SPILLOVERS AMONG SOVEREIGN CDS, STOCK AND COMMODITY MARKETS IN ASIA

BY

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ABSTRACT

This paper examines spillover among sovereign CDS, stock market and commodity market as single system by measuring the spillover index based on generalized Vector Autoregressive model and forecast error-variance decomposition using data between 2008-2020. Our findings show the U.S. stock dominates as contributor of spillover whereas developed Asian markets like Japan and South Korea have less significant contribution to the system. However, major Asian have larger influence in sovereign CDS market while Japan hold the highest net receiver for both sovereign CDS and stock market.

Keywords: Spillover, Asian market, Sovereign CDS, Stock market, Commodity market, Forecast error-variance decomposition

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Patariya Weerasiri

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Symbols/Abbreviations	Terms
CDS	Credit Default Swap
BIS	Bank for International Settlements
FEDV	Forecast Error Variance Decomposition
FRED	Federal Reserve Economic Data
GDP	Gross Domestic Product
MIN	Minimum
MAX	Maximum
OPEC	The Organization of the Petroleum Exporting Countries
Std Dev.	Standard Deviation
U.S.	United State of America
VAR	Vector Autoregression

CHAPTER 1
INTRODUCTION

Sovereign Credit default swaps (CDS) is a proxy for sovereign risk by reflecting investors' perceptions of the financial health of the country through the premium of CDS (CDS spread). Since CDS spread is determined by the probability of default and the percentage of the bond's value that is agreed to be recovered in case of a credit event (Anton, 2011), the movement of CDS spread reflect the change of market perspectives on sovereign risk as new information releases.

There are several factors that determined sovereign risk based on past literature such as debt-to-GDP, fiscal debt solvency, current account, commodity dependence, and political risk.

In effect to global financial crisis in 2007, debt level and fiscal deficit play a key role in determining level of sovereign risk especially Asian countries debt level has been rising significantly in the past two decades compared to other regions which makes Asian countries tend to be interesting for study.

Considering that the global financial system is very complicated and highly interconnected and interdependent. The impact from local event, it could easily be amplified to global event or the negative impact to one market could have chain impact to other markets despite seemingly uncorrelated which could be explained in term of spillover.

In common concept, spillovers refer to impact of shock or fluctuation in one country (market) on another country either same asset or different assets which impact can be both positive effects for instance can be useful to predict asset price in another market or negative effect by transmitting excess volatility to other country (market).

When financial markets are globally integrated, we hypothesized that volatility in major asset classes like stocks would have impact to other markets of gold which is considered to be a safe haven asset as investors would shift their investment from high-risk market to lower risk market when stock market is too risky causing fluctuation in gold market.

Apart from gold, Oil market is another commodity market that play key role in world economy since oil market is a key driven on world supply chain in which

oil prices can affect levels of inflation in an economy by increasing the cost of inputs. Especially, countries that have net energy import would get impact from the higher cost of import price which could push pressure to country's financial stability e.g. Sri Lanka, Lao. Additionally, oil companies mostly have high market capitalization which it's fluctuation may have impact to overall market economy and other asset classes.

Not only stock and commodity market, the sovereign CDS which represent credit risk of sovereign or state's ability to repay its debt could also connect to other financial market as its change in spread could imply financial stability that influence the cost of public-sector financing and consequently affect short-term and long-term financing of the corporate sector and households which impact to the value of the company and demand in the country.

Intuitively, this could be implied the same for the cross-country influencing in the same region as these countries dependent on each other in term of commercial trading as well as common market characteristic.

Although there are several literatures studied on relationship between commodities or commodities with stock but there are limited literatures studied on the relationship between Sovereign CDS with stock market and commodities markets especially in term of spillover.

The literatures regarding spillover usually focus on spillover between two assets or across country but not across multiple asset markets and countries especially not sovereign CDS market.

Given global financial integration, it is found to be interesting and important to study on spillovers among different asset markets as well as the sovereign CDS market from a systematic perspective. This paper follows the empirical approach of Diebold and Yilmaz (2009) by examining spillover among sovereign CDS, stock market and commodity market as single system by measuring the spillover index based on generalized Vector Autoregressive model and forecast error-variance decomposition using data between 2009-2020. While the paper addresses similar questions as in Sun et. al (2017), it focuses more on Asian markets using daily data between 3 November 2008 – 30 March 2022 to examine intermarket spillovers among CDS, commodities, and stock markets. The selected period encompasses the aftermath of the US-subprime crisis, European sovereign debt crisis until the ongoing COVID-19 pandemic. The

markets included in the study are China, Indonesia, Japan, Malaysia, Singapore, South Korea, and Thailand as well as United State of America as main global reference market. The paper also examines if the effect of the spillover changes over time by performing rolling spillover analysis and additionally provides sub-sample spillover analysis to investigate the effect of spillover in different sub-period if result will be changed or not.

The emphasis on Asia in this paper is motivated by rapidly rising debt level has in the past two decades compared to other regions. This implies higher concern for sovereign risk of Asian countries which makes it more interesting to understand the impact in Asian markets.

By addressing these questions, the results have important implications for investors to understand the spillovers among the major asset markets, especially the sovereign CDS market in order to diversify their investment in regular basis and particularly during the crisis that markets react to information aggressively.

Following the study, the results provide that stock market of U.S. dominates over stock market and sovereign CDS market in other countries and commodity market in every phase while stock market of developed countries like Japan and South Korea holds less contribution to the system but instead influence from advance economies of Hong Kong stock market. The main contributor in sovereign CDS are major Asian countries; China, South Korea and Malaysia as exception in which most contribution remain within sovereign CDS market. Surprisingly, Japan sovereign CDS remains as large net receiver similar to Japan stock market. Moreover, the countries with large contribution in sovereign CDS market conversely has limited contribution in stock market. Gold market is the least contributor from commodity market. In conclusion, sovereign CDS holds larger influence to stock market relative to commodity market while stock market gives more contribution to changes of sovereign CDS compared to the return of commodity markets but commodity markets have higher influence in stock market compared to Sovereign CDS.

CHAPTER 2
REVIEW OF LITERATURE

After Global financial crisis during 2009, investor tend to pay close attention to sovereign risk when they consider to make investment in both developed countries and emerging countries. Thereafter, Sovereign credit default swap (CDS) market has been in focus and gained attention from investors significantly after first introduced in 2000. According to BIS quarter review of December 2010, sovereign CDS which accounted for 20% of total CDS market was surged in volume after global financial crisis **(Badaoui, Cathcart, & El-Jahel, 2013; Groba, Lafuente & Serrano, 2013; Inaki and Torsten, 2018**).

The sovereign CDS is the bilateral swap contract which the underlying asset is government bond. The sovereign CDS premium or CDS spread is the cost that buyer require to make periodic payment for protection against a default event by sovereign borrower while seller obligated to pay the face value of the underlying asset in the event of default. Thus, the sovereign CDS is a useful tool for international investors to hedge exposure on the sovereign risk in the event that the debtor country could not repay its debt due to the lacking of financial resources. On the other hand, sovereign CDS spread consider to be an efficient proxy of sovereign risk as it reflects investors' perceptions on the financial health of country **(Yu 2016; Naifar, 2020)**

Following the strong growth in sovereign CDS market, there are many literatures study on sovereign CDS in several different contexts which can be grouped into 3 main topics.

The first topic is about spread determinants by **Blommestein, Eijffinger, and Qian (2016), Galariotisa et al., (2016) and Ho (2016)** that observe the contributable factor to sovereign CDS spread in Europe region and emerging countries respectively. Another type of literature study on dynamics of sovereign CDS contagion and price efficiency finds that there is contagion in same region when events happen in one country **(Huang, Chen, & Shen, 2014)** and developing countries in Asia show the most efficient CDS markets in term of the weak-form efficiency **(Sensoy, Fabozzi, & Eraslan, 2017).** The third types of literatures concern on spillover between sovereign

CDS and other markets especially commodity markets that there are many researches study spillover with different types of commodities including gold market, oil index, natural resources.

According to **Sun et al., (2011)**, there is significant correlation in emerging countries between oil price and sovereign CDS spread that moves in opposite direction consistent with **Arezki, R., & Brückner, M. (2012) and Alexandre and de Benoist (2010)** that also study emerging countries and find negative correlation between commodity prices (natural resources including oil) and sovereign bond spread but Arezki and Brückner result show specifically in democracies countries while positive correlation was observed in autocracies countries. **Bouri et al. (2017)** who specifically study in term of spillover found significant volatility spillover between commodity prices and sovereign CDS spreads for most of the countries but results vary overtime and type of commodity and expect there might be effect from other factors as well.

