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MASTER'S DEGREE PROGRAMME SECOND CYCLE IN ECONOMICS AND FINANCE

FINAL THESIS

THE CREDIT DEFAULTS SWAPS

A CASE STUDY FOR SOUTHEAST ASIA: THE RELATIONSHIP BETWEEN THE SOVEREIGN CDS AND THE STOCK INDEXES

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This thesis marks the success of my two years of master's degree in Economic and Finance at Ca'Foscari University of Venice and the ending of a profound, meaningful and encouraging journey. Due to the impact of the covid-19 pandemic, I could not defend my thesis in person nor attend the graduation ceremony at Ca'Foscari University and this is the thing that I regret the most. However, the period of preparing and writing the thesis was really meaningful and memorable to me.

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LIST OF ABBREVIATIONS

CDS	*Credit Default Swap*
LIBOR	*London Inter-Bank Offered Rate*
LCDS	*Loan-only Credit Default Swap*
ABCDS	*Asset-backed Credit Default Swap*
ASW	*Asset Swap Spread*
CCP	*Central counterparties*

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INTRODUCTION

Credit Default Swaps (CDS) have grown to be a multi-trillion-dollar, global essential market and there is tremendous academic literature on CDS developed in parallel with market practioners, public debates, and regulatory initiatives in this market. It is inevitable to note that there exists apparent relationship between CDS and other financial instruments such as: corporate bonds; sovereign bonds; corporate shares and the stock indexes, especially after the Economic crisis in the period 2007-2008, these relationships are state dependent. In this thesis, we will examine the lead-lag relationship between the sovereign Credit Default Swaps (CDS) and the stock markets for five Asian countries during the period 2016-2020. These five countries are Japan; Korea; Thailand; Indonesia and Philippines.

The first chapter will set the basic for the entire work by reviewing the literature about CDS and provide an overview of the universe of CDS products, their characteristics and the aggregate activities in the CDS market.

In the second chapter, we will examine the relationship between the equity, options, and corporate bonds with CDS markets. To be specific, we will demonstrate the arbitrage relationship between CDS and the underlying bond markets; focus on the effects of initiating CDS to the yield spreads of the corporate bonds market. Furthermore, we will also provide the evidence of the relationship between the equity and CDS market and the arbitrage opportunities between the credit and equity markets.

In the third chapter, we will point out the major differences between the sovereign CDS and the corporate CDS; the market participants and the trading activity on sovereign CDS markets. The second objective is to determine the determinants which affect the sovereign CDS market such as: global factors; local financial risk factor, etc. We will also discuss the danger of contagion and spillover during the financial and sovereign debt crisis, especially during the period of covid-19 pandemic. Last but not least, we will discuss the liquidity in the sovereign CDS market; the determinants which affect the CDS-bond basis and the impacts of sovereign CDS on the public bonds.

In the final chapter, we will analyze the lead-lag relationship between the sovereign CDS market and the stock market by running a VAR model. Furthermore, we will also a run 3-dimension VAR model by including the third variable – the historical stock volatility measured within 100 trading days in order to handle with the omitted variables issue. Finally, we will test for the differences in behavior between countries with lower credit quality and countries with higher credit quality by analyzing panel VAR model.

CHAPTER 1: Overview of CDS products and market Activity

A Credit Default Swap (CDS) is defined as a credit derivative contract in which a particular sovereign or company entity provides protection against a default and other risks for the buyer (Hull et al., 2004). In simple terms, a CDS is a bilateral agreement between two parties to swap the credit risk from one to other references (Chan-Lau and Kim, 2004).

In this transaction, the protection buyer will pay a periodical fee to the seller of protection; in return, the seller agrees that if there is the occurrence of defaults or credit events from the debt issuer during the term of contract, the seller will pay all premiums and interest to the buyer (Chan-Lau and Kim, 2004). The periodical fee, typically, is indicated in basis points per notional amount of CDS contract, and referred to a CDS spread or CDS premium. The credit event can be defined by the counterparties in the contract; commonly, it is a credit downgrade, insolvency, bankruptcy or inability of reference entity to make timely payment as defined by ISDA.

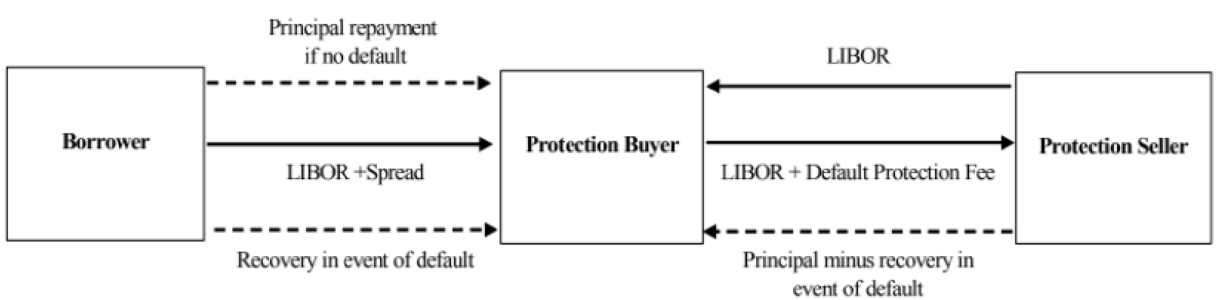

Figure 1.1: *Credit Default Swap (Source: Chan-Lau and Kim, 2004)*

In this chapter, we will present an overview of the universe of CDS products, their characteristic and the aggregate activities in the CDS market.

1.1 Primary CDS products types

There are many research studying on product forms of CDS, which indicate that CDS can take a variety of types based on the underlying reference entity and any other contractual definitions (Angelini, 2012; Amato & Gyntelberg, 2005).

From the perspective that CDS products are categorized depending on the sources of credit risks which derive the value and cash flow of CDS, there are 3 major forms of CDS, including single-name CDS (the most common type of CDS), multi-name CDS and asset-backed CDS (Culp et al., 2018).

1.1.1 Single-name CDSs

A single-name CDS is the most common form of CDS, which has market value and cash flows determined by the creditworthiness of a specific single underlying reference entity (or a "reference name") (Culp et al., 2018, p.3). This reference entity is referred to the borrower of bank loans or individual debt securities issuers who brings at least several credit exposures to the lender, such as the risk of failure to make payment for principle payment or required interest.

There are many different types of reference entities in single-name CDSs, in which the most prominent ones are sovereigns and private (both non-financial and financial) corporations. Otherwise, reference entity in single-name CDSs can also be state-owned enterprises (SOEs), municipals and other specific debt securities issuers.

The obligations of reference entities in single-name CDSs can be according to a specific set of loans underlying a given single-name CDS (called loan-only CDS or LCDS), or debt securities issued by a reference entity.

1.1.2 Multiple-name CDSs

Different from single-name CDS, multi-name CDS is referred to derivative contracts that has market value and cash flows derived from the credit quality of portfolios of underlying references name (more than one entities) (Angelini, 2012, p.885). Generally, multi-name CDS can be categorized as index CDS or basket/portfolio CDS. In term of index CDS, it can be classified as two different types, based on tranched portfolio exposures or on the whole portfolio.

1.1.2.1 Portfolio and Basket CDSs

A Portfolio or basket CDS is the most basic type of a multi-name CDS universe, which protects the protection buyer against credit risks from the default of any or all reference name in the underlying portfolio (Culp et al., 2018, p.4). In simple terms, the protection purchaser will be offered a payoff whenever any or all reference entities in the portfolio witness a credit shock.

It can be very expensive if the protection buyer purchases full credit protection on all reference entities in the underlying reference portfolio. From the perspectives of correlation traders or risk managers, one avenue to decrease the CDS protection cost is to limit credit risk scenarios of the reference portfolios. As a result, a basket CDS is preferable where the protection purchaser buys protection for a subset of entities in portfolio rather than for the all names in reference portfolio. The counterparties will agree on a basket of protection for which the CDS premium is paid to the protection seller, and each reference entity has a specific notional amount in the basket. Amid the term of contract, if any of the reference names witness a credit event, the affected entities will be removed from the basket and the protection buyer will be paid a payoff with a value of the pre-specified notional amount. The remaining entities in the basket are still covered until the original maturity date.

Basket CDS is generally categorized as first-to-default, n-out-of-m-to-default, nth-to-default and all-to-default (Umeorah et al., 2020). One of the most popular structure of basket CDS is nth-to-default or first-to-default, in which the protection seller experience a limited downside risks when the credit protection buyer receives payoff (by cash or physical settlement) based on the circumstance of the nth-credit event in the chosen reference name basket.

1.1.2.2 Index CDSs

In index CDS, the market value and the cash flow are linked to the creditworthiness of a portfolio of multiple reference names (or an index) that meet a standard basis defined by the index provider (Boyarchenko et al., 2019, p.4). Cash flows of an index CDS may be according to the total amount of an index or the index value over a particular range of loss in index value. In index CDS, instead of using the underlying debt liabilities of the underlying reference names in the reference portfolios to calculate index value, index value is based on single-names CDS spread for the reference names in the index.

In a whole-portfolio or a traditional index CDS, the protection buyers will pay a periodical fee to the protection sellers in exchange of a contingent payment if one or more reference entities experience credit events, leading to the reduction in the underlying index value. The payment will be expressed as basis points of the decreased index value.

For example, assume an index CDS is according to the values of 100 difference reference entities of issued by senior debt securities, and each of those reference names issues single class of bonds with value of $500. Otherwise, the initial index value is supposed to be 100. So, based on that index value, the notional amount of the index CDS will equal $50,000, and the cash flows of the index CDS is derived from $500 multiplier. Under index CDS, the protection buyer will receive $500 for each one-point decrease in the CDS index, and the maximum premium payment to cover credit losses on that index CDS will be $50,000 if there is no actual recovery of all underlying bonds.

1.1.2.3 Tranched Index CDSs

As mentioned above, index CDS can be classified based on the whole portfolio CDS or tranched portfolio exposure. Rather than buying protection based on specific index, in tranched index CDS, the protection buyer is allowed to purchase protection against risks of credit events on specific tranches (or "slices") of the underlying index (Boyarchenko et al., 2019, p.6). These tranches provides opportunities for investors to gain exposure to specific segment of the credit loss distribution of CDS index. Each tranche will have different sensitivity towards default loss correlations among underlying names. Tranches, as a result, can be defined in terms of the cumulative loss segment value or the decrease amount of value in the reference portfolio and underlying index.

For example, suppose there are two tranches of the index CDS. The equity tranche, known as the lowest tranche, will absorb the first 15% of the index losses because of credit events. If credit events happen during the term of tranched CDS, the protection seller in the lowest tranche is responsible for paying protection purchaser an amount equal to the declines from credit events, and this amount is up to 15% of the total index. The second tranche absorbs the loss of 15-30% on the index. As a result, higher-ranked tranche is fully insulated and unaffected by the losses which are lower than 15% of the index but only experience the losses when the value of the index decreases more than 15%.

Therefore, protection sellers in tranched CDS have to bear different level of credit loss risks in different tranches (or slices). In return of bearing the risk, payment for investors is different for each tranche. The equity tranche investors who bear the higher risk of losses will receive an upfront payment (defined as a proportion of the original notional amount of the CDS portfolio) along with a running spread. In contrast, senior tranche investors receive only the CDS spread with no upfront payment (Amato and Gyntelberg, 2005).

1.1.3 Asset-backed CDSs

The third type of CDS products is the asset-backed CDS (ABCDS) which is distinct fundamentally from index, single-name and multi-name CDSs. While in single-name or multi-name, cash flows and market value are derived according to the credit quality of reference entities, the cash flows and value of an asset-backed CDS are indicated by the creditworthiness of a specific underlying security or asset. Asset-backed CDS allows organizations to buy and sell protection on the value and cash flow of specific securities or assets, which are prominently issued via a structured financing product (Culp et al., 2018, p.6).

This asset-backed CDS is insulated from other CDS product types in some essential aspects.

Firstly, asset-backed CDS is based on a specific asset's credit quality which is issued by a legal entity. Generally, this entity is a finite-lived "special purpose entity" (SPE), for example a corporation or trust with a tax-favored residence which is solely formed to facilitate a planned structured financing process.

Secondly, an asset-backed CDS typically allows for two-way payment between contract's counterparties because asset-backed CDS are generally based on often-complex cash flows of the underlying asset-backed securities. In certain circumstances, the protection sellers may receive a reimbursement from protection buyers if the market value or cash flows of the reference securities recovers after the initial decrease. This aspect is insulated from other CDS products types where the protection buyers only have to make payments for the CDS spread to purchase the protection against defaults.

Furthermore, in an asset-backed CDS, a credit event has a broader definition than in other CDS agreements. A credit event in a traditional CDS is generally referred to a once-time occurrence (such as bankruptcy, credit downgrade, insolvency, or failure of reference entity to make payment as schedule). On the contrary, there may be many different credit events during the term of contract. Credit events in asset-backed CDS, therefore, are referred to a one-time settlement rather than a one-time occurrence.

1.2 Aggregate Market Activity

Section 1.1 provides the fundamental definition and knowledge of various types of CDS. Meanwhile, this section will present the aggregate activities of these product forms of CDS in the markets, including the notional amount outstanding of CDSs and their trading activity until the year of 2021.

1.2.1 CDSs notional amount outstanding

1.2.1.1 Single-name; Multi-name; Index CDSs

Figure 1.2 and 1.3 respectively show the quarterly CDS gross and net notional amounts outstanding of single-name and index CDS in the period of 2014–2019 reported by DTCC TIW Data.

As seen in Figure 1.2, the total CDS notional amounts outstanding obviously decreased by 53.9%, from $20.4 trillion in the first quarter of 2014 to $9.4 trillion in the second quarter of 2019. Therein, the decline from 2014 to 2016 contributed to a large proportion of total decline in notional outstanding of global CDS. Meanwhile, since the fourth quarter of 2016, total CDS (including single-name and index CDS) gross notional outstanding has remained flat at roughly $10 trillion, and at the end of 2019, equaled $9.4 trillion.

According to the data, the notional outstanding of both single-name and index CDS has been fairly constant since 2016, similar to the data trend of CDS market activities. Prior to the first quarter of 2017, single-name CDS accounted for the major part of gross notional amount outstanding (more than 50%). However, from 2017 to the end of second quarter of 2019, index CDS tended to account for the major proportion. Gross notional outstanding of index CDS was $5.8 trillion at the end of the second quarter of 2019, while the gross notional outstanding of single-name CDS was only $3.6 trillion.

