trade openness index, investor sentiment, political stability, and economic performance to comprehensively analyze factors influencing exchange rate volatility.

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