In addition to the spillover between sovereign CDS and commodity market, there are some literatures extended study on spillover to stock market as well. **Ngene, Hassan and Alam (2014)** find evidence of momentum in cointegration relationship in CDS and equity markets in 13 emerging countries. Many Literatures observe spillover between sovereign CDS and stock market in European countries including **Coronado, Corzo and Lazcano (2012), Ballester, Laura, and Ana (2020,2021) and Sorin and Anca (2020)** investigate the relationship between sovereign Credit Default Swap (CDS) and stock markets in European countries which results align as there is relationship of these two markets but magnitude and details vary by time and countries. **Tabak et al., (2016)** studied specifically in banking sector for the contagion of the two markets which evidence shows strong contagion in several cases.

The past literatures on spillover are mostly studied between two asset markets. Only a few studies concern spillover between multiple asset markets and countries. One of them is from **Mensi et al., (2017)** that reveals result showing crude oil market has higher impact than gold on the Islamic stock markets as well as be a greater receiver of shocks compared to gold while Islamic stock index is a net contributor of volatility in contrast to commodity market. While recent study of **Sun et al. (2020)** found that the stock market always plays key role in every period while the sovereign CDS market and the commodity market show significant effect during the

certain period. They evidence large effect spillover from sovereign CDS to stock in emerging country on the other hand effect from stock to sovereign CDS show more average in developed countries.

Evidence from the past literatures shows that different asset classes and countries have some interconnection between each other as global complex network. Thus, it would be interesting to study spillover between multiple assets classes and countries especially in Asia which not many literatures focusing on this region.

To further study spillover on multiple asset markets in Asia region, we based our study on previous paper of Sun et al. (2020) that would be the best suitable for reference in terms of both the studied factors and the methodology of generalized forecast error variance decomposition that eliminate of the limitation of ordering.

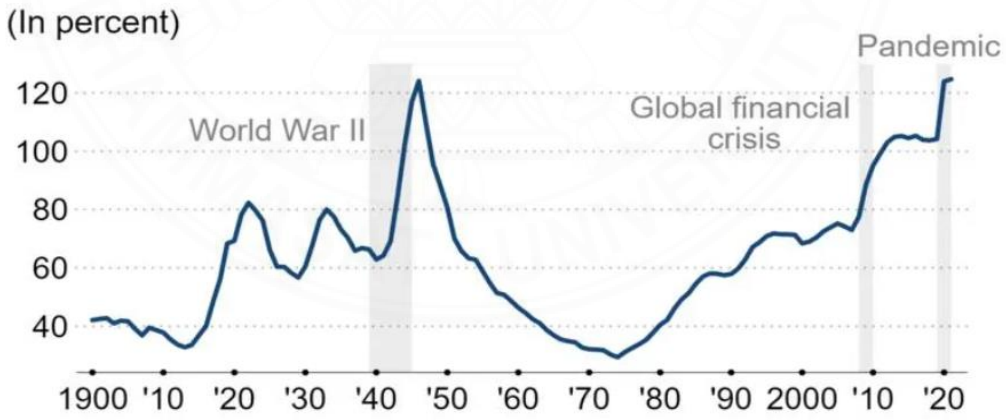
CHAPTER 3
DATA BACKGROUND AND SUMMARY STATISTICS

3.1 Data

In effect to global financial crisis in 2007, debt level and fiscal deficit play key roles in determining level of sovereign risk. As shown in figure 3.1, debt level as represented in term of debt-to-GDP was skyrocketed during crisis and rising continuously since global financial crisis. After event of global financial crisis, Asia countries debt level has been rising significantly in the past two decades compared to other zone as represented in figure 3.2 comparing external debt between 2000 and 2020. From this figure, it could be implied that the sovereign/country risk of these countries rose as debt level increased that makes Asia tend to be interesting for study.

Figure 3.1

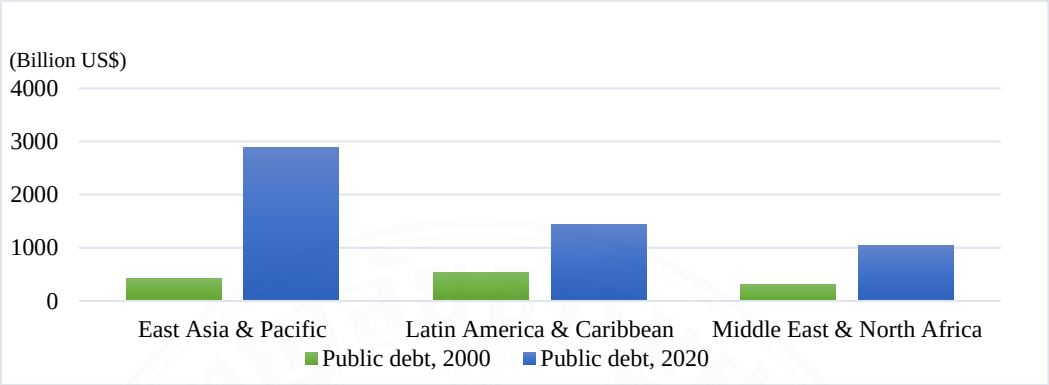
Debt-to-GDP ratio of advanced economies



Source: International Monetary Fund

Figure 3.2

External Debt in Developing Economies by Region



Source: Developing country external debt: From growing sustainability concerns to potential crisis in the time of COVID-19 by UNITED NATION UNCTAD

Therefore, we choose to focus our study scope in Asian countries by selected 7 representative Asian countries in both developed countries (Japan and South Korea) and developing countries (China, Hong Kong, Indonesia, Malaysia, and Thailand) upon dependency in terms of commercial trading (major export/import countries) and United States of America as its market has major impact to other countries around the world based on existing literatures.

The sample period covers 3 November 2008 – 30 March 2022 which involves many major financial events start from global financial crisis until the event of COVID-19 pandemic.

We obtain the sovereign CDS mid-spread of contract with five years to maturity and the stock index of selected countries from DataStream

We decide to choose oil and gold to represent commodities market as they are the main commodities exported or imported for these countries and have significant impact to economy. The oil prices refer from Europe Brent Spot price in U.S. dollar per barrel unit which Singapore's trader who act like trading commodity hub in Asia pacific region, mainly refers to. The oil price data retrieve from the U.S. Energy Information Administration in U.S. dollar per barrel unit, and gold prices are extracted from the FRED Economic Data is Gold Fixing Price 10:30 A.M. (London time) in the London Bullion Market shown in U.S. dollar per troy ounce.

Processing data to get daily returns calculate from difference of the stock indexed and commodity index and difference in spread for sovereign CDS changes in terms of logarithms.

Table 3.1 Data and Variable

Market	Variable	Description
Sovereign CDS Spread	CDS_J	Japan SNR 5Y - CDS Prem. mid
	CDS_C	Peoples Rep of china SNR CR14 5Y - CDS Prem. mid
	CDS_H	HK Special ADM Regn SNR CR14 5Y - CDS Prem. mid
	CDS_T	Kingdom of Thailand SNR CR14 5Y - CDS Prem. mid
	CDS_I	Rep of Indonesia SNR CR14 5Y - CDS Prem. mid
	CDS_K	Republic of Korea SNR CR14 5Y - CDS Prem. mid
	CDS_M	Malaysia SNR CR14 5Y E - CDS Prem. mid
	CDS_U	USA SNR CR 5Y - CDS Prem. mid
Stock Index	Stock_J	Nikkei Stock Index
	Stock_C	Shanghai SE Composite Stock Market Index
	Stock_H	Hang Seng Composite Index
	Stock_T	Stock Exchange of Thailand Index
	Stock _I	Jakarta Stock Exchange Composite Index
	Stock_K	Korea Stock Exchange Index
	Stock_M	FTSE Bursa Malaysia Index
	Stock_U	S&P 500 Index
Commodity	Oil	European Brent Spot Price
	Gold	Gold Fixing Price 10.30 A.M. (London time)

Data source: Sovereign CDS spread and Stock Index from DataStream
Oil Price from https://www.eia.gov/
Gold Price from FRED Economic Data

3.2 Descriptive Statistics

From Statistics data in table 3.2, it shows that all Sovereign CDS changes have negative mean value in contrast with all sample stock markets and commodity markets that have positive mean value. For standard deviation, all sovereign CDS samples have higher level of standard deviation in relative to stock markets and commodity markets in which Japan has the highest standard deviation of 5.55% followed by Indonesia (4.26%) and U.S. (4.11%) that could imply high volatility in these countries. Among stock markets, Japan and China have the highest standard

deviation of 1.36% followed by Hong Kong at 1.32% while Oil market has high standard deviation at 2.83%. The skewness of stock markets and commodity markets are all negative while sovereign CDS are all positive except for Hong Kong. For Kurtosis, it shows considerably high for many variables especially for oil market return. Furthermore, we test augmented Dickey and Fuller's unit root test (1979, 1981) to ensure that all series are stationary and justified to be used in our analysis with VAR model approach.