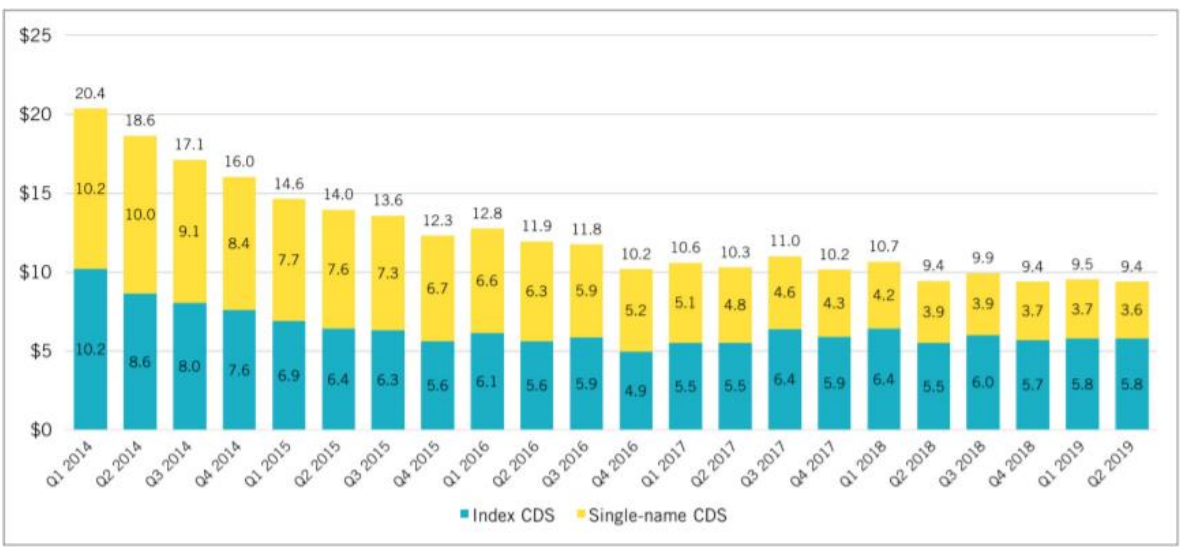

Figure 1.2: *CDS Gross Notional Outstanding (Unit: US$ Trillions)*

(Source: DTCC TIW Data as reported in ISDA report, 2019)

As figure 1.3 shows, the net notional outstanding of both index and single-name CDS has fluctuated between $1.4 trillion and $1.7 trillion from 2015. Different from the gross notional outstanding, the index CDS net notional amount was higher than single-name CDS outstanding for the whole period.

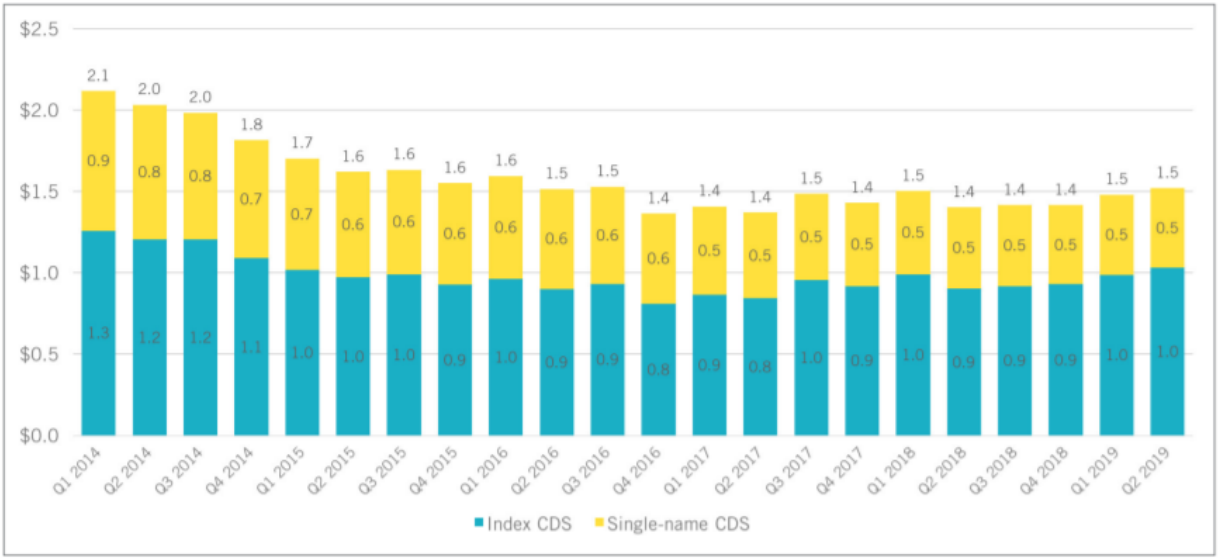

Figure 1.3: *CDS Net Notional Outstanding (Unit: US$ Trillions)*

(Source: DTCC TIW Data as refereed in ISDA report, 2019)

Figure 1.4 illustrates the CDS gross notional amounts outstanding by counterparty types (including central counterparties (CCPs), reporting dealers, and non-financial customers) from December 2018 to December 2020. Data shows that CCPs had the highest shares of total CDS gross notional outstanding and this share increased by 7% from 55% in 2018 to 62% in 2020.

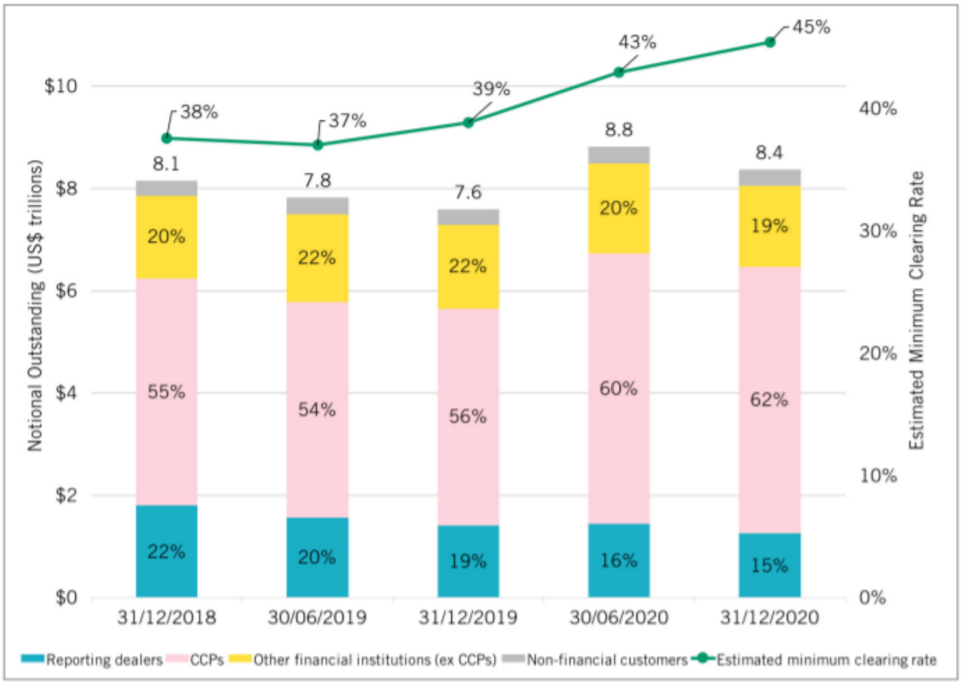

Figure 1.4: *CDS Gross Notional Outstanding by Counterparty Type*

(Source: BIS OTC Derivative Statistics)

1.2.1.2 Single-name Corporate and Sovereign CDSs

Figure 1.5 illustrates the composition of single-name CDS by reference entity types (including corporate and sovereign CDS) in the period of 2014 to 2021.

Sovereign and Corporate CDS contribute to the majority of single-name CDS activities. For comparison purposes note that, according to the BIS Derivatives Statistics, total notional amounts outstanding of global single-name CDS was about $3.44 trillion in the first half of 2021, with about $1 trillion in sovereign CDS and about $2.3 trillion of that in corporate CDS. Corporate CDS remained the largest proportion of single-name CDS during the period, accounted for about 69% on average.

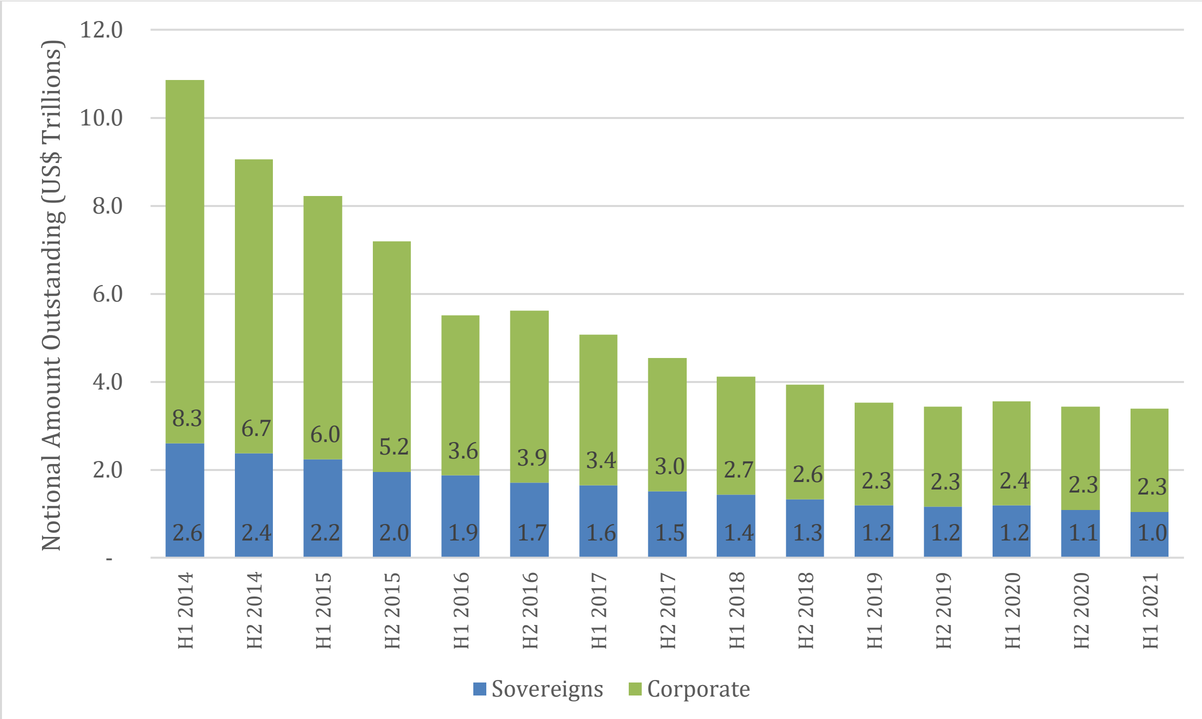

Figure 1.5: *Single-name CDS notional amount outstanding by Reference Entity Type (US$ trillions)*

(Source: BIS Derivatives Statistics)

It can be seen that both corporate and sovereign CDS declined significantly from 2014 to the first half of 2021. As section 1.2.1.1 illustrated the downward trend of global single-name CDS, corporate CDS accounted for a large share of this decrease in notional amount outstanding of single-name CDS from 2014 to the year end of 2017. However, both sovereign and company single-name CDS market activities have consistently flat since 2018. Notional amounts outstanding of sovereign single-name CDS was between $1 trillion and $1.4 trillion per semi-annum, while this amount of corporate single-name CDS was around $2.3 trillion and $2.7 trillion.

1.2.2 CDS trading activity

Notional amounts outstanding of CDS reflects the overall amount of protection bought and total amount of protection sold in aggregate respectively in the market on any particular date. Notional outstanding, however, does not demonstrate how "liquid" or "active" the market (based on different CDS products) has been. Therefore, to illustrate the CDS market liquidity and trading activity, the total number of transaction count per quarter of both index and single-name CDS from the first quarter of 2014 to the second quarter of 2019 was showed in Figure 1.6.

It is indicated that the total transaction counts of CDS declined significantly by roughly 57%, or put differently, the number of transactions decreased from total 545 thousands in the beginning of

2014 to 235 thousands in the second quarter of 2019. Both index and single-name CDS followed the downward trend of market data.

However, whereas total trade volumes of single-name CDS obviously reduced over the period, index CDS experienced less fluctuation in the number of transaction count. From 2014 to the first half of 2016, there was tremendous decline in the total number of transaction of single-name CDS. Since 2016, index CDS exceeded single-name CDS and accounted for the major number of trade volume in the market, with trading volume remaining flat between 135 thousands and 165 thousands till the second quarter of 2019 – equal to 54.3% of total market transaction counts on average.

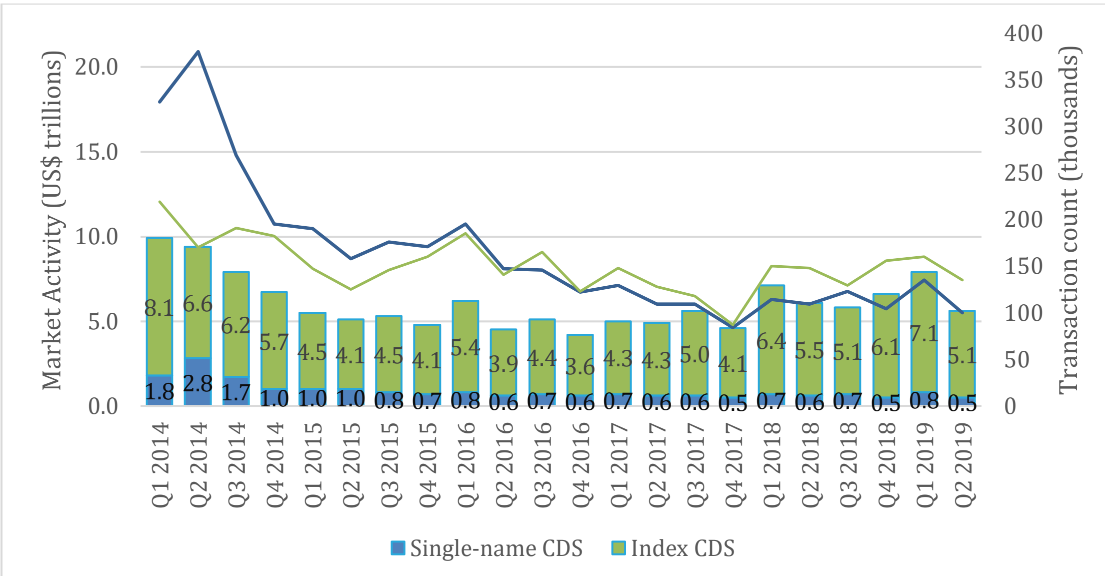

Figure 1.6: *CDS Market Activity and Transaction Count*

(Source: DTCC TIW data)

CHAPTER 2: CDSs and related markets

The introduction of CDS has facilitated alternative tools for derivatives market participants to hedge, invest, and speculate. Therefore, the creation of CDS trading may presumably have altered characteristics (such as liquidity of pricing, price discovery, or informational efficiency) of the related markets.

Thus, in this section, we will examine the relationship between the equity, options, and corporate bonds with CDS markets. To be specific, we will demonstrate the arbitrage relationship between CDS and the underlying bond markets; focus on the effects of initiating CDS to the yield spreads of the corporate bonds market. Regarding the equity markets, we will provide the evidence of the relationship between the equity and CDS market; the arbitrage opportunities between the credit and equity markets. Furthermore, we will provide evidence to show that options and CDS can be jointly priced and that the introduction of CDS may also have influence on the market efficiency, option price, and liquidity.