Table 3.2 Descriptive Statistics (Period: 3 November 2008 – 30 March 2022; Daily)

Variables	Mean	Min	Max	Std. Dev.	Kurtosis	Skewness	ADF
Sovereign CDS Changes							
CDS_J	-0.04%	-51%	49%	5.55%	14.62	0.16	-51.37***
CDS_C	-0.03%	-30%	24%	3.41%	7.62	0.50	-40.50***
CDS_K	-0.07%	-30%	20%	3.32%	7.53	0.14	-40.22***
CDS_T	-0.05%	-25%	26%	2.88%	11.48	0.46	-38.14***
CDS_H	-0.03%	-36%	37%	2.85%	56.65	(1.06)	-42.24***
CDS_M	-0.04%	-29%	44%	3.45%	16.00	1.02	-39.28***
CDS_I	-0.07%	-22%	41%	4.26%	8.75	0.58	-46.69***
CDS_U	-0.02%	-44%	63%	4.11%	53.50	2.14	-42.41***
Stock Returns							
Stock_J	0.03%	-11%	8%	1.36%	5.07	(0.39)	-41.76***
Stock_C	0.02%	-9%	7%	1.36%	6.02	(0.77)	-41.82***
Stock_K	0.03%	-9%	8%	1.11%	7.42	(0.34)	-40.71***
Stock_T	0.04%	-11%	8%	1.08%	11.70	(0.72)	-41.01***
Stock _H	0.02%	-7%	9%	1.32%	3.86	(0.15)	-41.29***
Stock_M	0.02%	-5%	7%	0.66%	7.73	(0.09)	-38.83***
Stock_I	0.05%	-9%	10%	1.13%	7.50	(0.10)	-41.33***
Stock_U	0.04%	-13%	9%	1.19%	12.94	(0.70)	-43.02***
Commodity Return							
Oil	0.02%	-64%	41%	2.83%	101.49	(2.63)	-44.65***
Gold	0.03%	-9%	7%	1.01%	6.52	(0.21)	-42.83***

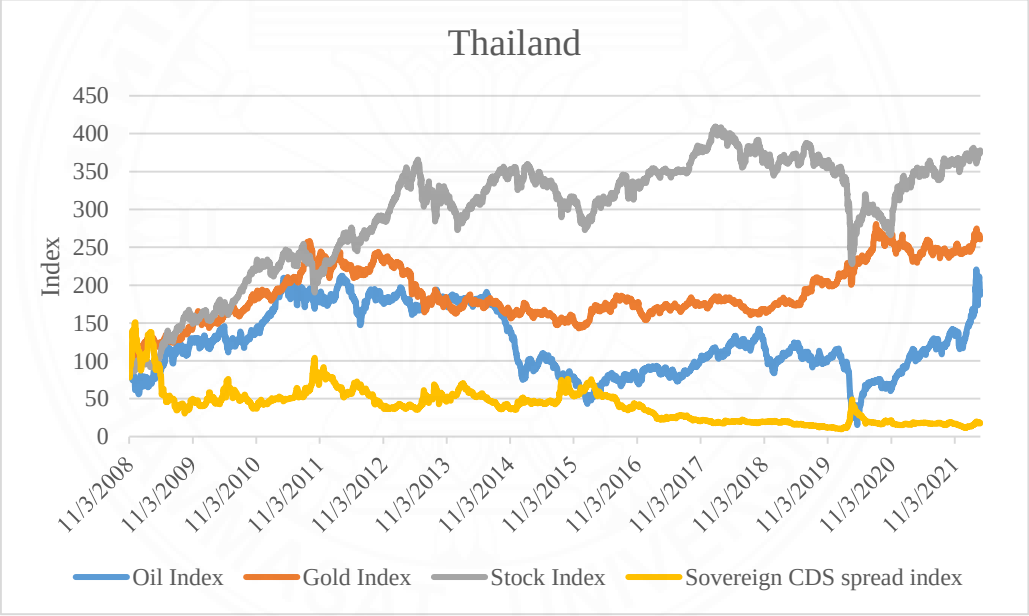
Note: ADF is the augmented Dickey and Fuller's unit root test with intercept and trend
***significance level at 1%

3.3 Correlation analysis

The following figure 3.3 demonstrates initial view of correlation between different asset market indexes for Thailand which we can observe that there are some linkages among these markets. For instance, sovereign CDS premium keeps high level at the beginning of the period while the stock index and gold price remain low as we can see some pattern through time.

Figure 3.3

Thailand index of Stock, Sovereign CDS and Commodity market



In order to see more details of the connection among different asset markets, we conduct Pearson correlation coefficients to see pairwise correlation with result shown in Table 3.3. Obviously, changes in sovereign CDS spread have negative correlation with return of stock markets and commodity market while return of stock markets have positive correlation with return on commodity markets. For pairwise correlation, sovereign CDS of U.S. has the lowest average correlation coefficients of 0.05 while the highest average correlation coefficients are Hong Kong and Indonesia stock markets at 0.12 and the highest correlation coefficients pair is within the

sovereign CDS market which is China-Hong Kong pair (0.82) followed by China-Korea pair (0.77). For the view of correlation within stock market, the highest belongs to Indonesia-Hong Kong stock market (0.64) whereas the lowest correlation is U.S.-China stock market pair (0.12).

In terms of correlation between markets, the pair of China sovereign CDS-Indonesia Stock market gives the highest correlation coefficient (-0.48) followed by Hong Kong sovereign CDS-Japan stock market (-0.47) and China sovereign CDS-Japan stock market (-0.45) pairs. For commodity market, it has higher average correlation coefficient with stock markets compared to sovereign CDS market in which oil market reveals higher correlation than gold market. The highest correlation pairs for commodity market are Oil market-U.S. stock market pair (0.28) and gold market – Hong Kong stock market and Thailand stock market (-0.13).

Table 3.3 Pearson correlation coefficients (Period: 03.11.2008 – 30.03.2022; Daily)

	Sovereign CDS changes								Stock Returns								Commodity Returns	
	CDS_J	CDS_C	CDS_K	CDS_T	CDS_H	CDS_M	CDS_I	CDS_U	Stock_J	Stock_C	Stock_K	Stock_T	Stock_H	Stock_M	Stock_I	Stock_U	Oil	Gold
CDS_J	1																	
CDS_C	0.18	1																
CDS_K	0.18	0.82	1															
CDS_T	0.19	0.73	0.75	1														
CDS_H	0.12	0.25	0.25	0.27	1													
CDS_M	0.16	0.77	0.76	0.74	0.26	1												
CDS_I	0.14	0.57	0.58	0.53	0.17	0.6	1											
CDS_U	0.04*	0.09	0.09	0.1	0.04	0.09	0.08	1										
Stock_J	-0.16	-0.45	-0.47	-0.4	-0.13	-0.43	-0.32	-0.08	1									
Stock_C	-0.01*	-0.25	-0.24	-0.2	-0.05	-0.23	-0.18	-0.04*	0.28	1								
Stock_K	-0.09	-0.42	-0.44	-0.37	-0.11	-0.42	-0.35	-0.07	0.57	0.33	1							
Stock_T	-0.08	-0.36	-0.36	-0.34	-0.09	-0.37	-0.3	-0.06	0.32	0.24	0.42	1						
Stock_H	-0.09	-0.48	-0.48	-0.4	-0.12	-0.47	-0.37	-0.07	0.52	0.55	0.64	0.48	1					
Stock_M	-0.07	-0.33	-0.36	-0.3	-0.09	-0.37	-0.3	-0.07	0.38	0.22	0.46	0.43	0.48	1				
Stock_I	-0.08	-0.37	-0.39	-0.37	-0.1	-0.41	-0.34	-0.09	0.35	0.24	0.46	0.47	0.49	0.46	1			
Stock_U	-0.02*	-0.18	-0.18	-0.13	0	-0.17	-0.15*	-0.07	0.16	0.12	0.24	0.25	0.23	0.14	0.18	1		
Oil	-0.02*	-0.12	-0.14	-0.12	0	-0.17	-0.11*	-0.06	0.14	0.12	0.17	0.19	0.2	0.15	0.15	0.28	1	
Gold	-0.02*	-0.07	-0.06	-0.08	-0.06	-0.09	-0.1	-0.02*	-0.03*	0.07	0.09	0.13	0.13	0.09	0.11	0.05	0.1	1

* Denote insignificance at level 1%

CHAPTER 4
EMPIRICAL METHODS AND RESULTS

4.1 Empirical Methods

To study spillovers among sovereign CDS, equity and commodity market, this paper follows methodology from **Sun et al. (2020)** by applying Diebold and Yilmaz (2009, 2012) approach. This approach progresses spillover effects between variables by employed **forecast error variance decomposition (FEVD)**. This model allows us to breakdown the forecast error variances of each variable into parts which are attributable to the shocks to other variables.

Consider a covariance stationary P-th order (P=5), N-variable VAR(p),

$$x_t = \sum_{i=1}^{P} \emptyset_i x_{t-i} + \varepsilon_t \tag{1}$$

where $\varepsilon \sim (0, \Sigma)$ is a vector of uncorrelated error terms, $x_t = (x_{1t}, x_{2t}, \dots, x_{Nt})$ is a vector of N endogenous variables which are the selected market index return of different countries (N =18 variables) as indicated in data section, $\emptyset_i$ is a N x N coefficient matrix where i=1, 2, …,P

The moving average coefficients of model (1) are the key to understanding the dynamics of the VAR system which can be written as

$$x_t = \sum_{j=0}^{\infty} A_j \varepsilon_{t-j}$$

where the N ×N coefficient matrix A_j obeys the recursion of $A_j = \Phi_1 A_{j-1} + \Phi_2 A_{j-2} + \cdots + \Phi_P A_{j-P}$ with A_0 being an N×N identity matrix and with $A_j = 0$ for $j < 0$ then we derive spillovers from generalized forecast error variance decompositions of moving average of model (1). This generalized VAR framework will eliminate the possible dependence of the results on ordering.

According to **Diebold and Yilmaz (2012)**, we exploit H-step-ahead generalized forecast error variances decomposition framework by Koop, Pesaran, and Potter (1996) and Pesaran and Shin (1998) to generate H-step-ahead error variances where H =10 for our study in forecasting x_i that are due to shocks to x_j, for i, j = 1, 2, . . . , N, where N is total market index of different countries such that i ≠ j.

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

where Σ is the variance matrix for the error vector ε, σ_{jj} is the standard deviation of the error term for the j^{th} equation, and e_i is an N x 1 selection vector, with one as the i^{th} element and zeros elsewhere. This N×N matrix θ^H gives the contributions of variable j to the forecast error variance of variable i. Because all the variance contribution shares for each i do not sum to one under the generalized decomposition i.e. $\Sigma_{j=1}{}^{N}\theta_{ij}{}^{H} \neq 1$. We normalized each entry by sum of row as follow:

$$\tilde{\theta}_{ij}^{H} = \frac{\theta_{ij}^{H}}{\sum_{j=1}^{N} \theta_{ij}^{H}} \tag{3}$$

Note by construction; $\sum_{j=1}^{N} \tilde{\theta}_{ij}^{H} = 1$ and $\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{H} = N$

The matrix $\widetilde{\theta^H} = \widetilde{\theta^H{}_{ij}}$ shows the spillover effects among the N variables. The main diagonal elements contain the own-variable spillovers (contributions) and the off-diagonal elements show the cross-variable spillovers (contributions).

The total spillover index is defined as follow

$$TS = \frac{\sum_{i,j=1, i\neq j}^{N} \tilde{\theta}_{ij}^{H}}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{H}} \times 100 = \frac{\sum_{i,j=1, i\neq j}^{N} \tilde{\theta}_{ij}^{H}}{N} \times 100 \tag{4}$$

Net spillover for each variable

We calculate the spillover to others, the spillover transmitted by a certain variable to all other markets. The spillover to others equals the numerical weighted out-degree (5) and the spillovers received from all other markets which is numerical weighted out-degree (6) show as follows:

$$d_i^{out} = \sum_{j=1 j\neq 1}^{N} \tilde{\theta}_{ji}^{H} \quad (5) \qquad d_i^{in} = \sum_{j=1 j\neq 1}^{N} \tilde{\theta}_{ij}^{H} \quad (5)$$

The net volatility spillover is the difference between the gross volatility shocks transmitted to and those received from all other markets.

$$NS_i = d_i^{out} - d_i^{in} \quad (6)$$

4.2 Empirical Results

4.2.1 Full-sample spillover

The spillover index for full-sample period was derived based on 10-day ahead forecast-error variance decompositions represent in Table 4.2. The table shows estimated contribution from variable j to the forecast error variance of variable i. For the diagonal elements that i = j, it measures internal spillovers within one market while the off-diagonal element i ≠ j measures spillover across different markets or countries. The total receiver from other of the variable is the row sums excluding internal spillover of the element ("Contribution from others") and the total contribution is the column sums represent spillover that variable contributes to other ("Contributions to others").

From the result in Table 4.2, the total spillover index within the sovereign CDS, equity and commodity markets is 50.2% which can be interpreted that about half of all total forecast error variance affects by the shocks from other markets in relative to its own shock. This suggests considerable internal interaction among these markets. For internal spillovers within Sovereign CDS market, we can see the large effect among China, South Korea, Thailand and Malaysia in which China sovereign CDS changes show the highest average contribution within sovereign CDS market of 8.33% followed by South Korea 8.26%, Malaysia 8.13%, Thailand 7.2% respectively

while other developed counties like Japan and U.S. contribute relatively small to other countries sovereign CDS changes such as U.S. account for 0.4% of sovereign CDS changes of China and average 0.43% to sovereign CDS market.

On the other hand, the internal spillovers within stock markets, U.S. stock return contribute a large portion of 8.23% averagely within stock market which contributes the most to Japan and South Korea stock market for 14.55% and 9.83% respectively and the least to China stock market for 3.02% while China stock market contributes 1.33% to stock return in U.S, 1.97% in Japan and the largest in South Korea 2.92%. Another major contributor in stock market is the stock return in Hong Kong with contribution 61.95% that largely affecting stock return of China 16.46% and South Korea 11.54%. It could be considered that effect between developed market and developing market is smaller than within developed market or developing market except for Hong Kong.

Next, we consider spillover between sovereign CDS and stock market. First, the spillovers from sovereign CDS to stock market, China and South Korea are the major contributors with average contribution of 8.33% and 8.24% respectively to stock market return while Japan and U.S. as developed countries provide relatively small contribution with average of 0.58% and 0.43% to stock market return. On the contrary, the spillovers from stock market to sovereign market show that U.S. stock market return is the top contributor to all sovereign CDS markets with average contribution of 5.20% followed by Hong Kong stock market 2.58%, Indonesia stock market 1.91% and South Korea stock market 1.83% whereas China stock market contributes the least for both stock market and overall sovereign CDS market at average 2.86% and 0.6% respectively.

For the spillovers of sovereign CDS - commodity markets and stock market – commodity, return of stock market give more contribution to changes of sovereign CDS compared to the return of commodity markets while contribution from return of commodity markets to sovereign CDS changes and return of stock market that commodity market has stronger influence to stock market than sovereign CDS market especially in oil market but limited for gold market which similar to Mensi et al., (2017).

In addition to pairwise spillovers and the total spillover index for the entire system, we also measure the net spillover of each variable to identify whether the

variable is the net spillover contributor or net receiver in which the net spillover will be derived from the difference between total spillover from the variable to all other variables and total spillover from all other variables to the variable. For full-sample period, we can see that U.S. and Hong Kong stock markets are the major net contributors with net contribution of 59.93% and 18.44% while China, South Korea and Malaysia are the net contributors from sovereign CDS markets to the entire system.