2.1 CDSs and corporate bonds

One of the most immediate instruments associated with CDS trading is the reference bond underlying the insurance product. This subsection aims to provide an overview of CDS bond and corporate bond basis (as known as the price relationship between corporate bonds and CDS). In the following, the effects of CDS on corporate bond markets will be discussed by reviewing both theoretical and empirical literature.

2.1.1 CDS bond basis

a. Fundamental of corporate bonds

A corporate bond is a financial instrument that a company issue to borrow debt capital, in return, the company is required to pay investors/bond purchasers coupon or interest periodically during a certain period of time and to repay the notional amounts at maturity date (Fabozzi 2010, p.1).

According to Fabozzi (2010), there are three major characteristics of corporate bonds, including maturity, notional value and coupon rate. The maturity describes the end of period of time during which the bond issuer must make periodic interest payments and fulfill other bond contract requirements. The term of notional value refers to the total amount which the issuer of the corporate bond is required to repay at the maturity date. Lastly, the coupon rate is the amount of periodic interest on the notional amount which corporate has to pay. In addition, put and call provisions, which grant the investors or issuers certain rights, are two embedded options that are occasionally utilized in corporate bond issuances. However, since the latter analysis will focus on straight bonds with no embedded options, detailed explanations of them will be omitted.

Credit risk and maturity can be used to distinguish corporate bonds. Regarding maturity, bonds with less than five-year maturity are viewed as short-term bonds, those with five to 12 year maturity are referred to as intermediate-term bonds, and if maturity is higher than 12 years, bonds are called long-term. In terms of credit risk, bonds are viewed as investment grade bonds if credit rating is BBB (medium credit quality) or higher, instead, those with credit rating of BB or lower are referred as non-investment grade, junk bonds or high-yield (Fabozzi, 2010, p.2-3). Commonly, credit risks for investing in corporate bonds refer to the uncertainty about the issuers' willingness or abilities to pay for the periodic coupon timely or repay the notional amounts at maturity (Widle and Colmant, 2015, p.4).

For further discussion of the relationship between CDS and corporate bonds markets, their common measures of corporate bonds (including yield to maturity, bond price, and yield spread) are presented in detail. First, the corporate bond price is derived by supply and demand. Theoretically, the bond price should be equal to the corporate bond value which is calculated by discounting the predicted corporate bond's cash flow, while taking into account some risk factors (such as credit risks, or liquidity risks) (Fabozzi, 2010, p.21). Second, the yield to maturity is referred to as the rate of return which investors will receive if they hold the bond to the maturity date; hence, discounting the predicted cash flow at the yield to maturity results in a value that equals the bond price (Fabozzi, 2010, p.39). In terms of yield spreads, it is reviewed as the differential amount between the yield to maturity of corporate bonds and a riskless investment, which is typically represented by government bonds or swap rates (Elton et al. 2001, p.251). According to Elton et al. (2001), there are different factors related to taxes and risk influencing yield spread. Market participants, however, often treat corporate bond yield spreads as if credit risks mainly reflect yield spreads, resulting in the distinction between high-yield and investment grade bonds. As a result, yield spreads are frequently referred to as credit spreads in order to simplify the terminology. In addition, credit risk is not only one of the major determinants of corporate bonds yield spreads, but also a driver of the changes in the credit derivatives market.

b. Arbitrage relationship between CDSs and corporate bonds

According to the fundamental of corporate bonds discussed above and CDS shown in chapter 1, credit risk is considered as the major factor which links CDS and corporate bonds. According to Wilde and Colmant (2015, p.10), the yield spread is widely believed to fully reflect the credit risk of a bond investment. When investing in corporate bonds or credit default swaps, there are obviously other risks to consider, such as liquidity risk, counterparty risks or interest rate risks. Short-selling constraints may also apply when trading CDS or corporate bonds. Abstracting from other risks or short-selling constraints, and assuming that yield spread reflects properly credit risk, these two debt instruments will have an arbitrage relationship. The CDS premium, thus, should be equal to the corporate bond yield spread. If this relationship does not prevail, yield and price can be put downward pressure by using a proper arbitrage strategy, eventually causing the equation to hold.

In case that CDS premium is lower than the yield spread on a specific corporate bond, market participants can exploit an arbitrage opportunity by selling a CDS and purchasing a riskless bond to take a short position in the bond and a synthetic long position. In the opposite case, when the CDS premium exceeds the yield spread on a certain corporate bond, market participants can take an arbitrage opportunity by purchasing a CDS and selling a riskless bond to take a synthetic short position on the bond. This strategy is referred as a negative basis trade (Oehmke and Zawadowski, 2014, p.4), and will be discussed further later in this subsection.

This arbitrage relationship between corporate bonds and CDS demonstrates the interdependence of these debt instruments. The establishment of a CDS market can benefit corporate debt issuers by reducing the yield spread on corporate bonds in the presence of arbitrageurs (Oehmke and Zawadowski, 2014, p.2). Researchers have done a range of in-depth analyses of the theoretical and empirical relationship between corporate bonds and CDS; the related literature review will be presented in detail in section 2.1.2 below.

c. Definition and determinants of CDS bond basis

The "basis" is a term used to describe the difference between CDS premium and bond spreads. The basis should be zero in a perfect market with no frictions, because otherwise there would be unexploited arbitrage opportunities (Duffie, 1999 as cited in De Wit, 2006).

More precisely, it can be seen in Figure 2.1 that investors can attain an entirely hedged position by purchasing CDS protection; entering into an asset swap, in which the fixed coupon of the bond is traded for a floating rate (spread + LIBOR) and into a leveraged long position in the underlying bond (utilizing it as collateral to obtain a close-to-LIBOR rate through the repo markets).

If the basis is negative (when the asset swap spread – ASW is higher than the CDS spread), a profitable arbitrage opportunity exists by using the investment strategy in Figure 2.1. Because the investors would pay the CDS spread and receive the ASW spread, they can earn a risk-free return through a fully leveraged position. On the other hand, if the basis is positive (it means that the ASW is lower than the CDS spread), the same result would be obtained by short selling the underlying bond and selling the CDS through a reverse repo, in which bonds are borrowed and the short sale proceeds are invested at the LIBOR. All the investment strategy from Figure 2.1, in this case, would be in reversed flow, so that investors can receive the CDS spread and pay the ASW spread.

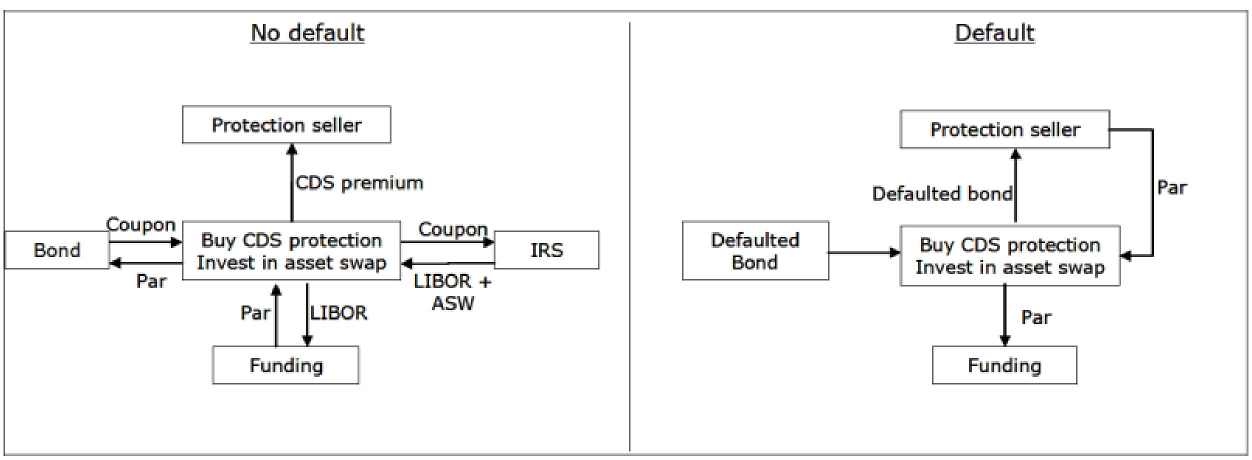

Figure 2.1: *Theoretical no-arbitrage relationship between corporate bonds and CDS*

(Source: Duffie, 1999 as cited in De Wit, 2006)

There are several reasons that explain why the basis is not zero in real life, relating mostly to technical factors, to counterparty risk, and to frictions in the repo.

Regarding to technical factors, there are at least two considerations implying the discrepancy of the cash flows in Figure 2.1. Firstly, due to the introduction of the standardization of CDS premium and the new ISDA protocol in 2009, advanced payment is required to purchase protection. Secondly, because a haircut is frequently requested in order to create a leveraged long position on the bond, the nominal amount of the CDS/bond position is lower than the nominal amount of the funding via repo.

The basis can be either negative or positive due to the effect of frictions in the repo market. A common example of positive basis is that when CDS price cannot be negative (since no protection seller would accept negative premiums), the ASW spread for top rated entities (for instance AAA/Aaa names) is generally negative (since LIBOR rates are often relevant to AA-/Aa3 institutions in the interbank lending market). As described above, market participants should sell CDS and short sell the bonds to earn profit with such positive basis trades. Nevertheless, borrowing the underlying bond may be expensive or difficult due to the fact that supply of liquid and highly-rated bonds may be lower than the demand to borrow them (since those who owe such bonds might be prevented from giving collaterals due to the institutional and legal restrictions) (Duffie, 1996 as cited in De Wit, 2006). These types of frictions would result in the lower-than-LIBOR repo rate (referred to as "special" repo rate), and even if the basis is positive, the arbitrage may not create a profitable opportunity.

Otherwise, counterparty risk is also considered as an important driver of the CDS-bond basis, since it makes arbitrage not fully risk-free. Theoretically, although the protection buyer may lose a positive market value if the reference entity's credit quality has improved, his obligation to make payments is terminated if he defaults or misses a premium payment (also referred to as "close-out" or "default termination"). The counterparty risk of the protection seller, therefore, may be quite limited. Moreover, if the seller of protection defaults after the reference entity's credit event, the protection buyer is instead subjected to the gap between the recovery and the nominal value of the defaulted bonds. The buyer of protection, therefore, may request sufficient collateral. If we suppose that the protection buyer remains subjected to substantial counterparty risk, the return from the negative basis in the arbitrage may not be enough to offset the CDS transaction's counterparty risk. As a result, if all other factors are equal, a negative basis circumstance could be explained by the counterparty risk. Furthermore, because risk premium may change over time in response to the overall situation of the market, the counterparty risk may have a varying influence on the basis depending on market conditions.

There are many current research studying and confirming the arguments that the basis is influenced by the counterparty risk, flaws that make short selling or funding difficult or prohibitively expensive (funding risk). Arce et al. (2012), for instance, found that there are three majors affecting the basis, including financing costs, the counterparty risk, and the differential liquidity between CDS and bonds. Otherwise, Fontana and Scheicher (2010) illustrated that the sovereign entities' basis is impacted by not only the other global and country-specific risk factors, but also the cost of short selling bonds. Fontana (2009) and Bai and Collin-Dufresne (2009) stated a similar finding that the determinants of the basis for private entities are collateral quality, funding risk, and counterparty risk.

2.1.2 The effects of CDS on bond markets

With the initiation of CDS markets, investors in the fixed income market now have another option for trading credit risk. This, however, raises a question of whether and how the introduction of CDS trading influences on the underlying bond market. This subsection will provide the theoretical and empirical effects of CDs on corporate bond yield spreads by reviewing a variety of literature.

a. Effects leading to lower yield spreads on corporate bonds

Previous academic research on the interdependence between CDSs and corporate bonds has identified a number of avenues through which CDSs could have a beneficial effect on corporate bonds, resulting in decreased yield spreads.

First, Ashcraft and Santos (2009) point out the informational advantages which come along with the CDS market. When corporations issue a new bond, investors face the challenge to assess the corporates' credit risk in order to fairly price the bond. This problem arises from an asymmetric distribution of information between corporates and investors. It is costly for investors to gather information and assess credit risk, which results in an information premium charged by investors. Investors' ability to assess credit risk has been limited before the onset of CDS trading. The yield spread of corporate bonds, as discovered by Elton et al. (2001), contains other risks than credit risk and therefore cannot not be referred to as a clean measure of credit risk. Credit ratings, provided by private institution such as Moody's, Fitch or Standard & Poor's, have historically proven to have some shortcoming as mentioned by Dilly & Mählmann (2014). Adverse incentive schemes have led rating agencies to assign overly optimistic ratings and consequently lowering the quality of ratings. Thus, credit ratings provide investors with information about the credit risk of corporations, but entail some fundamental shortcoming, which compromises the quality of credit risk assessment. The onset of CDS trading has created a new source of information about credit risk. Since CDSs prices solely reflect credit risk, market participants have access to a relatively clean measure of credit risk of a specific reference entity as soon as a CDS is traded for this reference entity. The availability of new decision-relevant information reduces the severity of asymmetric distribution of information and could therefore lead to a reduction in information premium, which ultimately leads to lower yield spreads.

In addition, Duffee and Zhou (2001) highlight banks' potential benefits of CDS trading with regard to adverse selection problems when transferring credit risk. The argumentation of Duffee and Zhou (2001) is that banks possess private information about the credit quality of corporations with which they have lending relationships. When banks want to transfer credit risk to other investors, they face a "market for lemons" problem. This is because investors will assume that banks just want to lay off low-quality credit risk; hence banks willing to transfer high-quality credit risk will be forced to sell at lower prices. This problem might keep banks from transferring credit risk which inevitable creates inefficiencies. Duffee and Zhou (2001) further argued that banks' private information varies over time and are more valuable for long-term maturities. The reason for this argument is that revenues of new project financed with debt provided by banks will only realize in the distant future, whereas short-term revenues depend on existing projects which are more easily observable by all investors. Thus, banks' private information about short-term credit risk is not as valuable. By creating a way to solely transfer short-term credit risk, the "market for lemons" problem would be diminished and an efficient transfer of credit risk could be established. CDSs, which can be traded with different maturities, open up such a way. In consequence, banks enjoy benefits from CDS trading, which again might be passed on to corporate bonds resulting in lower yield spreads. Shim and Zhu (2010), empirically, found the similar outcomes for certain Asian markets, demonstrating how CDS reduced the costs of bond issuance, especially for smaller non-financial enterprises. It is stated that a reduction in the monitoring incentive by lending banks (who can use CDS to change their exposure, which could in turn impair the bondholder's pricing) may explain the adverse influence of CDS trading on credit spreads. This study showed different results from those focusing on the US market, because the Asian corporate bond market was underdeveloped when CDS started to trade, thus establishing a 'jump-start effect' of CDSs on the Asian bond market. The authors used a dataset covering 10 Asian economies over the period from 2003 to 2009. Shim and Zhu (2010) found a statistically and economically significant impact of CDS trading on yield spreads and liquidity. On average, the presence of CDSs lowers yield spreads by 18 basis points and bid-ask spreads by 2.1 basis points at issuance.