We can observe that China in term of Sovereign CDS has strong influence to other market in contrast to China stock market that provide explicitly small contribution. This suggests that China as a main economic driven in Asia and the largest exporter in the world has significant impact to other countries in the Asia region that the increasing in vulnerability of China economy affects to the stability of the rest of the Asia while the intervention of Chinese's government with capital control in stock market still keeps their market separate from the rest of the world. The same hold for South Korea that its sovereign CDS market contributes about the same level as China which explains how important of South Korea economy to the other countries in the region given the world's seventh largest exporter of goods and the ninth largest importer refers to World Trade Organization 2021 whereas stock market is mainly influenced by Hong Kong and U.S. stock market which could be implied from the large sized of stock market capitalization of these two countries considered 10 times bigger than other sample countries stock markets that the shock effect provides high contribution except China and Japan stock market. More interestingly, Japan as another developed country in contrary clearly shows that its shock has relatively less impact to the entire system as result in the net receiver for both sovereign CDS and stock market while shock from others has a certain level of impact to Japan stock market but very limited to Japan sovereign CDS. Another key finding is that Hong Kong stock market does have strong presence in Asia which its shock has significant effect to the system second to U.S. stock market as it is the third-largest stock market in Asia followed Japan and China but consider higher liquidity and more familiar to investors than China stock market while impact in term of sovereign CDS is still limited. Lastly, similar to many studies, U.S. stock market takes dominant role as a key contribution to this entire system in contrast to U.S sovereign CDS that does not appear to have substantial connectedness with other markets in this region.

Table 4.1 Full –Sample spillover table (03.11.2008 – 30.03.2022): Total spillover index= 50.22%

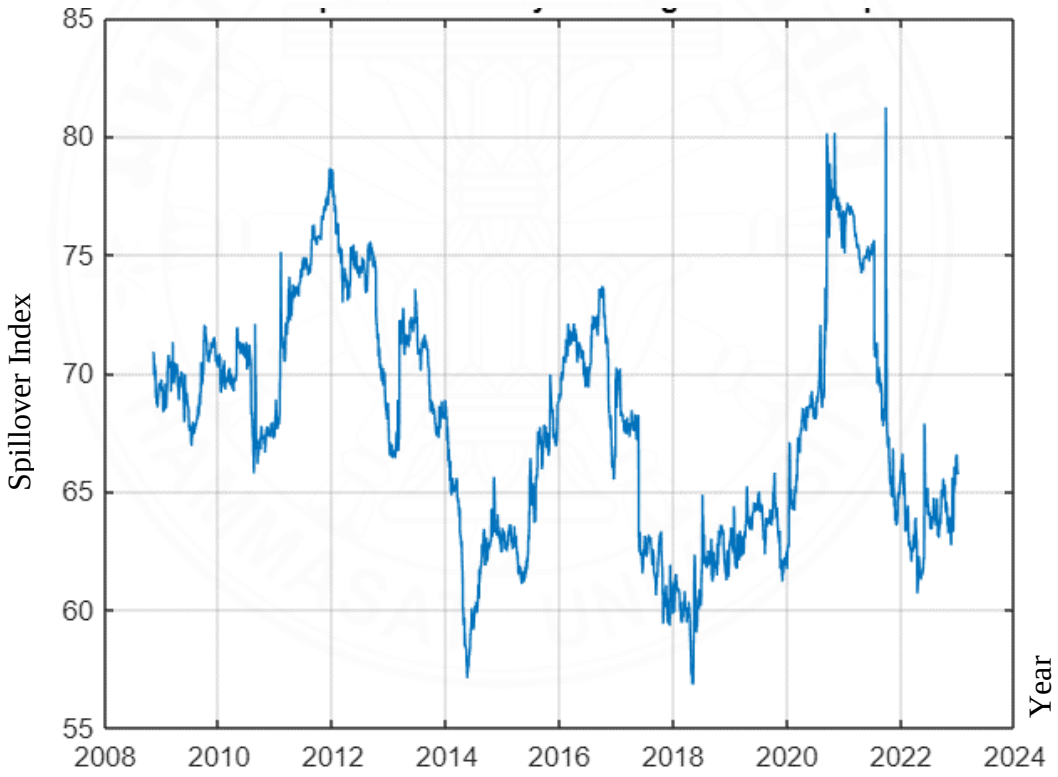
To (i)	From (j)																		
	CDS_J	CDS_C	CDS_K	CDS_T	CDS_H	CDS_M	CDS_I	CDS_U	Stock_J	Stock_C	Stock_K	Stock_T	Stock_H	Stock_M	Stock_I	Stock_U	Oil	Gold	Contribution from others
CDS_J	82.78	2	2.01	2	1.28	1.78	0.93	0.27	1.04	0.1	0.44	0.55	0.6	0.3	0.54	2.34	0.72	0.32	17.22
CDS_C	0.7	25.81	15.43	11.64	1.25	13.5	6.81	0.4	2.22	1.08	2.59	2.34	4.21	1.19	2.13	7.42	0.89	0.38	74.19
CDS_K	0.66	15.23	25.22	11.93	1.22	12.53	6.78	0.53	2.67	0.97	3.02	2.12	4.11	1.54	2.4	7.58	1.19	0.27	74.78
CDS_T	0.7	12.68	13.21	27.28	1.55	12.87	6.74	0.53	1.7	0.73	2.3	2.98	3.12	1.15	2.74	7.73	1.54	0.45	72.72
CDS_H	0.78	3.99	3.91	4.23	74.18	3.73	1.16	0.59	0.57	0.36	0.92	0.66	0.98	0.33	0.67	1.81	0.59	0.54	25.82
CDS_M	0.53	13.55	12.52	11.43	1.21	24.71	8.24	0.36	1.88	0.84	2.84	2.98	3.95	1.86	2.9	7.89	1.81	0.5	75.29
CDS_I	0.46	9.85	9.83	8.41	0.62	11.6	36.98	0.32	1.2	0.58	2.21	2.37	3.2	1.45	3.29	5.89	1.19	0.55	63.02
CDS_U	0.24	1.03	0.73	0.83	0.48	0.9	0.72	90.25	0.57	0.14	0.33	0.41	0.47	0.45	0.64	0.98	0.61	0.22	9.75
Stock_J	0.68	3.86	4.39	2.51	0.34	3.31	1.59	0.51	41	1.97	8.65	2.73	6.75	2.66	2.19	14.55	1.97	0.33	59
Stock_C	0.08	2.27	2.02	1.42	0.12	1.77	0.89	0.09	2.58	57.3	4.49	2.46	16.46	1.55	2.18	3.02	0.92	0.38	42.7
Stock_K	0.08	3.41	3.8	2.37	0.19	3.61	2.12	0.25	7.41	2.92	35.66	4.72	11.54	4.7	5.03	9.83	1.81	0.57	64.34
Stock_T	0.14	3.59	3.19	3.14	0.18	4.04	2.62	0.16	2.26	1.88	5.32	42.91	7.61	5.79	7.16	7.33	1.84	0.83	57.09
Stock_H	0.11	4.46	4.36	2.6	0.19	4.23	2.41	0.18	4.84	9	9.87	5.49	31.28	4.78	5.42	8.52	1.63	0.63	68.72
Stock_M	0.22	2.58	3.14	1.75	0.1	3.57	2.1	0.2	3.05	1.2	6	6.97	7.16	44.38	7	7.58	2.43	0.56	55.62
Stock_I	0.17	3.5	3.81	3.44	0.21	4.36	3.28	0.31	2.14	1.68	5.73	7.31	7.34	6.14	41.64	6.76	1.48	0.7	58.36
Stock_U	0.16	3.23	3.4	2.51	0.06	3.2	1.96	0.41	3.74	1.33	5.22	5.22	5.09	2.22	2.8	54.13	4.8	0.53	45.87
Oil	0.22	1.14	1.33	0.79	0.07	2.07	0.85	0.4	1.28	1.01	2.31	2.4	2.99	1.63	1.47	6.21	73.02	0.81	26.98
Gold	0.11	0.57	0.45	0.78	0.7	0.9	0.89	0.16	0.42	0.46	0.72	1.81	1.58	0.58	1.02	0.37	0.92	87.55	12.45
Contribution to other	6.05	86.95	87.53	71.75	9.76	87.98	50.08	5.7	39.58	26.27	62.97	53.53	87.15	38.32	49.58	105.81	26.33	8.59	**50.22%**
Net contribution/ (receive)	-11.17	12.76	12.75	-0.97	-16.06	12.69	-12.94	-4.05	-19.42	-16.42	-1.37	-3.56	18.44	-17.29	-8.78	59.93	-0.65	-3.86	**Total spillover index**

4.2.2 Rolling spillover analysis

As the spillover effect is dynamic which could be changed over time especially through the various financial events during the sample period. To capture spillover movement in different financial events, this study assesses the time-varying spillovers index by applying rolling-window analysis based on 200-day rolling window with a 10-day forecast horizon. The time-varying spillover index is illustrated in Figure 4.1 (From 10.08.2009 – 30.03.2022).