Moreover, it is argued that the introduction of the CDS market will increase credit supply. Hirtle (2009) highlighted that CDSs provide a way to separate funding of debt capital from taking on credit risk. Banks' ability to provide debt capital depends mainly on their capitalization and their ability to absorb risk. By engaging in lending activities banks will assume credit risk for which they need to hold costly regulatory capital which consequently limits their ability to supply credit. CDSs open up a way for banks to divest themselves of credit risk, reducing the need to hold regulatory capital and thus freeing up capacity to supply credit to firms. The ability to do so crucially depends on whether a CDS is traded on a specific reference entity or not. If a CDS is traded, banks can supply credit at lower cost, since they can avoid holding costly regulatory capital. Hirtle (2009) argued that these factors might lead to greater supply of credit in the market. Saretto and Tookes (2013) stressed this point by stating that if a market fragmentation exists between those who want to assume credit risk and those who want to provide debt capital, credit supply should increase following the introduction of CDSs. Furthermore, Saretto and Tookes (2013) added that banks are able to maintain client relationships in the form of continuing credit supply even if this means taking on more credit risk initially, because by purchasing CDSs those banks can reduce their credit risk exposure. Thus, both Hirtle (2009) and Saretto & Tookes (2013) argued that the onset of CDS trading will lead to higher credit supply. Assuming that the credit demand is not impacted by the onset of CDS trading, credit should be available at lower prices. Put differently, a higher supply of credit will result in lower yield spreads on corporate bonds.

b. Effects leading to higher yield spreads

First, in the context of the empty creditor problem, Bolton and Oehmke (2010) not only showed the upside of credit protection via CDS, but also shed light on the downside. Creditors with CDS holdings basically have two options. Those creditors either force firms into bankruptcy in order to capture the payoff of CDS contract or they agree to restructure in order to receive future cash flows from the restructured debt obligations. Nevertheless, Bolton and Oehmke (2010) showed in their analytical model that creditors will "over-insure" by buying CDSs excessively. Thus, ex-post over-insured creditors will never choose to renegotiate with borrowers and will always force firms into bankruptcy in order to trigger CDS payments, which are more valuable for them, although it is not a social optimum. Given these ex-post results, the onset of CDS trading might have an adverse effect on the cost of debt, because the risk of being forced into bankruptcy has increased. This might even lead to excessive risk-taking which again increases default risk. In consequence, yield spreads might increase after the onset of CDS trading.

Furthermore, Ashcraft and Santos (2009) highlighted the adverse effect of creditors' ability to lay off credit risk with regard to monitoring. Banks or other credit suppliers who have exposure to a borrower's credit risk have an incentive to monitor borrowers by reviewing information about borrowers' business results on a frequent basis. By doing so, the creditor has some control over repayment risk and can mitigate the probability of default. Ashcraft and Santos (2009) pointed out that creditors' ability to lay of credit risk by buying CDSs and the subsequent reduced exposure to the borrower obliterates the incentive to monitor. A reduced level of monitoring will increase the likelihood of borrowers' financial distress. The problem might become even more severe when borrowers anticipate the reduced monitoring efforts, which can lead to moral hazard and elevate the default probability. Thus, through this monitoring channel, the introduction of CDS contracts might have a negative impact on the cost of debt, leading to higher yield spreads.

Brancati and Macchiavelli (2014), additionally, indicated that new and more precise information about credit risk delivered by CDSs could trigger adverse effects. The authors argued that financial crisis occur through coordinated behavior of market participants. By coordinating their behavior, agents mutually attack an entity, may it be a corporation or any other market participant. If there is broad agreement about certain fundamental information, hence more precise information, agents are able to coordinate their behavior by anticipating each other's actions. In contrast, if information is dispersed, agents cannot clearly anticipate the behavior of others which puts a limit on their ability to coordinate. Thus, in a market with precise, consensual information, large scale attacks are more likely than in a market with dispersed information. Ashcraft and Santos (2009) have highlighted that CDSs deliver new and more precise information about an entities default risk; thus CDSs serve as an instrument to reduce information dispersion, which increases agents' ability to coordinate. Following Brancati and Macchiavelli (2014) reasoning, the introduction of CDS trading might lead to more broad scale attacks on corporations, which increases the likelihood of default. Thus, another channel through which the onset of CDS trading might lead to higher yield spreads has been detected.

Che and Rajiv (2010) suggested in their theoretical study that CDS could have negative externalities on credit supply. They specifically stated that people who are optimistic on a company's future can offer CDS protection instead of providing financing. The credit supply that falls as a result of CDS activities of absorbing collateral will encourage enterprises to choose the projects that are riskier. Therefore, the introduction of CDS trading may limit the corporations' ability to issue new bonds, and lead to higher credit spreads.

c. Conclusion

All in all, there are arguments that the onset of CDS trading might have positive as well as negative effects on yield spreads on corporate bonds. Mostly of arguments are based on theoretical researches, while which effect is dominating remains an empirical question.

2.2 CDS and the equity markets

The corporate capital structure is defined by the traditional Merton (1974) structural model as a series of contingent claims on a company's assets. Both equity and debt values are derived by the asset volatility, the value of firm's assets, and the risk-free borrowing rate. In other words, the same company-specific information is used to determine debt and equity pricing, and so returns. In the absence of any frictions, both equity and CDS market should be properly interconnected. Furthermore, there is a no-arbitrage pricing relationship between credit and equity spreads, which should also hypothetically apply to the CDS and equity spreads.

In this part, several literature will be reviewed to indicate both theoretical and empirical relationships between these two financial instruments. The literature will be divided into two main classes which study the capital structure arbitrage between CDS and equity markets as well as the information flow between the two markets. Furthermore, the last part of this section will provide a review of CDS trading effects on any externalities of equity market (including credit sharing, and the information spillovers).

2.2.1 Fundamentals of equity market

Before investigating the relationship between equity and CDS markets, it is essential to acknowledge the definition and characteristics of equity markets. According to Elton et al. (2007, p.7), equity is defined as a common stock that represents an ownership claim on a corporation's asset and earnings. After the debt claim owners have been paid, the firm's management can either reinvest part or all of the profits back into the business or distribute out the remaining profits as dividends to stockholders. This means that on the exchanges, the ownership claims are being traded. Limited liability is also a characteristic of equity. This means that if the underlying entity bankrupts, the investors only lose their initial investment, and creditors hence have no legal claims on them. Furthermore, an investor, by purchasing a share, will have voting rights (Elton et al., 2007, p.17).

Equity is not only used for investment, but also for speculation – the equity price is governed by demand and supply, and equity has a high level of volatility. Equity, therefore, is considered as a risky investment. Risk and future return expectations are the two elements that influence the price of equities. It is improbable that all investors have the same expectations, but if they did, there would be no need for equities trading. The average of all the information and expectations that investors have is the price of equity. As a result, market efficiency is critical since it determines how quickly information is integrated into the price of shares.

Many research has been studying about how the future price of equity is determined effectively (Elton et al., 2007, p.442), and a number of trading is motivated by the desire to earn a higher return than the average. The research have varied from developing a simple criteria for choosing the equities that will outperform the market to speculating on broad influences on equity prices (Elton et al., 2007, p.442). Investors will not be able to consistently choose "winners" if the market is efficient, but the hunt for an effective approach has occupied and continues to occupy thousands of people.

The drivers of a common share price are, in general, a function of the company's earnings, projected growth rate, cost of capital, risk and dividend. The issue occurs when the determinants must be identified and applied into a system that correctly values or selects equity using these concepts (Elton et al., 2007, p.442).

There are many different equity valuation models, but none of them has proven to be superior in the search for above-average performance. The impact of various models varies depending on the market's efficiency. There are two popular valuation models, namely the discounted cash flow model and Merton model. As for Merton model, the author described a model that employs share prices to estimate default probability based on market quotes, equity volatilities, and balance sheet data. This methodology allowed credit risk to be calculated on a daily basis, which is important for CDS pricing (Merton, 1974).

2.2.2 Information flow between CDS and equity markets

The CDS spread and equity price of a company are both vulnerable to fundamental events relating to the future cash flow information. Informed traders may opt to trade in solely one of these two forms of investment; meaning that in the market which is chosen for information-based trading, the price discovery will be earlier. A part of the literature which concerned with the relationship between CDS spreads and equity prices also studied about whether information is incorporated simultaneously in the equity and CDS markets. They found that there will be a lead/lag relationship between equity and CDS markets if information is embedded first into one of them. A lead/lag relationship refers to asymmetric information and can be used to determine the market inefficiencies. This type of relationship would be estimated because the two markets differ in liquidity, number of traders, age and organization. The results of empirical research concerning with the relationship between the equity and CDS markets are mixed.

One of the first research analysing the lead/lag relationship between bonds, equity and CDS is Longstaff's paper in 2011. He used a sample data of 67 single-name CDS corporations from March 2001 to October 2007 and demonstrated that there exists no definitive connection between those markets. In contrast, Lake and Apergis (2009) studied the equity market in Europe and the U.S. from 2004 to 2008; and by applying MVGARCH-M modelling, they discovered that equity prices were led by CDS spreads. In the same spirit, Hartmann (2008) found the same result by studying on 6-year graphical inspections data (from 2002 to 2008) in Europe and the U.S. The author, in addition, also demonstrated that under deteriorating conditions, equity prices were affected more strongly by CDS spreads. Using the data of cumulated abnormal relative changes of CDS spreads (CARC) and cumulative changes in rating adjusted CDS spreads (CCAS) in the U.S during 6 years from 1997, Zhang (2005) revealed that CDS markets led the equity markets. Chan et al. (2009) also concerned with the relationship between CDS spreads and equity prices but in the case of Asian markets. By applying VECM modelling to analyse data from seven countries in Asia, he found that while equity prices only led the CDS spreads in one among seven countries, CDS spreads led in five among seven countries.

Norden and Weber (2004) used a VAR model approach to analyse the individual CDS spreads, bond spreads, and equity prices of 58 global corporations from 2000 to 2002. They discovered that the relationship between these three markets was dependent on the underlying reference entities' credit quality. That is, whereas mutual feedback of information existed between high yield CDS spreads and equity prices, investment grade CDS spreads were led by equity prices. The authors also stated that the volatility of equity were led by the volatility of both investment grade and high yield CDS spreads, as well as that the volatility of equity provided additional feedback on high yield CDS spreads.

The equity and CDS market data of 79 companies in the U.S. from 2001 to 2004 were utilized by Acharya and Johnson's paper (2007) to discover that there was a negative effect of changes in CDS spreads on the prediction of stock returns. The flow of information from CDS markets to bond markets is limited to days with negative information and limited to enterprises which witness negative credit news. Furthermore, the authors also showed that there was higher intensity of information flow if companies have a larger number of relationships with banks. This evidence is interpreted by the authors to support insider trading in the CDS markets by banks that used private information derived from bank-lending relationships. They, however, found no evidence that the asymmetric information negatively impacts the equity market's liquidity or equity prices. The reason for this could be that the benefits of information-based trading in terms of liquidity provision outweighed the disadvantages from the informed traders. In a later paper, Acharya and Johnson (2010) discovered the existence of localized flow of information within markets. They found that the involvement of more insiders in a leveraged buyout led to a higher level of insider activities, if more equity participants in the lending syndicate were connected with higher level of suspicious option and stock activities.

Several studies have different findings compared to Acharya and Johnson (2007) that instead of CDS markets, informed investors chose to trade in the equity markets. For example, Hilscher et al. (2014) documented that the CDS markets were led by equity markets on a daily and weekly basis. They assumed there were factors affecting informed traders in selecting a market venue, including considerations of transaction costs, leverage, and price impacts. Based on this hypothesis, a separate equilibrium was predicted, in which informed investors predominantly traded in the equity markets due to the high bid-ask CDS spreads. On the other hand, liquidity traders, did trade in CDS markets. The authors also found that while credit returns can be predicted by equity returns on a daily and weekly basis, with a four-week time lag; equity returns cannot be estimated by credit returns. Such findings are related to regulatory suggestions, such as to prohibit naked corporate CDS trading. Furthermore, they discovered that the CDS spreads was slowly adjust after the information was released in the equity market. It means that there was a considerable delay in the adjustment of CDS spreads and this delay can be explained by the mispricing or transaction costs which were generated by the inattention of investors.

2.2.3 Arbitrage relationship between CDS and equity markets

As mentioned in section 2.2.1, Merton (1974) highlighted the structural model which predicted complete integration between the credit and equity markets. The Merton model suggested that the *"market price of risk (the Sharpe ratio) must be the same for all contingent claims written on a firm's assets"*, as stated by Friewald et al. (2014, p.2419). As a result, risk premium in the credit market must be related to the risk premium in the equity market. Friewald et al. (2014) used CDS data from a sample of 491 companies in the U.S. during the period from 2001 to 2010 to directly estimate the risk premium and analyzed the relationship between the credit and equity markets. They used the CDS forward curve to estimate risk premium for particular companies and then linked this premium to excess equity return. Through the paper, they found a considerable positive relationship between equity excess return and risk premium with a monthly frequencies.

Several researches give empirical evidences of considerable short-term pricing disparities that could be used for capital structure arbitrage, notwithstanding Merton's (1974) assertion that credit and equity should be priced similarly on a risk-adjusted basis. Capital structure arbitrage is defined as a strategy of trading that relies on the mispricing between equity of a company and its CDS. When the market-observed CDS spreads are much lower (higher) than the hypothesized model-implied CDS spreads, a capital structure arbitrage technique can be applied by purchasing (selling) the stock and the credit protection. The arbitrageurs will gain profit if the market-observed spreads converge to the model-implied CDS spreads. To compensate for the fluctuations in the CDS spreads' values, a delta-hedged equity position might be utilized. Whereas this strategy is theoretically market-neutral, if both equity price and CDS spread rise at the same time and the arbitrageurs have short positions in both markets, they might experience the mark-to-market losses.

The existing studies attempt to discover the pricing disparities from various viewpoints, such as restrictions to arbitrage across markets, differential risk factors, or wealth transfers between bond holders and shareholders. Various pricing variables may alternatively span the returns in each market, explaining the permanent pricing differences. For instance, many researchers documented that CDS spreads are not solely a credit risk's measurement, but also contain liquidity components. Duarte et al. (2007) focused on the restriction to arbitrage across credit and equity markets. They used 5-year CDS of 261 companies during the period of 2001-2004 and studied the return and risk factors of a capital structure arbitrage technique which is used in this countries. For each CDS enterprise amid the observed time period, the authors simulated such strategy in which the arbitrageurs would short sell the stock and sell the CDS protection if the model-predicted CDS spread was below a threshold percentage of the market-observed CDS spreads. After 180 days, or when the observed and model-based spreads converged, the position will close. The bid-ask spread reflects the transaction cost, which is considered to be 5%. In addition to the transaction cost, initial capital is needed to fund the equity position. The capital structure arbitrage profits are regressed on a proxy for default risk or a set of bond and equity markets variables to indicate if this excess returns gained are abnormal. They found that to yield a 10% annualized standard deviation return, the initial capital needed for other fixed-income arbitrage strategies is several times smaller than for a capital structure arbitrage strategy. Otherwise, a significant amount of "intellectual capital" is required for an arbitrage trade to mitigate the risks and demonstrate the arbitrage opportunities utilizing complex models. Furthermore, the profits are only generated by the capital structure arbitrage method if there is a significant difference between the model-implied and market-observed CDS spreads, for example a substantial threshold percentage which the arbitrage transaction is started above. The author, however, stated that only a small percentage of individual arbitrage tactics in their sample converged between model-predicted and market CDS spreads. Nevertheless, the regression analysis implies that capital structure arbitrage produces risk-adjusted superior returns.

In the same spirit, Kapadia and Pu (2012) also used the restriction to arbitrage to analyse the low correlation between equity and CDS markets. They suggested that, in theory, the integration of these two financial assets should be strengthened by the capital structure arbitrage strategy used by market practioners. However, due to the connection of frictions with idiosyncratic risk and/or illiquidity, the arbitrage has transaction costs; as a result, investors are unable to leverage the arbitrage opportunity, and the pricing disparities hence remain. The restrictions to arbitrage, therefore, can explain the shortage of integration between the credit and equity markets. This hypothesis was investigated by studying CDS data of 214 companies over 9 years from 2001. The authors utilized the concordance of price fluctuations in the CDS and stock markets to identify short-term pricing disparities. Overall, they found that equity volatility, idiosyncratic risk and illiquidity jointly account for 29% of the pricing disparities explanation between CDS spreads and equity returns, which must reflect the two markets' integration. At the same time, the regressions' low explanatory power showed that the two most important predictors of CDS spreads (debt level and equity volatility (Ericsson et al., 2009)), cannot completely explain the differences of prices.

During the financial crisis, the lack of arbitrage capital available to investors has been presented as a reason for the breaches of no-arbitrage pricing across markets, which might also apply to the CDS and equity markets. Duffie (2010c), for instance, proposed the shortage of dealer capital as an explanation for the anomalies in the CDS-bond basis. In the same spirit, Mitchell and Pulvino (2012) stated that during the crisis, the wide negative CDS-bond basis could be explained by the depletion of arbitrage capital.

2.2.4 The effects of CDS trading on equity market

a. Potential Impact of Risk Sharing

According to Boehmer et al. (2012), if the CDS market has no purpose other than risk sharing in credit markets (for example, insurance firms and bank utilize CDS only for hedging loan portfolios), traders will be encouraged by hedging demand rather than speculation. We, in that case, will not expect the introduction of CDS markets to have direct impacts on the informational efficiency of equity markets. This is because any resulting trades in the equity market are according to hedges which are well-understood by all market makers, and market participants will use the predicted hedging activity to set equity prices. Investors issuing CDS contracts, for instance, may want to actively hedge their positions in the equity market (selling the CDS means a short increase in the company's value). Dealers are able to do it by taking a short equity position, which they would increase (by selling shares) when equity prices fall and decrease (by purchasing shares to cover the short), when prices increase, using delta hedging methods. Although we do not expect the impacts of these transactions on price efficiency, they could result in negative liquidity "externality". This is because trades generated by the hedging strategy are in the same direction of the overall order flow and thus, the liquidity of equity market are led to decline.

In a follow-up paper, Boehmer et al. (2015) focused on the impacts of CDS contracts on the characteristics of equity markets, such as price efficiency and market liquidity. The authors observed the data from an ex-ante perspective and found that the liquidity of equity markets could be improved by the impacts of CDS trading since CDS contracts are considered as efficient measures for risk sharing. Under a delta hedging strategy, the CDS protection seller can actively hedge his position in the equity market; CDS trading, therefore, may lead to a higher number of transactions in the equity market. Furthermore, investors may be endogenously attracted by the opportunity to hedge to enter both CDS and equity markets. Otherwise, instead of equity markets, investors choosing CDS markets may leads to the decrease in the equity market liquidity.

b. Trader-Driven Information Spillovers

CDS markets offer a new method for investors with private credit risk signals so they can transact on their information. Due to the illiquidity of bond markets, these informed trades may not occur without the presence of CDS. Blanco, Brennan, and Marsh (2005) with the assumption that information-based investors trade in CDS found in their paper that bonds prices are less informative about the credit quality of the issuing firms than the prices in CDS markets. In the same spirit, Acharya and Johnson (2007, 2010) and Berndt and Ostrovnaya (2007) showed evidence of insider trading in the CDS market. In details, Acharya and Johnson (2007) argued that CDS contracts are used as a venue for insider trading and that due to the negative trader-driven spillovers, trading in CDS markets may decrease the price efficiency of equity markets. Alternatively, because of the positive impact of information spillovers, information-based CDS trading could improve the equity markets' informational efficiency. More specifically, when informed investors trade in more than one market, market participants may find it difficult to learn from these transactions. Additional second-order effects may be induced by such informational externalities. On the one hand, the increase in trading opportunities set may encourage informed investors to be more competitive, leading to the market exit of a variety of uninformed investors, and the market liquidity therefore decreases. Investors, on the other hand, may be attracted by the improved price efficiency of equity markets and trade these securities more, the liquidity of equity market thus is improved. Ultimately, whether the equity markets are impacted negatively or positively by the introduction of CDS markets remains an empirical question.

On the other hand, many literature also illustrated the possibility that informed investors, with the presence of CDS, would trade in both equity and CDS markets and these trades will decrease the price efficiency of equity market. Biais and Hillion (1994), for example, indicated that these effects are because of the complex multi-security trading strategies; or as Goldstein et al. (2014) stated that these impacts are due to the heterogeneity in investors' access to CDS markets. These two impacts are not mutually exclusive; nonetheless, determining the primary effect is a still question of empirical research.

The theoretical ambiguities mentioned above have been reflected in the market fragmentation research to the extent that CDS and equity markets offer alternative ways for trading on private information about corporation risks (such as they are relatively close substitutes). A number of theoretical approaches to the fragmentation questions were summarized by Fong et al. (2001) and O'Hara (1995). According to empirical studies by Amihud, Lauterbach, and Mendelson (2003), when two similar financial assets of the same business are exchanged on the market, the value of stock is decreased because of fragmentation. O'Hara and Ye (2011) compared equities with more and less fragmented stocks and investigated that more fragmented trading is more liquid (low transaction cost and quicker execution), with higher price efficiency but also greater volatility. Since the implications of theoretical research of fragmentation trading is mixed, they encourage further empirical research studying about the impacts of fragmenting the information and orders flows.

2.3 CDSs and equity options

Before the introduction of CDS market, equity derivatives (for example exchange-traded options) were used as hedging strategies. Carr and Wu (2010) demonstrated the straightforward relationship between CDS contract and deep out-of-the-money put option by providing the similarities between CDS and put options. They, through this rationale, stated that CDS and options can be jointly priced. They also studied the co-movement of currency option implied volatilities and sovereign CDS spreads utilizing data from Mexico and Brazil. From the research, it is stated that the currency return variance is less persistent than the default intensity. Several arbitrage trades, in practice, are based on options and CDS. Fonseca and Gottschalk (2013) showed the evidence of the cross-hedging strategy between option volatility and CDS spreads during financial crisis period.

There are some key distinctions between these forms of financial assets. Firstly, CDS usually has a longer maturity. While the most liquid CDS contracts have five-year maturity, the most frequently traded options have the maturity of three months. Second, whereas CDS are traded OTC, options are exchange-traded. Moreover, institutional investors dominate the CDS market, meanwhile both individual and institutional traders trade options. Although the initiation of CDS may also influence on the option market efficiency, liquidity and price, there is little recent studies discussing on this dimension.

CHAPTER 3: The Sovereign CDS

Sovereign CDS (SCDS) are deemed to depict accurately the underlying credit risk within a country's economy. Following the European sovereign financial crisis, which began in 2008 with the collapse of Iceland's banking system and escalated to other nations such as Portugal and Greece in 2009, the SCDS market moved into the spotlight of financial markets and has been under intensive scrutiny. This led to a temporary prohibition in May 2010 by BaFin (the German financial regulator Bundesanstalt fuer Finanzdienstleistungsaufsicht) and a permanent ban in November 2012 by E.U. on naked sovereign CDS holdings.

While the credit insurance market for government debt developed majorly after the 21st century, it is evidenced anecdotally by Tet (2009) that sovereign CDS trading occurred earlier in 1994, when Citibank's and J.P. Morgan's asset management entered into written contracts on Belgian, Italian and Swedish government bonds.

To understand the development of sovereign CDS, in this section, I will discuss sovereign CDS by reviewing the main differences between the sovereign and corporate CDS; the market participants and the trading activity on sovereign CDS markets. The second objective is to determine the determinants which affect the sovereign CDS market, including global and local risk factors; local financial risk factor. We will also discuss the danger of spillover and contagion amid the sovereign debt and financial crisis, especially during the period of covid-19 pandemic. Last but not least, I will discuss the sovereign CDS market liquidity; the determinants which impact on the CDS-bond basis and the effects of sovereign CDS on the public bonds.

3.1 Major differences from corporate CDS

As discussed, both sovereign and corporate CDS are established to provide protection against default or credit events of the underlying entities. These SCDS, however, have four main differences: the nature of credit events, the currency denomination of the contract, the time period of trading contract, and the use of sovereign CDS as proxy hedges.

Firstly, one of the fundamental differences between sovereign and corporate CDS markets refer to the definition of credit events that trigger the protection payment. Standard corporate CDS's credit events are trigger in case of failure-to-pay, bankruptcy, and restructuring events. In contrast, sovereign CDS do not trigger through bankruptcy events, but moratorium or repudiation instead. Vogel et al. (2013) stated that sovereign CDS in Europe triggers through moratorium or repudiation instead of bankruptcy because of the low possibility of a sovereign declaring bankruptcy. Only sovereign CDS contracts are subject to repudiation or moratorium, which requires the occurrence of two events. First, one or more obligations are disclaimed, invalidated, or a moratorium, rollover, or postponement is imposed by a government agency of the appropriate reference company. The second occurrence refers to a restructuring event or a failure-to-pay in terms of one or more obligations before or on the evaluation date of repudiation moratorium (Haworth et al., 2010). In simple words, this happens when the reference entity declares or repudiates a moratorium in regard to one or more relevant obligations in addition of an agreed default requirement.

	Bankruptcy	Failure to Pay	Repudiation/ Moratorium	Restructuring (Old R)	Restructuring (Mod Mod)	Restructuring (Multiple Holder Obligation Requ.)
West. European Sovereign	No	Yes	Yes	Yes	No	Yes
European Corporate	Yes	Yes	No	No	Yes	Yes

Table 3.1: *Credit event triggers for corporate and sovereign CDS (Source: Vogel et al., 2013, p.11)*

A second difference between sovereign and corporate CDS is that there are more concentrated trading in the five-year contract for corporate reference entities than sovereign entities. The total gross notional amount outstanding for above one to five-year maturities for sovereign reference entities in 2012 was $18.25 trillion, reflecting 67.76% market share. In contrast, Packer and Suthiphongchai (2003) and Pan and Singleton (2008) used Bank for International Settlements (BIS) data to show that three- and ten-year maturity contracts contributed for roughly a fifth of total sovereign activity, and that one-year maturity accounted for 10% of total trade.

Another aspect of CDS contract which is particularly essential for the sovereign reference entity is the denomination of the contract's currency. The rationale for this is that in the event of default, the sovereign faces a high danger of perhaps re-denomination or currency depreciation. For example, if the United States defaulted, a protection payout in dollars would be far less appealing than a payout in euros. Since price quote on the identical underlying sovereign government differs across various denominations of currency, this risk is also priced into credit insurance arrangements. Market makers can also directly transact these disparities in so-called quanto swaps that protect against both a currency devaluation and a credit event simultaneously.

Finally, sovereign CDS are unique in that they could be utilized as proxy hedges to reduce an exposure of a portfolio to a certain country. The use of proxy hedges is especially important in case of the European Union's permanent restriction on naked CDS positions, which was enacted in November 2012. The regulation, however, specifically allows for the purchases of uncovered CDS contracts to hedge a portfolio of investments whose value had a historical correlation of at least 70% with the government bond price in the 12 months (or longer) before to the CDS purchases.

3.2 The market for sovereign CDS

JP Morgan created CDS in the early 1990s to fulfill the growing demand for credit risk slicing and dicing. Over the previous decade, CDS has grown at nearly three-digit rates year after year. In this subsection, we will provide information on the structure and market size of sovereign CDS markets. After that, we will discuss the market participants and its proportion in the overall sovereign CDS market.

3.2.1 Market size and structure

Sovereign CDS are a small but rapid rising segment of the CDS market, which was first developed in the early 2000s. Brady bond futures contracts (for three countries – Mexico, Brazil, and Argentina) on the Chicago Mercantile Exchange initially gave some options for hedging or trading sovereign credit risk (CME). Some suggested that the rise of sovereign CDS, which provided a superior and more flexible hedging alternative, contributed to the contracts' demise in October 2001 (Skinner and Nuri, 2007).

However, the sovereign CDS market has only grown significantly since 2008, while other CDS markets have shrunk. The post-2008 surge is most likely due to the requirement to hedge derivative counterparty credit risk exposure, which had to be declared more thoroughly under the new accounting standards that took effect in 2006 (see Figure 3.1). The gross notional amount of SCDS outstanding at the end of June 2012 was around $3 trillion, compared to $27 trillion for CDS as a whole. Since June 2012, these values have decreased, owing to a netting of outstanding holdings as regulators' increased concerns about counterparty risk and calls for greater transparency have resulted in portfolio compressions. Otherwise, it can be also partially explained by the fact that credit derivatives were central to the financial crisis from 2007-2009.

From 2012, the total notional amount of sovereign CDS outstanding decreased gradually, end up at $1.7 trillion at the end of the second half of 2016.