Figure 4.1

Total spillover index (200-day rolling windows, 10-step Horizon)



Our time series spillover index starts at around 70% which is the ongoing period of European sovereign debt crisis that continue to expand and peak in 2012 causing index to reach up to 79% before declining to the low level around 57% in 2014 as global economy gradually recovers from the impact of European crisis. Around mid-2014 the oil price begins to plunge with lowest record in 2016 that the total spill

index illustrates significant fluctuation during the period as the index rise to level of 70% again in 2016 and later decline easing from agreement among OPEC on production limit and demand recovery. Again in 2020, total spillover index spikes up along with the start of turmoil situation as COVID-19 pandemic halts economic activities around the world with the highest record of total spillover index of 80% in the sample period. To test total spillover index sensitivity, this study performs the robustness tests with different H step-ahead forecast error variance decomposition and days of rolling window as shown in Appendix A (figures A.1 and A.3) in which it shows similar pattern of total spillover index despite the changes of parameter. Hence, it can be implied that the results are robust and consistent. From the time-series spillover index result, it demonstrates clear characteristics of each phase as major economic events occur. Therefore, it is important to further study on the specific effect in different sub-sample periods of sovereign CDS-equity-commodity system.

4.2.3 Sub-sample spillover analysis

According to the dynamic time-varying spillover index result, we split the spillover effect analysis into three main sub-sample periods shown in Table 4.3 using the same lags and 10-day ahead forecast error variance decomposition as full-sample analysis.

Table 4.2 Sub-sample periods

Phase	Time frame
Phase 1	03.11.2008 - 14.04.2014
Phase 2	15.04.2014 - 25.05.2018
Phase 3	28.05.2018 - 30.03.2022

The results of all sub-sample periods are presented in Table 4.4 to Table 4.6. We can observe that different periods provide vary in results which phase 1 shows the highest total spillover index of 55.5% followed by phase 3 at 53.5% and phase 2 at 47.3%. The result indicates that the effect during phase 1 which cover many major economic events such as European sovereign debt crisis, late U.S. subprime crisis and announcement of three rounds of quantitative easing implies to have more influence on spillover to this system than the effect during COVID-19 pandemic in phase 3 and Brexit and European crisis in phase 2. In line with full-sample result, U.S. Stock market

is clearly a key contributor in this entire system as it dominates over other markets for all the sub-sample periods while Hong Kong stock market keeps strong influence as a main net contribution for phase 1 and phase 2 but lower contribution in phase 3. On the other hand, Japan maintains as a major net receiver for both stock market and sovereign CDS as well as China stock market despite major events of quantitative and qualitative monetary easing announcement from Bank of Japan during phase 1 and China stock market crash in phase 2 sample period. In the first phase, the spillover contribution is mainly led by the stock market while sovereign CDS markets increase contribution in second and third phase leading by China, South Korea and Malaysia but mainly contribute within sovereign CDS market. In contrast to full-sample result, commodity market of Oil market turns to be net contribution in first and second phase consistent with the record of sharp drop of oil price during 2008 financial crisis due to diminishing demand and purchasing power that oil prices fell 70% in less than a year and plunge again after mid-2014 to 2016 almost 60%. Apparently, U.S. stock market always be dominant contributor in every phase similar to the result from **Sun et al. (2020)** while the major sovereign CDS countries show increasing trend of contribution in phase 2 and 3 especially Malaysia. Furthermore, commodity market particularly contributes to the system in major oil events during phase 1 and phase 2.

Table 4.3: Spillover table phase 1 (03.11.2008 – 14.04.2014): Total spillover index = 55.49%

	From (j)																		
To (i)	**CDS_J**	**CDS_C**	**CDS_K**	**CDS_T**	**CDS_H**	**CDS_M**	**CDS_I**	**CDS_U**	**Stock_J**	**Stock_C**	**Stock_K**	**Stock_T**	**Stock_H**	**Stock_M**	**Stock_I**	**Stock_U**	**Oil**	**Gold**	**Contribution from others**
CDS_J	78.35	2.65	2.21	1.88	1.44	2.43	1.89	0.65	1.49	0.27	0.42	0.51	0.75	0.58	0.48	2.70	0.70	0.60	21.65
CDS_C	1.03	23.09	14.81	11.39	1.83	12.19	10.23	1.56	1.82	0.88	1.71	1.87	3.48	1.11	2.89	7.85	1.56	0.71	76.91
CDS_K	0.81	14.30	22.10	10.99	1.65	12.30	11.01	1.56	1.85	0.89	1.94	1.98	3.62	1.36	3.20	8.14	1.81	0.48	77.90
CDS_T	0.77	12.12	11.99	23.72	1.77	12.80	9.52	1.63	1.59	0.95	1.68	3.00	3.46	1.36	3.65	7.40	2.01	0.58	76.28
CDS_H	0.71	5.00	4.71	4.37	60.35	4.93	3.43	1.69	0.75	0.38	1.52	1.13	1.51	0.71	1.10	3.76	2.62	1.33	39.65
CDS_M	0.92	12.12	12.44	12.07	1.85	21.93	10.34	1.36	1.29	0.74	1.95	2.35	3.69	1.78	3.35	8.88	2.25	0.70	78.07
CDS_I	0.79	11.35	12.53	10.02	1.59	11.34	25.14	1.39	1.07	0.96	2.07	2.18	3.91	1.68	5.00	6.97	1.18	0.85	74.86
CDS_U	0.58	2.28	1.76	2.09	1.92	1.48	1.42	74.05	1.02	0.31	0.67	1.33	1.56	1.42	2.24	3.61	1.82	0.46	25.95
Stock_J	1.16	3.26	3.30	2.68	0.63	2.29	2.00	1.52	39.56	1.49	7.52	2.74	6.54	3.65	3.19	14.90	3.06	0.52	60.44
Stock_C	0.14	1.63	1.81	1.80	0.31	1.43	2.55	0.33	2.63	53.40	5.10	2.81	14.35	3.00	3.21	2.30	2.09	1.11	46.60
Stock_K	0.19	2.35	2.41	1.82	0.52	2.36	2.86	0.66	6.91	3.37	35.78	3.94	12.24	4.51	5.39	11.18	2.45	1.06	64.22
Stock_T	0.25	2.85	2.77	3.35	0.38	2.81	3.02	0.86	2.92	2.34	4.35	40.89	8.94	5.37	8.93	6.49	2.20	1.30	59.11
Stock_H	0.27	3.05	3.23	2.49	0.29	3.11	3.37	0.72	4.35	7.38	9.49	5.98	27.97	5.43	7.01	11.38	3.02	1.46	72.03
Stock_M	0.46	1.77	2.23	2.13	0.25	2.17	2.78	1.00	3.42	2.39	5.38	6.07	8.53	40.76	8.62	8.41	3.01	0.62	59.24
Stock_I	0.40	3.70	4.00	3.89	0.31	3.58	5.06	1.29	3.22	2.15	5.09	7.46	8.87	6.68	35.17	6.50	2.07	0.59	64.83
Stock_U	0.20	1.99	1.98	1.69	0.12	1.29	1.80	1.91	2.48	1.21	5.97	3.58	5.66	3.10	2.40	55.61	8.03	0.98	44.39
Oil	0.29	0.84	0.85	1.06	0.24	0.66	0.95	1.10	0.59	2.10	2.63	2.34	4.96	2.11	1.87	9.31	65.99	2.09	34.01
Gold	0.33	1.29	1.03	1.16	1.72	1.86	1.98	0.32	0.26	1.04	1.10	2.47	2.97	0.59	0.92	0.73	2.87	77.36	22.64
Contribution to other	9.29	82.56	84.04	74.88	16.82	79.04	74.21	19.52	37.65	28.85	58.57	51.73	95.04	44.42	63.45	120.49	42.74	15.44	**55.49%**
Net contribution/ (receive)	-12.36	5.66	6.15	-1.40	-22.82	0.97	-0.65	-6.43	-22.79	-17.75	-5.65	-7.37	23.01	-14.82	-1.39	76.10	8.74	-7.20	**Total spillover index**