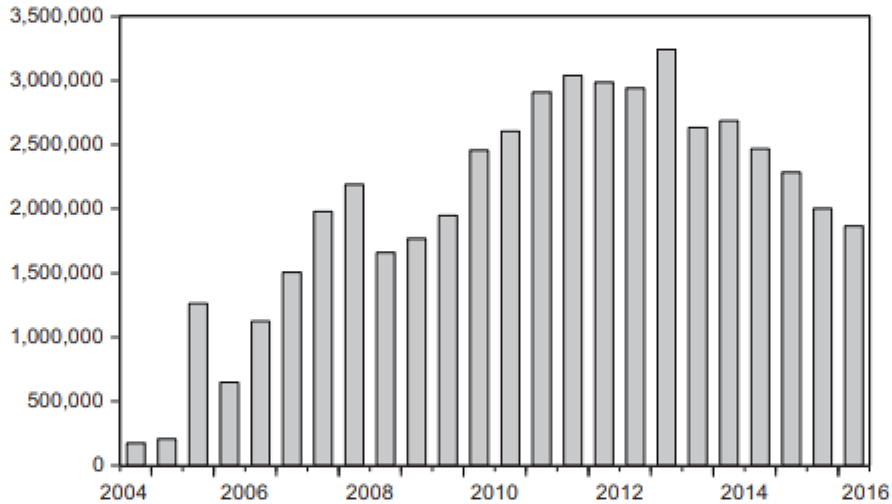

***Figure 3.1**: Notional amount outstanding of Sovereign CDS from 2004-2016 (in millions USD)*

(Source: Data from BIS Statistics)

3.2.2 Market participants

While the market share of contracts written on a single reference entity decreased gradually from 2019 to 2021, it still represents a bulk of the gross notional amount outstanding of overall sovereign CDS in 2019 (with the market share of 93.9% of total sovereign market at the end of second half of 2021). Although these number sound impressive, CDS (especially sovereign CDS) still contributes for a fraction of the total notional outstanding amount in all OTC derivatives (which is 609,996 trillion USD in 2021), which are 1.5% and 0.19% respectively.

Period	All OTC	Credit Derivatives (%)	Sov. All (%)	Sov. Single-name (%)	Sov. Multi-name (%)
2021 - H1	609,996	9121 (1.5)	1109 (12.16)	1041 (11.41)	68 (0.75)
2020 - H2	582,055	8649 (1.49)	1140 (13.18)	1084 (12.53)	56 (0.65)
2020 - H1	606,821	9050 (1.49)	1250 (13.81)	1183 (13.07)	67 (0.74)
2019 - H2	558,513	8119 (1.45)	1228 (15.13)	1158 (14.26)	70 (0.87)
2019 - H1	640,352	8418 (1.31)	1265 (15.03)	1184 (14.07)	81 (0.96)

	2018 - H1	2019 - H1	2020 - H1	2021 - H1
All Counterparties	**1458**	**1265**	**1250**	**1109**
Reporting Dealers	**581**	**461**	**422**	**312**
(Fraction)	39.85%	36.44%	33.76%	28.13%
Other financial institutions	**856**	**783**	**802**	**740**
(Fraction)	58.71%	61.90%	64.16%	66.73%
Central counterparties	590	500	540	497
Banks and securities firms	95	127	126	132
Insurance and financial guaranty firms	30	20	27	22
SPVs, SPCs, and SPEs	9	11	10	8
Hedge Funds	62	46	35	7
Other financial customers	70	79	64	74
Non-Financial Institutions	**20**	**20**	**26**	**28**
(Fraction)	1.37%	1.58%	2.08%	2.52%

Table 3.2: *Sovereign credit derivatives – Notional amount outstanding (Unit: billion USD)*

(Source: Data from BIS Statistics)

Due to the lack of transparency in OTC markets, determining the ultimate risk holder in a broad network of bilateral risk exposures is difficult. During sovereign crises, hedge funds are frequently criticized for artificially inflating public borrowing rates by taking one-sided speculative bets on governments' default. Doubts about such assertions can be justified by looking at Table 3.2 for a snapshot of all counterparties alleged to be active in sovereign CDS trading. First, these statistics suggest that central counterparties accounts for a bulk of total sovereign credit derivatives, with a gross notional amount outstanding of around $497 billion in first half of 2021, which represents a market share of 44.81%. The second highest traded participants are reporting dealers (which was the highest proportion of sovereign CDS before 2018), with a gross notional amount outstanding of $312 billion or a market share of 28.13% in 2021. The fact that hedge funds, with a gross notional amount outstanding of $7 billion, represent a much smaller fraction (0.63%) of the market and decreased significantly from 2018 to 2021, suggesting that sovereigns CDS are utilized primarily for hedging purposes.

3.3 Sovereign CDS spread determinants

As a result of the growth of CDS market, as well as the role of it in the global financial crisis, academic studies on CDS spreads and instruments thrived. Furthermore, as Ang and Longstaff (2013) explain, utilizing CDS spreads rather than debt spreads for researching credit risk has a significant advantage: debt spreads are influenced by a variety of factors other than credit risk. However, in comparison to the literature on corporate CDS, the literature on sovereign CDS emerged more slowly (Doshi et al., 2014). Many recent researches, for example, concentrate on emerging market CDS spreads (e.g. Ammer and Cai, 2011; Hilscher and Nosbusch, 2010; among others), or corporate or bank CDS spreads (see Galil et al., 2014; Chiaramonte and Casu, 2013). Moreover, early studies on credit spreads focus primarily on drivers of bond yield spreads and the roles of common financial market as well as global factors (e.g. Remolona et al., 2008; Eichengreen and Mody, 1998).

In terms of sovereign CDS, one would intuitively expect country-specific fundamentals to cause changes in sovereign spreads. There are many research studying these determinants of sovereign CDS spreads (e.g. Hui and Fong, 2011; Hilscher and Nosbusch, 2010; Carr and Wu, 2007; among others). Nonetheless, there is abundant proof that global variables unrelated to a country's economy account for a large portion of the fluctuation in sovereign CDS spreads, particularly at greater trading frequencies (Ang and Longstaff, 2013; Longstaff et al., 2011). It is also stated that the importance of individual country and global factors can differ across countries and over time. Furthermore, the majority of research mention a risk that originates in the U.S. The European sovereign debt crisis, on the other hand, has brought the importance of country-specific variables back to the frontline, with a focus on the sovereign-bank nexus.

In this subsection, we will review the academic literatures which indicated determinants of sovereign CDS, including: global and local risk factors, and local financial risk factor. According to the literature, whereas the role of domestic risk variables is more relevant in times of distress and for nations experiencing financial instability, global risk determinants are favored in research disregarding distressed countries and often outside crisis periods.

3.3.1 Global risk factors

The significance of global risk variables in determining sovereign CDS spread is typically justified by the co-movement over time of sovereign spreads, as can be seen in Figure 3.2 for a sample of 13 countries. Otherwise, along with this co-movement of CDS across sovereign entities, Pan and Singleton (2008) also stated that whenever there is a surge in risk aversion as results of global risk-related events (such as the major political bailouts of European governments, or fluctuations in the monetary policy of the U.S. in response to the decreased growth rate, which has caused investors to unwind their carry trades, most company bankruptcies of the usual suspects Lehman Brothers and Bear Stearns), sovereign spreads tend to jump sharply (as can be seen in Figure 3.2). This coincidental observation illustrates that global risk factors contribute in explaining the variation in sovereign CDS. Furthermore, the substantial factor structure in spreads lends support to the significance of global risk, as the first principal element may explain a much larger proportion of the spread fluctuation than it can in stocks. The exact figure varies depending on the sample frequency and nations analyzed, but according to Longstaff et al. (2011) and Pan and Singleton (2008) it can be as high as 96 percent at the daily basis and 64 percent at the monthly decision interval.

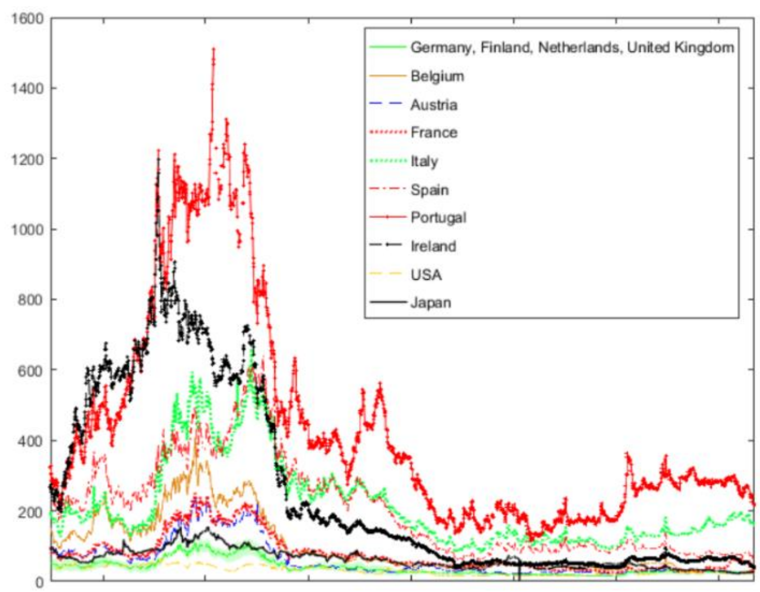

Figure 3.2: *Sovereign CDS spreads in 13 countries between 28 June 2010 and 9 May 2017*

(Source: Gathered by Molleyres and Zimmermann, 2019)

Figure 3.3: *Average 5-year Sovereign CDS spreads in 38 countries from 9 May 2003 to 19 August 2017*

(Source: Data from Markit illustrated in Pan and Singleton, 2008)

The study by Longstaff et al. (2011) is one of the few literature that breaks down sovereign CDS determinants into global macroeconomic and country-specific components. They revealed that credit spreads are more closely linked to the global financial factors and equity markets in the United States than to country-specific economic indicators. They found that the first principal element contributes for a large proportion of the variability in sovereign spread, and that this variable is strongly (inversely) linked to the CBOE volatility index (VIX) in times of market turbulence, with 75% correlation coefficient. Pan and Singleton (2008) also indicate that the spreads of Korea, Turkey, and Mexico have a similar strong correlation with the VIX. Their main focus is deciphering the parameters of the risk neutral default and recovery procedures using the information in the term structure. With this purpose, they build a theoretical pricing model to divide spreads into the components relating to the estimated losses and a risk premium and find out that risk premium are likely to co-move significantly over time, and are highly correlated with the CBOE VIX option volatility index, the volatility in the own-currency options market, as well as the spreads between the 6-month US Treasury bill rate and the 10-year return on US BB-rated industrial corporate bond. These findings also support in confirming the existence of time-varying risk premia in sovereign CDS market.

Other literatures that explain the significance of global risk factors in affecting sovereign spreads are those by Augustin and Tedongap (2014), Ang and Longstaff (2013), Zhang (2008), and others.

In which, Zhang (2008) constructed a CDS pricing model and applied it to Argentina to infer variations in expectations regarding projected recovery rates post default and estimated default probabilities, which is related to Pan and Singleton's (2008) article. According to the authors, there was an association between the variations between historical default probabilities, risk-adjusted return and the changes in the economic cycle, both Argentine and the U.S credit condition and the general regional economy. Ang and Longstaff (2013) discussed global risk factors by comparing CDS spreads written on sovereign states in European countries and the United States. They extracted the spreads' dependencies on a common component and classified it as systemic risks rather than extracting the risk premium. And they found evidence that global financial factors influenced this component of systemic risk, while dismissing the linkages to macroeconomic fundamentals.

Augustin and Tedongap (2014), in contrast to Ang and Longstaff (2013), used data of CDS spreads in 38 countries to demonstrate that the uncertainty in macroeconomic and the expected consumption growth in the United States are substantially related to the first two principal components taken from the complete term structure of those countries' spreads. The global financial risk parameters such as the U.S. excess equity return, the variance risk premium, the CBOE volatility index, investment-grade bond spreads, the price-earnings ratio, or high-yield and has no effect on these findings.

Benzoni et al. (2015) proposed a different explanation for the co-movement in sovereign spreads, claiming that after negative country-specific events, agents reconsider their perceptions about all countries' default probabilities, resulting in higher correlations of credit spreads than if spreads were solely based on macroeconomic factors. Anton et al. (2013) indicate another probable approach for the high co-movement in sovereign CDS spreads. They discovered that dealer quotes for sovereign CDS spreads commonly have a tight relationship with cross-sectional CDS return correlations. Given the high concentration of CDS trading among U.S dealers, these commonality in dealer quotes would also explain the strong association between CDS trading and the U.S. risk variables.

In further research, there is also a literature strand suggesting the connection between sovereign spreads and other asset markets (such as energy or commodity markets). Arezki and Brückner (2012) showed a negative correlation between price changes in international commodity and the sovereign bond spreads (the proxy of sovereign credit risk) in emerging countries. Wegener et al. (2016) used the bivariate VAR-GARCH-in-mean models to investigate the association between sovereign CDS spreads and oil prices in nine countries (including the United States, the United Kingdom, Malaysia, Qatar, Norway, Venezuela, Russia, Saudi Arabia, and Brazil). They found that positive shock in oil prices helped oil-producing countries improve their fiscal stability, but reduced sovereign CDS spreads. Pavlova et al. (2018) had a similar research on the dynamic spillover of volatility and crude oil price on the sovereign CDS in ten oil-exporting entities (including the United Kingdom, Norway, Qatar, Kazakhstan, Malaysia, Russia, Mexico, Colombia, Brazil, and Venezuela). Using data from October 2008 to September 2015, they investigated that crude oil shocks primarily affected Mexico, Russia, Colombia, and Venezuela. Furthermore, they also discovered that the amount of spillovers from changes in crude oil prices was higher than the spillovers from crude oil uncertainty to SCDS spreads. Bouri et al. (2018) investigated the relationship between crude oil implied volatility shocks and BRICS sovereign risk. The discovered that whereas oil importers (India and China) were more prone to negative shocks in oil volatilities, oil exporter (Brazil and Russia) were more prone to positive shocks.

3.3.2 Global and Local risk factors

Rather than solely influenced by global risk factors, the co-existence of both country-specific and global risk factors are evidenced in many research. For example, according to the intuition that both domestic fundamentals and investor appetite for risk influences prices of financial asset, Remolona et al. (2008) studied monthly 5-year sovereign CDS spreads in emerging markets from January 2002 to May 2006 and decomposed them into a market-based proxy of expected loss and a risk premium. The authors analyzed how each of these components related to measures of global risk appetite/risk aversion and measures of country-specific risk. Fundamental variables include foreign exchange reserves, GDP growth consensus predictions, industrial production, and inflation. Measures of global risk aversion are used as the VIX, a Risk Tolerance Index by JP Morgan Chase, and the effective risk appetite indication in Tsatsaronis and Karramptatos (2003). They found empirical evidence that whereas market liquidity and country-specific fundamentals affects more on sovereign risk, sovereign risk premium seems to be affected by global risk aversion. Thus, both elements have different behaviors.

Carr and Wu (2007) proposed a joint valuation approach for sovereign CDS and currency options issued on the same nation, and conducted an empirical analysis from 2 January to 2 March, 2005 for Brazil and Mexico. They showed that CDS spreads had strong positive coincident relationships with foreign options delta-neutral straddle implied risk reversals and volatility. This research reinforced their hypothesis that political or economic instabilities in a sovereign country led to the aggravation of currency return volatility and the decrease in sovereign credit quality. Surprisingly, their findings also indicated that there are additional consistent credit spread movements that the estimated model overlooked. Using the data amid the sovereign debt crisis over the period of September 2009 to August 2011, Hui and Fong (2011) reversed the analysis demonstrated information flow from the sovereign CDS markets to the dollar-yen currency options markets. Pu and Zhang (2012b), in a similar spirit, illustrated the significant effects of dual-currency spreads (which have predictive potential up to ten-day period) on the bilateral exchange rates for ten Eurozone countries from January 2009 to December 2010, by exploiting the differences of pricing between EUR and USD denominated sovereign CDS spreads.

Other researchers also studied other domestic and country-specific fundamentals. Hilscher and Nosbush (2010), for example, oversaw sovereign debt prices of 31 countries from 1994 to 1997 and found that a large share of changes in sovereign prices of emerging markets can be explained by the difference in country fundamentals. Otherwise, Liu and Morley (2012) applied a Granger non-causality and a Vector Autoregressive (VAR) tests on their research to explore the relationship between sovereign CDS spreads and the local economic factors (including exchange rate and interest rate). After analyzing, the authors found that there are limited effects of domestic interest rates on sovereign spreads, while the dominant determinant of sovereign spreads is the exchange rate.

Aizenman et al. (2013) exploited a dataset of more than fifty sovereign economies (both within and outside Europe) from 2005 to 2010 (prior to and post the global financial crisis) to develop a pricing model of sovereign risks. They found that fiscal space and other economic factors can partly explain CDS spreads. Beirne and Fratzscher (2013), in the same spirit, discovered the determinants of sovereign CDS spread in 31 emerging and advanced countries amid the sovereign debt crisis in Europe. Their research indicated that, in contrast to the modest level of impacts on sovereign risk of regional contagion, most of the magnitude of sovereign risk as well as its rise during the crisis are explained by countries' economic fundamentals. Furthermore, Galil et al. (2014) investigated sovereign CDS spreads determinants by exploiting a larger database of 718 companies in the US over the period 2002-2013. Their analysis confirmed that the change in the median CDS spreads in the rating class, stock return and the changes in its volatility surpassed other factors to be the explanation of the changes in CDS spreads.

Ismailescu and Kazemi (2010) considered whether rating changes influenced on sovereign CDS spreads by using data from 22 emerging countries from 2 January 2001 to 22 April 2009. The authors concluded that CDS of speculative grade countries respond primarily to positive announcements, whereas spreads of investment grade economies respond mostly to negative credit rating releases. Furthermore, by the time the credit rating change is published, the information content of negative credit event have already been anticipated and represented in CDS spreads. On the other hands, since an upcoming positive credit rating event contains new information, CDS spreads do not completely anticipate it.

In a recent research, Naifar (2020) conducted an empirical analysis on what factors (including both local and global financial factors) determined sovereign CDS spreads in the GCC regions. By using daily data from 5 April 2013 to 17 January 2020, the author found that local factors had higher impacts on changes of sovereign CDS spreads than the global ones. Those local factors (as represented by stock returns on sovereign CDS spreads) showed a significantly negative effect on spreads in all countries. The coefficients, however, are not the same in all nations and differed according to the market conditions.

3.3.3 Local financial Risk factors – The Sovereign Bank-Nexus

Since the European sovereign debt crisis worsens as a result of bank bailouts during the financial crisis, there are more and more evidences indicating a closed connection between country-specific financial risk and sovereign CDS. For instance, Acharya et al. (2013) demonstrated the two-way feedback effects between the financial industry and sovereign credit risk. Their findings suggest that government bailouts can have a negative influence on the sovereign's financial health, lowering the values of government guarantees inherent in financial institutions and causing collateral harm to the public bond holdings of banks. Consequently, once the government has committed disproportionately to financial guarantees, financial businesses and sovereign CDS spreads will strongly co-move. In contrast to the two-way feedback effect, Dieckmann and Plank (2011) emphasized the unilateral transfer from private to public risks, which allows market participants to integrate their expectation about banking industry bailouts. They discovered that the state of the global financial system and the status of a country's financial system have considerable impacts on the CDS spread behavior, while the intensity of these impacts appearing to be dependent on the significance of a country's financial system prior to the crisis. Furthermore, they also showed that member countries of the European Economic and Monetary Union are more sensitive to the financial system's health. Similarly, Ejsing and Lemke (2011) described the transfer from private to public risk from January 2008 to June 2009 by indicating the reduction in banks' CDS spread at the rising price of sovereign spread, as a consequence of financial bailouts.

Sgherri and Zoli (2009) examined the correlation between CDS of the financial industry and sovereign CDS in ten European nations between January 1999 and April 2009. In addition to the dominance of a common time-varying component, they discovered that country banking system's solvency also increasingly contributed to the explanation of sovereign spreads. Alter and Schuler (2012) examined the price discovery mechanisms in both bank and sovereign CDS spreads prior to and after the financial rescue package from the ECB, the International Monetary Fund (IMF) and the E.U by using a vector error correction methodology. They found that before the bailouts, default risk was passed on primarily from banks to the sovereign sectors, but that risk was also transmitted backwards from sovereigns to banks after the government rescue packages.

3.3.4 Conclusion

In conclusion, by surveying literature, there are strong arguments over whether country-specific factors (which are majorly related to the stability of the local financial sector) or global risk fundamentals have relatively stronger impacts on sovereign CDS spreads. The explanations for the changes sovereign CDS spreads would probably focus mainly on those two factors. Furthermore, it is suggested to concentrated on the time-variation in terms of CDS structure for both sources of risk (local and global risk factors) in the future research for more valuable information going forward, as encouraged in Augustin and Tedongap (2014) as well as Pan and Singleton (2008).

3.4 Contagion and Spillover

The rising sovereign debt crisis has been followed by a proliferation of the concepts of contagion and sovereign risk spillovers across countries, both in popular press and in the academic work. It is ambiguous whether actual contagion exists. It could be the case that country spread simply co-move more or less due to the common exposure to regional or global credit events, which have time-varying correlations. The correct definition of the concept has a big impact on the findings in the literature. As a consequence, it is crucial to distinguish various concept more clearly and assure that they allow for the identification of contagion mechanisms. To this end, I will first review the literature studying the contagion effects across sovereign entities. Following this, I will study the relationship between corporate and sovereign CDS spreads by focusing on major academic results.

3.4.1 Contagion across sovereign CDS

Using a dataset between 2004 and 2011, Beirne and Fratzscher (2013) investigated the existence of contagion impacts in 31 emerging and developed nations. They defined contagion into three major types: regional contagion, defined as "an intensification of cross-country transmission of sovereign risk"; fundamentals contagion, defined as "an intensification of cross-country transmission of sovereign risk during crisis periods"; and herding (or pure) contagion, defined as "temporal cross-country relationship of the unexplained sovereign spreads components" (Beirne and Fratzcher, 2013 as cited in Augustin et al., 2014, p.131). Their findings supported fundamentals contagion, since during the crisis period, financial markets became more sensitive to countries' economic fundamentals in comparison to the pre-crisis period, indicating that financial markets were given a wake-up call. This finding was especially noticeable in the GIIPS economies. Regional spillovers, on the other hand, have diminished throughout the crisis, and no evidence of spillovers from GIIPS countries to other areas has been discovered. Finally, there has been limited evidence of herding contagion, which was relatively infrequent and did not dominate the crisis period.

Bouker and Mansouri (2021) utilized data of Eurozone sovereign economies from 28 February to 11 March 2021 and analyzed the contagion of sovereign risk across those financial markets, both during and after the debt crisis in Europe, and particularly focused on casual impacts of Covid-19 pandemic and pre-Brexit. The authors combined MRS-ARMA and copulas methodologies to examine the asymmetric dependence structure and the regime transition process across financial markets. They discovered that there is switching of regimes; and during major crisis events (such as Covid-19 pandemic, the European debt crisis 2009-2012, or pre-Brexit), dependence structure moves from a weak interdependence structure (low dependence) to a strong interdependence structure (high dependence) regime. This suggested that most of the global crisis events have exacerbated the effects of sovereign risk spillovers on financial markets in peripheral European economies and others.

On the other hand, Caporin et al. (2013) illustrated a reverse result of sovereign contagion and rejected the existence of it in eight European economies from November 2008 to September 2011, by examining if the spillover effects across countries differ for average and large shock realizations after considering for common characteristics. It is indicated, according to quantile regression approaches, that the dependence between fluctuations of any two CDS changes does not vary as consequences of the sign and the size of the movements. This is substantial evidence of linearity in shock propagation, implying that the linkages between countries are the same in normal and tumultuous times. Additional tests showed that as the sovereign debt crisis has worsened, bilateral correlations across nations have decreased, and that correlations are higher for small changes in spreads, but lower for big changes in spreads.

The contagion channel was investigated by Bai et al. (2012) through the correlation with national fundamentals (distinguishing between domestic and aggregate liquidity and credit events) in twelve European economies from 2 January 2006 to 31 May 2012. The authors used a stylized rational expectations equilibrium model to study how country-specific or aggregate events may impact on each other through feedback and spillover effects. They decomposed sovereign CDS spreads into fundamental liquidity and credit risks elements, and illustrated that liquidity seemed to trigger the first wave of the sovereign debt crisis (August 2008 to April 2010), while fundamental credit risk were more likely to triggered the second wave (May 2010 to May 2012). Four main findings were yielded after testing for feedback and spillover effects based on a structural vector auto regression. First, international credit shocks tend to generate a positive and strong reaction in CDS premia, and vice versa, domestic credit shocks tend to have considerable effects on aggregated credit events in other European nations. Second, domestic liquidity appears to react considerably to foreign liquidity shocks, resulting in a significant contagion impact through the aggregate liquidity channel. Third, domestic liquidity events appear to have a considerable negative impact on global liquidity events, indicating a flight-to-liquidity phenomenon. Finally, it is argued that there seemed to be no effect of local liquidity events on either foreign or domestic credit risks. According to Bai et al. (2012), thus, contagion across sovereign CDS is mostly caused by fundamental credit risk. Darolles et al. (2012), on the other hand, focused solely on a liquidity channel for 18 emerging countries from January 1, 2007 to February 25, 2011. They argued that contagion effects were channeled through problems of liquidity in the sovereign debt market. This finding was estimated by a state-space model with time-varying asymmetric volatilities, which documented that the probability in a state of high cross-country correlations coincide with high market illiquidity, proxied by the CDS-bond basis.

Spillovers the across countries are also represented by raising time-varying conditional default probabilities, according to Zhang et al. (2012). They proposed a Copula-based methodology for estimating daily marginal, conditional, and joint risk-neutral default probability, which takes into account fat-tailed and skewed spread distributions, as well as time-varying volatilities and correlations between nations. This model was calibrated daily to a group of ten European nations by utilizing USD denominated daily 5-year CDS spreads on the date of the period 1 January 2008 to 30 June 2011. Similarly, Brutti and Sauré (2015) investigated the Greece spillover effects across financial shocks on 11 other counties in Europe. They found that the intensity of contagion depended on the exposures of cross-country banks to sovereign debt. If all other factors were equal, the transmission rate to the countries with the least exposure to Greece (0.08% of GDP) was around 46% lower than the rate to the countries with the highest exposure (1.12% of GDP).

3.4.2 Spillover between sovereign and financial CDS

In parallel to the researches on the correlations between banks and sovereign risk, several literature studied spillover effects between the financial sectors and sovereign CDS. Contagion/spillovers between these two sectors, for instance, were investigated by Bruyckere et al. (2013) through a data set of more than 50 banks and 15 countries over the period 2006-2011. They defined spillover by the relationship in spreads after they had accounted for the impacts of common exposures and economic fundamentals. Excess correlations (refers to the correlations in residual CDS spreads after the impacts of global and local risk factors being removed) were found statistically significant for 86 percent of the banks in the sample, with an average excess correlation of 17 percent. Following this, the author used these excess correlations to determine the drivers with regards to country-specific and bank variables. And they found that banks and their home countries had higher average excess correlations than banks with other countries (average excess correlations are 18.7% and 15.5% respectively). The results are stronger for GIIPS economies (4.47%). Furthermore, it is also stated that the magnitude of excess correlations between bank-country depended on banks size, and that correlations are stronger if banks have higher proportion of non-interest income, or rely more on wholesale funding, or if banks are less-well capitalized. Countries with higher credit risk are stated to have higher excess correlation with banks; however, this effect will decrease if capital adequacy ratios are high. Finally, the author also demonstrated that countries with higher debt-to-GDP ratios seemed to have pronounced contagion effects between banks and countries, and home countries had the largest magnitude of this effect among others.

Alter and Beyer (2013) used daily 5-year sovereign and bank CDS spreads of 11 EU nations from October 2009 to July 2012 to try to quantify spillover effects between sovereigns and banks during the sovereign debt turbulence. They developed spill-over indices using the findings of impulse response functions and a VAR model modified with exogenous components to contribute for any impacts from regional and common characteristics. The authors decomposed the contagion indexes into 4 components to capture excess spillover among banks, sovereigns, banks to sovereigns, and sovereigns to banks by aggregating spill-over indices over time. Overall, the findings suggested that during the sovereign debt crisis, there were greater (higher) interdependencies between banks and sovereigns.

Billio et al. (2013) used a different approach to examine the feedback effects and time-varying dependencies across banks, insurance corporates and sovereigns in three areas (including Japan, the United States, and Europe). The authors proposed to quantify the dynamics of systemic risk and the interactions of financial system by combining contingent claim analysis, network analysis, and Granger causality applied to CDS spreads.

3.5 Frictions and CDS-bond relationship

According to Duffie (1999), it is theoretically argued that the CDS spreads and the spreads on a par floating rate notes over a risk-free benchmark should be roughly equaled. Consequently, the difference between the bond and CDS spreads (which is also defined as CDS-bond basis) should be zero in a perfect market with no frictions. However, as discussed in section 2.1.1, it is empirically highlighted that this theoretical arbitrage relationship had deficiencies, prompting researchers to study whether the cash bond market reflects new information more quickly (or whether it is more informationally efficient than the CDS market), or vice-versa. Determinants of CDS-bond basis which related to limits of friction and arbitrage was alternatively investigated in one or both of CDS and cash bond market.

These aspects were also discussed in section 2.1.1 of this thesis, so in this subsection, we will focus providing literature review on the price discovery and informational efficiency of sovereign CDS spreads as well as the sovereign CDS market liquidity. Following this, we will end up by reviewing how the introduction or existence of sovereign CDS influences public bonds.

3.5.1 Price discovery and informational efficiency

In terms of price discovery, while there appears to be some agreements that the CDS market is more efficient for corporate entities, this consent is mixed and ambiguous for sovereign reference entities. These inconsistencies could be the consequences of the variation in time periods, data sources, sampling frequency, or sample size. However, while several researchers declared in favor of CDS markets and others in favor of bond markets, my understanding of the literature is that because the credit derivatives market has developed, the price discovery in this market increased.

Augustin (2014) provided a thorough literatures reviews across this topic, so I limit the findings to the primary insights from these studies in this section.