Table 4.4 Spillover table phase 2 (15.04.2014 – 25.05.2018): Total spillover index = 47.32%

	From (j)																		
To (i)	**CDS_J**	**CDS_C**	**CDS_K**	**CDS_T**	**CDS_H**	**CDS_M**	**CDS_I**	**CDS_U**	**Stock_J**	**Stock_C**	**Stock_K**	**Stock_T**	**Stock_H**	**Stock_M**	**Stock_I**	**Stock_U**	**Oil**	**Gold**	**Contribution from others**
CDS_J	73.17	1.71	2.27	2.30	0.85	1.76	0.84	1.45	2.71	0.62	1.50	1.36	1.51	0.68	0.61	5.01	0.97	0.68	26.83
CDS_C	0.56	26.41	15.02	12.74	0.78	14.16	5.26	0.39	1.91	0.76	2.18	1.96	4.59	2.08	1.79	7.91	1.29	0.19	73.59
CDS_K	0.86	15.95	27.58	10.96	0.30	12.37	5.25	0.35	2.73	0.80	3.51	1.41	5.08	1.87	1.77	7.63	1.48	0.11	72.42
CDS_T	1.13	14.51	11.95	29.13	0.98	13.35	5.33	0.48	1.17	0.55	2.08	2.65	3.21	2.33	2.33	6.68	1.99	0.15	70.87
CDS_H	0.80	2.33	0.95	2.70	80.78	4.41	1.08	0.49	0.47	0.72	0.43	0.68	0.68	0.45	0.56	1.23	0.74	0.50	19.22
CDS_M	0.65	15.28	12.81	12.88	1.46	28.70	5.84	0.30	1.25	0.77	1.92	1.97	4.22	2.46	2.32	5.20	1.85	0.14	71.30
CDS_I	1.05	8.21	8.06	7.31	0.38	8.61	50.57	0.75	0.63	0.25	1.18	1.64	1.71	1.50	1.71	4.42	1.57	0.44	49.43
CDS_U	0.74	1.69	0.83	1.71	0.21	1.00	2.22	86.60	0.45	0.26	0.72	0.29	0.61	0.70	0.39	0.65	0.41	0.52	13.40
Stock_J	2.04	3.33	4.34	2.07	0.21	2.27	0.72	0.52	42.50	1.95	7.30	2.84	6.12	2.44	0.99	13.95	2.07	4.34	57.50
Stock_C	0.40	1.55	1.61	1.11	0.54	1.45	0.22	0.16	1.61	62.80	2.16	2.03	17.59	0.30	1.40	4.14	0.76	0.15	37.20
Stock_K	0.47	3.31	5.04	3.04	0.33	2.97	1.30	0.38	7.20	1.19	42.15	3.73	10.09	4.51	3.27	8.64	1.79	0.60	57.85
Stock_T	0.30	3.12	2.40	3.36	0.42	3.19	1.63	0.27	2.36	1.79	4.45	51.87	6.43	5.35	4.92	6.22	1.57	0.34	48.13
Stock_H	0.36	5.50	5.75	3.65	0.11	5.01	1.24	0.25	4.16	9.59	8.16	4.34	33.88	4.25	2.86	8.19	2.42	0.27	66.12
Stock_M	0.14	3.63	3.06	3.19	0.36	4.04	1.91	0.26	2.97	0.65	5.03	4.74	5.53	46.98	6.34	8.09	2.91	0.16	53.02
Stock_I	0.49	2.90	2.91	3.20	0.07	4.73	1.96	0.04	0.84	1.04	4.62	5.29	4.13	7.38	51.77	6.63	1.49	0.49	48.23
Stock_U	1.20	3.66	3.18	2.79	0.20	2.13	0.91	0.60	3.22	1.91	4.33	4.43	4.06	2.12	1.35	59.39	3.85	0.68	40.61
Oil	0.63	1.28	1.59	1.38	0.54	2.65	0.29	0.39	0.60	0.42	1.78	1.81	2.68	1.31	0.74	6.26	75.41	0.22	24.59
Gold	0.82	0.37	0.80	0.62	0.46	0.44	0.66	0.67	7.29	0.71	1.87	0.96	1.58	0.19	1.47	1.79	0.82	78.47	21.53
Contribution to other	12.64	88.33	82.60	75.02	8.19	84.54	36.64	7.76	41.58	23.99	53.22	42.12	79.83	39.92	34.83	102.65	27.97	10.00	**47.32%**
Net contribution/ (receive)	-14.19	14.75	10.18	4.15	-11.03	13.23	-12.78	-5.64	-15.92	-13.21	-4.62	-6.01	13.71	-13.09	-13.40	62.04	3.38	-11.53	**Total spillover index**

Table 4.5: Spillover table phase 3 (28.05.2018 – 30.03.2022): Total spillover index = 53.46%

	From (j)																		
To (i)	**CDS_J**	**CDS_C**	**CDS_K**	**CDS_T**	**CDS_H**	**CDS_M**	**CDS_I**	**CDS_U**	**Stock_J**	**Stock_C**	**Stock_K**	**Stock_T**	**Stock_H**	**Stock_M**	**Stock_I**	**Stock_U**	**Oil**	**Gold**	**Contribution from others**
CDS_J	75.68	2.29	2.44	2.77	0.11	4.03	1.13	0.58	1.23	0.36	0.73	1.67	0.96	1.02	1.14	2.04	1.55	0.27	24.32
CDS_C	0.69	26.20	15.36	10.31	0.69	13.66	6.25	0.23	3.31	2.34	3.26	3.23	4.46	0.97	1.27	6.57	1.02	0.19	73.80
CDS_K	0.61	14.60	24.58	11.74	0.67	12.11	5.69	0.05	4.09	1.73	4.45	3.85	3.60	1.83	1.12	7.00	1.83	0.47	75.42
CDS_T	1.07	11.14	13.82	26.97	0.89	11.72	6.92	0.23	3.36	1.42	3.31	3.02	2.73	0.70	1.44	8.30	2.40	0.56	73.03
CDS_H	0.22	2.32	2.13	3.01	85.33	1.79	1.13	0.28	0.48	0.64	0.44	0.43	0.54	0.40	0.15	0.28	0.15	0.28	14.67
CDS_M	0.55	13.25	11.72	8.63	0.49	23.07	8.47	0.18	4.28	1.99	3.88	4.32	4.07	1.73	2.49	7.95	2.54	0.41	76.93
CDS_I	0.35	9.07	8.86	7.50	0.44	12.86	35.69	0.22	2.54	1.13	2.82	2.68	3.56	1.15	2.93	5.97	1.91	0.35	64.31
CDS_U	1.00	1.51	0.49	1.17	0.74	1.11	0.65	85.20	1.30	0.71	0.69	0.65	1.06	1.12	0.72	0.49	0.54	0.85	14.80
Stock_J	0.49	4.66	5.14	2.27	0.19	6.41	2.28	0.25	35.23	3.23	10.46	4.20	6.47	2.01	1.39	12.30	2.56	0.47	64.77
Stock_C	0.19	3.74	2.95	2.13	0.29	4.14	1.48	0.12	4.07	44.56	6.18	3.05	18.00	1.58	2.17	3.46	1.29	0.61	55.44
Stock_K	0.28	3.95	4.82	3.02	0.13	6.03	2.61	0.12	8.77	4.45	30.18	6.87	10.14	4.50	4.30	7.14	2.02	0.67	69.82
Stock_T	0.43	4.61	4.70	2.83	0.28	7.02	3.47	0.17	2.73	2.22	6.17	37.68	5.30	6.10	4.42	8.12	2.98	0.77	62.32
Stock_H	0.55	5.06	4.28	2.54	0.21	5.51	3.14	0.14	5.56	12.24	10.31	5.51	31.00	4.21	3.33	4.80	1.16	0.43	69.00
Stock_M	0.95	2.72	4.10	1.46	0.24	4.72	2.16	0.16	3.31	1.41	6.03	9.46	5.84	43.07	5.65	5.89	2.00	0.82	56.93
Stock_I	0.41	2.71	3.33	2.92	0.31	6.18	3.20	0.33	2.57	2.29	6.50	6.58	4.65	5.99	43.40	6.07	1.91	0.66	56.60
Stock_U	0.94	3.47	5.55	4.12	0.09	7.15	2.84	0.21	6.19	1.69	4.18	6.65	3.34	2.16	3.23	42.75	4.54	0.91	57.25
Oil	0.69	1.77	3.55	1.71	0.22	3.93	1.67	0.34	3.53	1.55	3.13	3.84	1.85	1.92	1.87	6.38	60.60	1.44	39.40
Gold	0.60	0.19	0.29	0.22	0.30	1.41	0.52	0.67	0.40	1.24	1.02	1.28	0.95	1.54	0.87	1.11	0.85	86.54	13.46
Contribution to other	10.01	87.04	93.54	68.35	6.27	109.78	53.59	4.29	57.71	40.61	73.56	67.27	77.51	38.94	38.49	93.86	31.25	10.16	**53.46%**
Net contribution/ (receive)	-14.31	13.24	18.12	-4.67	-8.40	32.85	-10.71	-10.51	-7.06	-14.83	3.74	4.95	8.52	-17.99	-18.11	36.61	-8.15	-3.30	**Total spillover index**

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

Considering that the global financial system is highly interconnected and interdependent in which different asset markets are closely linked together. As well as the sovereign CDS market that has been expanding ever since 2008 global financial crisis, it is interesting to understand how sovereign CDS market links to main financial market of stock market and commodity market in term of spillover. By understanding this connectedness, it will benefit for the investors to apply in their investment strategies of asset allocation and risk management in different situations.

The scope of this paper specifically studies on the interconnection among sovereign CDS, Stock market and commodity market by focusing on some countries in Asia since past literatures were focus in more advanced economies in Europe and America but very limited in Asia to combine all these three markets altogether as a single system. The following insights are obtained during our study.

First, the stock market of U.S. dominates over stock market and sovereign CDS market in other countries and commodity market in every phase while stock market of developed countries like Japan and South Korea holds less contribution to the system but instead influence from advance economies of Hong Kong stock market.

Second, the main contributor in sovereign CDS are major Asian countries; China, South Korea and Malaysia as exception in which most contribution remain within sovereign CDS market. Interestingly, Japan sovereign CDS remains as large net receiver similar to Japan stock market. Moreover, the countries with large contribution in sovereign CDS market conversely has limited contribution in stock market. Gold market is the least contributor from commodity market. In term of commodity markets, they have higher influence in stock market compared to Sovereign CDS while stock market gives more contribution to changes of sovereign CDS compared to the return of commodity markets. While sovereign CDS holds larger influence to stock market relative to commodity market.

Finally, the spillover index of the sovereign CDS-stock market-commodity market system varied through time as influenced by the major economic events during

the certain periods. Despite the fact that stock market dominates the system in every phase for U.S., the sovereign CDS and commodity market particularly contribute to the system during phase 3 for sovereign CDS and phase 1 for commodity market.

These findings are potentially useful to individual investors and financial institutions to appropriately manage risk of their portfolio with various asset allocation in different kinds of situations including financial crisis.

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APPENDIX

APPENDIX A

Figures and Tables

Figure A.1

Total spillover index (120-day rolling windows, 10-step Horizon)

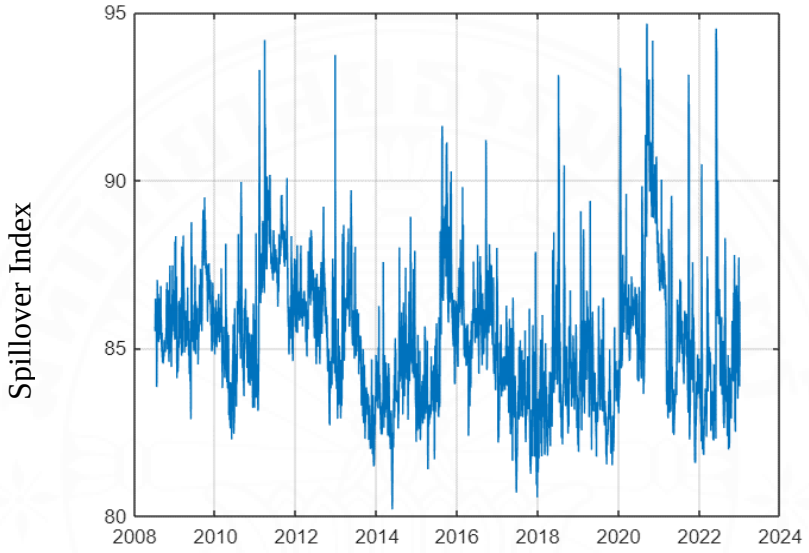


Figure A.2

Total spillover index (120-day rolling windows, 15-step Horizon)

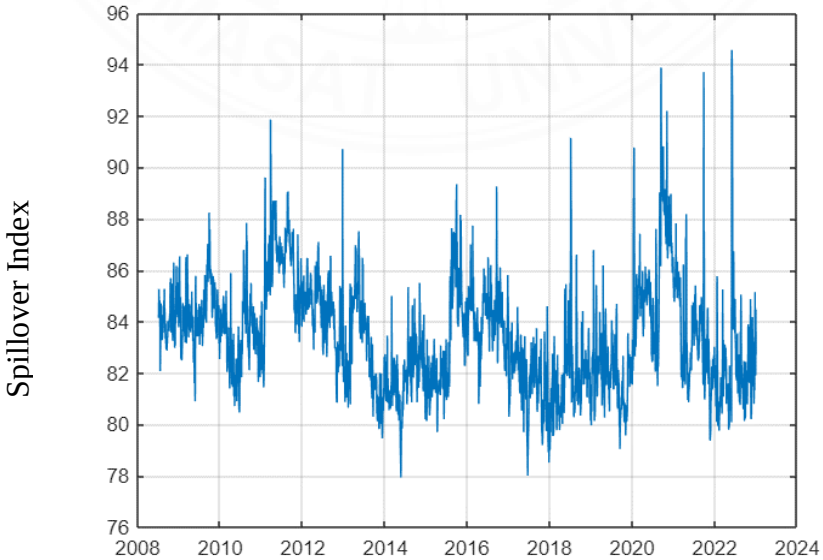
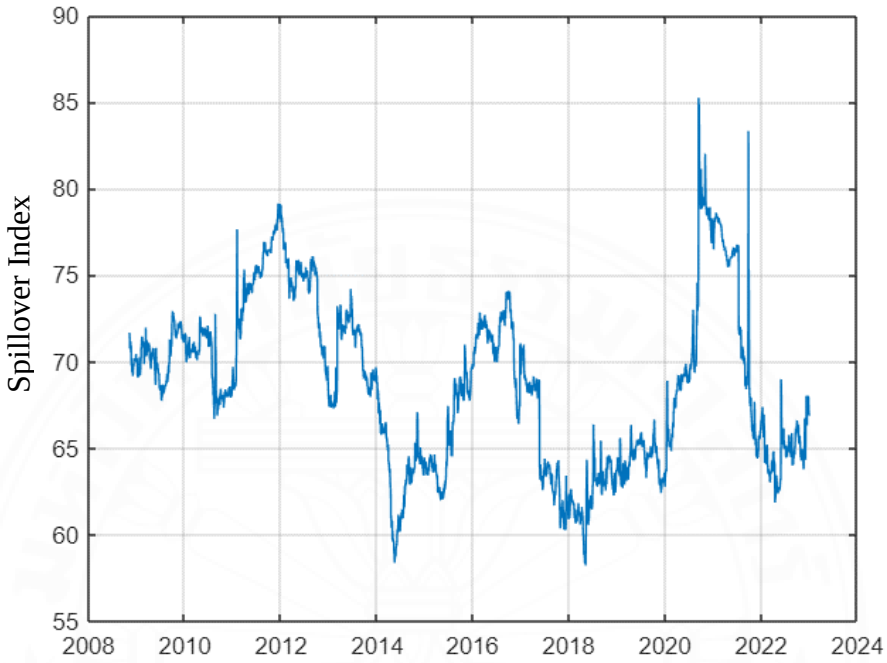


Figure A.3

Total spillover index (200-day rolling windows, 15-step Horizon)



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