Several researchers indicated the time-varying dependence of informational efficiency and argued that it was more informational efficient in the more liquid of both CDS and the bond markets. The price discovery is thus state dependent and a feature of relative liquidity in the two markets (Arce et al., 2013). Ammer and Cai (2011), who showed that CDS price leadership correlated negatively with the amount of bonds outstanding and favorably with the bond-to-CDS ratio of bid-ask spreads, brought the differential liquidity arguments for price discovery to the fore. Coudert and Gex (2013) also studied the liquidity of state-dependent price discovery and confirmed that during the global financial crisis, CDS played a more essential role compared to bond. These authors also linked their findings to market participants, which illustrated that while a bearish CDS trader will stay in and buy protection, a bearish bond investor will stay out. Otherwise, these findings can also explain the increases in relative efficiency of information of sovereign CDS markets over time, even as the market has grown.

Palladini and Portes (2011) used CMA quote data of six developed European countries from 30 January 2004 to 11 March 2011 and found that CDS spreads dominated in the price discovery process. Varga (2009), who used the CMA database to analyze Hungary from 6 February 2004 to 18 June 2008, ended up with a similar conclusion. O'Kane (2012) utilized likewise the CMA data to investigate cross-correlations and conducted Granger causality tests for six European countries from January 1, 2008 to September 1, 2011. He found that Granger causality moved from bond to CDS markets in France and Italy, while a reverse result is indicated for Spain and Greece. Exceptionally, for Ireland and Portugal, causality seemed to move in both directions.

In contrast, instead of studying the relative informational efficiency of bonds, the direct informational efficiency of sovereign spreads were focused by Gündüz and Kaya (2014). Using both parametric and non-parametric methodologies, the paper exploited the long-memory properties of volatility (squared spread change) and spreads return (spread change) for ten countries in Europe across the period from August 2007 to October 2011. The result suggested that markets were (weak-form) informationally efficient in favored of long-memory in spreads change and information is impounded into prices in a timely basis. On the other hand, there is considerable evidence for long memory in volatilities in six out of ten countries, implying that sovereign default risk persists. Otherwise, there was also a evident that country-risked was raised by higher sovereign default risk. Lastly, additional components of analysis could be found in other literatures, such as Adler and Song (2010), Carboni (2011), Boone et al. (2010), and Li (2009).

3.5.2 Liquidity in the sovereign CDS market

Whereas the dynamics between derivatives markets and cash raised intriguing concerns, the drivers of short-term deviations from the equilibrium relationship are also worth investigating. The arbitrage opportunity seems to be naturally explained by differential liquidity. Because the underlying traded instruments are by nature simple contractual agreements, early research on this concern proposed that the credit derivative market was completely liquid. In the cash market, on the other hand, physical money is actually traded when the asset is bought. Similarly, in order to deduce liquidity features of the bond market, Longstaff et al. (2005) proposed CDS spread as pure determinant of default risk. Even for corporate reference contracts, the academic studies on liquidity impacts in the CDS markets is relatively young, although the literature is developing quickly. Bongaerts et al. (2011) and Tang and Yan (2007) both focused on liquidity features in the synthetic credit derivatives markets for corporate reference entities. The former demonstrated that both liquidity risk and liquidity features accounted for around 20% of the time series variation in CDS spreads, while the latter provided a strong evidence for a protection seller's projected liquidity premium. However, the cost of the premium is still negligible.

In terms of sovereign CDS, Pan and Singleton (2008) studied the liquidity components of sovereign spreads from interactions with market participants, particularly at short-term maturities. The disparities between the model-implied and observed spreads of Turkey, Brazil, and Mexico is linked to the fact that big institutional traders allegedly express their perspectives on sovereign credit risks by short-term trading in CDS contracts, despite the fact that a liquidity variable is not integrated directly into their pricing model. Using bid-ask spreads as a proxy for a sample of daily CDS spreads from Credit Trade (which accounts for roughly 10% of the overall sample), Meng and Ap Gwilym (2007) studied the drivers of CDS liquidity from July 7, 2003 to March 3, 2005. They found that the imbalance/pressure of demand and supply, downgrade watch status, price clustering and volatility are linked to higher bid-ask spread. Furthermore, greater bid-ask spreads are linked to lower credit ratings and CDS maturities that are less popular. Higher notional amounts exchanged are associated with a reduction of bid-ask spreads, and there is evidence of bid-ask spread commonality. As their trading has developed, bid-ask spreads have also narrowed. Most crucially, speculative-grade sovereign reference entities have greater bid-ask spreads on average than speculative-grade corporate reference entities, but investment-grade issuers appear to have no such difference. Finally, bid-ask spreads for CDS spreads referencing subordinated debt and contracts specifying restructuring as a credit event are wider.

Using a factor model, Badaoui et al. (2013) decomposed sovereign CDS spreads into four components (including correlation, systematic liquidity, country-specific liquidity and default risk components) to account for correlated liquidity and credit risks. The authors assumed that CDS and bond spreads are driven by the same default risk components, but that they may have various systematic and country-specific liquidity components which are all interrelated. Over the period November 2005 to September 2010, a daily calibration using both CDS and bond spreads for 9 emerging countries provided evidence that the credit risk components account for the highest amount of sovereign CDS spreads (roughly 55.6 percent), the liquidity risk component for about 44.32 percent, and the correlation risk component for a small amount of 0.043 percent. Furthermore, the findings also suggested a negative correlation between liquidity and default risk.

Finally, Pelizzon et al. (2013) measured the Italian CDS spreads to investigate the dynamic relationships between sovereign credit risk and liquidity in the Italian government bond market. They discovered that the relationship between liquidity and credit risk is influenced by credit risk levels, and information flows from credit risk to liquidity. Both lagged and contemporaneous CDS spread variations, specifically, explained quoted bid-ask spreads in the interdealer market up to a 500-basis-point endogenously determined CDS threshold, over which both the intensity and speed of credit risks transmission are affected. Moreover, the authors also revealed that the announcement of Long-Term Refinancing Operations (LTROs) by the European Central Bank was beneficial in reducing the dynamic relationship between sovereign credit risk and liquidity.

3.5.3 The impact of sovereign CDS impacts on public bonds

As mentioned in the introduction of chapter 3, speculation in the sovereign CDS market was one of the explanation of the increase in public borrowing prices during the European debt crisis. As a result, BaFin, Germany's financial regulator, imposed an outright ban on naked sovereign CDS in May 2010, despite the fact that the European Commission's official report failed to give conclusive proof (See Criado et al., 2010). In November 2012, the European Union followed Germany's lead and restricted the use of sovereign credit swaps to investors wanting to hedge long positions.

Portes (2010) supported the prohibition of naked CDS, arguing that naked CDS purchases unnecessarily raised borrowing rates. This viewpoint was largely supported by statistical data in

Palladini and Portes (2011), which showed that CDS spreads had superior price discovery for six countries in Europe and that information transferred from the CDS to the cash market. Both Duffie (2010a) and Duffie (2010b) shared an opposing views that the prohibition of naked CDS affected on the reduction of price information quality and market efficiency, as well as the increase in execution costs. Furthermore, due to the empty creditor problem, a covered insurance holder's monitoring incentives may have been diminished, lowering the borrower's efforts to make effective investments. As a result, these channels would result in greater public borrowing costs rather than lower.

Sambalaibat (2011) investigated the topic of naked CDS from a theoretical perspective, demonstrating that the effect is dependent on the insurance market's infrastructure. The ultimate outcome was determined by the parameter values, and naked CDS buyers may promote either under-investment or over-investment, resulting in lower borrowing costs. Verdier (2004) additionally provided a legal analysis of how credit derivatives may affect the national debt restructuring process.

While the theoretical evidence on the effects of sovereign CDS on public bonds is mixed and ambiguous, the empirical evidence currently available indicated a favourable result. For example, Ismailescu and Phillips (2011) explored whether the presence or introduction of sovereign CDS has any negative consequences on sovereign bonds. The authors described sovereign CDS as effective monitoring tools that can help countries with informational opacity lower their unfavorable selection costs. Furthermore, they encouraged market involvement by allowing for better risk sharing among high-default countries. Their findings showed that the CDS introduction makes public bond markets more comprehensive, and that the sovereign bond price efficiency improved after the CDS introduction (although this seemed to be restricted to low financial market openness and high default risk economies). Finally, CDS introduction raised borrowing cost for low financial market openness and high default risk nations by approximately three to five percent (about 14 basis points), but reduced borrowing cost for investment grade nations by 15-26 percent on average (13 basis points). Pu and Zhang (2012a) investigated Germany's temporary naked CDS prohibition on May 19, 2010, providing specific evidence that the bid-ask spreads and sovereign CDS spreads of the GIIPS countries continued to grow after the restriction. They, on the other hand, discovered that the volatility of sovereign CDS spread has decreased.

To conclude, the empirical and theoretical evidence makes it impossible to draw any conclusions to support or against the idea that increasing CDS spreads triggered the rise in public borrowing cost amid the sovereign debt crisis. Maintaining the argument in favor based solely on the information of price, without knowledge of trading position in relation to actual public exposures, is difficult to justify, in my opinion. Furthermore, there is little recent evidence of trading information in relation to the size of the public debt market. Even if the price discovery in the CDS market with information flows from the derivatives to the cash markets is evidence to support the idea that price speculation increases public borrowing cost, regulators should acknowledge that empirical findings are largely ambiguous when making drastic regulatory changes that may ultimately harm the efficient information transmission in financial markets.

CHAPTER 4: A case for Southeast Asia: Empirical Test on the relationship between the Sovereign CDS and the stock indexes.

4.1 Literature review and methodology

Credit Default Swaps (CDS) have grown to be a multi-trillion-dollar, global essential market and there are tremendous academic literatures on CDS developed in paralleled with the market practioners, public debates, and regulatory initiatives in this market. It is inevitable to note that there exists apparent relationships between CDS and other financial instruments such as: corporate bonds; sovereign bonds; corporate shares and the stock indexes, especially after the economic crisis in the period 2007-2008, these relationships are state dependent. In this chapter, we will examine the lead-lag relationship between the sovereign Credit Default Swaps (CDS) and the stock markets for five Asian countries during the period 2016-2020. These five countries are Japan; Korea; Thailand; Indonesia and Philippines. The study of the lead-lag relationships has shown to be a valuable method of analyzing the dynamic behavior of several associated markets or asset prices. These relationships indicate that if one market processes new information faster than another, the leading market is more sensitive to the new information and more liquid. The relationship between the markets of sovereign CDS, sovereign bonds and the stock index have been disregarded until recently, due to the insufficient liquidity of some markets for sovereign CDSs. During the year 2010, the sovereign CDS spread surged to the maximum levels as the euro zone economies came under pressure from growing uncertainties about the ability of some European nations with stagnant economies to accomplish significant reductions in their budget deficits without defaulting or being rescued. Therefore, the relationship between sovereign CDS and stock markets or sovereign bonds became the concentration of several analyses (see e.g the papers by Arce et al. (2013), Coudert and Gex (2010), Fontana and Scheicher (2010)). At the sovereign levels, the research conducted by Courdert and Gex (2010) confirms the findings from previous literatures on the leadership of the CDS pricings. Arce et al. (2011) examined sovereign CDS and bond markets and discovered that the price discovery mechanism is state dependent.

The relationship between CDS spreads and equity prices has been discussed in papers by Bystrom (2005) and Fung et al (2008) among other. Using a sample of European i-Traxx CDS indexes, Bystrom obtains the evidence of firm-specific information being embedded into stock prices before it is embedded into CDS spread. He also finds that the stock price volatility is significantly correlated with CDS spread. Fung et al. (2008) using a Vector Autogressive Model (VAR) and daily index data, also document a leading role for the stock markets with respect to the CDS market. They discover a tighter link between the stock and the CDS markets during the 2008 credit crisis era, as well as a crucial function for investment grade CDSs in integrating information. Furthermore, the definite leading role of the stock market with respect to the CDS market and bond market is highlighted in the research of Noden and Weber (2009) and Forte and Pena (2009). A striking important finding in Norden and Weber (2009) is that the lower the quality of the credit, the greater the co-movement of the CDS market and the stock market. Longstaff et al. (2003), on the other hand, find little indication of the stock market playing a leading role in connection to the CDS market.

In this thesis paper, we will concentrate on analyzing the relation between the sovereign CDS spread and the stock pricing of some Asian countries. Although there is a variety of literatures studying about the contemporaneous co-movement of the CDS spread and the stock market of European countries, there are few papers conducting the research on this relationship of Asian countries, especially at the sovereign level.

It is not possible to illustrate the price discovery due to the differing characteristics of the two markets analyzed here, one connected to sovereign credit risk and the other to market risk. Instead, we examine Granger causality in a VAR model in order to test for price leadership. By using the closing price of the country's main stock index as the proxy and the daily prices of the 5-year sovereign CDS spreads in five different countries during the period from 2016 to 2020, this paper will contribute to the existing literature in three main aspects.

Firstly, we will study the lead-lag relationship between the sovereign CDS and the stock indexes in order to determine if there is a market playing a leading role in the process of incorporating new information. I find a co-movement between the two markets and the relationship between both markets is state dependent.

The secondly objective is to test whether or not there was a change in the relationship during the covid-19 pandemic period. In line with previous research (Norden and Weber,2009), we estimate a three dimensional VAR model, adding the historical volatility measured within 100 trading days of the stock market to check for a potential omitted variable problem.

Finally, we will test for the differences in behavior in countries with lower credit quality and countries with higher credit quality. Therefore, we will split the sample into 2 groups: countries with higher credit quality (Japan, Korea) and countries with lower credit quality (Indonesia, Thailand and Philippines). The results corroborate with the previous findings that during the sample period (2016-2020), the CDS markets take the lead in the process of incorporating new information, especially during the covid-19 pandemic. We also find a result which support earlier findings of Norden and Weber (2009) that the lower the quality of the credit risk (the sovereign CDS market in our case), the stronger the co-movement between CDS markets and the stock markets.

4.2 An overview of the data

In this research, we use the daily data of the closing price of 5-year sovereign CDS spreads of 5 Asian countries and their own stock indexes. We intend to use the contracts of 5-year as the benchmark maturity of the sovereign CDS spread, even though the contracts of 10-years or 15-years are still available. We use the mid-points between quoted bid and ask points for the 5-year maturity CDSs denominated in USD, which is the standard currency in this market. The sample consists of the data of five Asian countries namely Japan; Korea; Indonesia; Thailand and Philippines. With regard to the proxy for stock market, we use the the closing prices of the country's main stock index such as: ^N225 (Japan); KS11 (Korea); JKSE (Indonesia); SET (Thailand) and PCOMP (Philippines).

The selection of these countries is determined by the intention to have a set of risky countries (countries with a high CDS premium) and the safer countries (countries with lower risk premium). The intention of this part is to examine the how relationship between sovereign CDS and the stock market behaved during the period from 2016 to 2020, especially in the year 2020 when the economics all over the world have been hit severely by the covid-19 pandemic.

We summarized the CDS average premium for each country in the year 2020 in **Table 4.1**. By doing this, we can separate the sample into 2 groups: Asian countries with lower risk premium (CDS average premium under 50pts) and Asian countries with higher spreads (CDS average spreads above 50pts).

Table 4.1: *Average spread of CDS of each countries in 2020*

Country	CDS average spread in 2020
Indonesia	119.85
Philippines	57.96
Thailand	52.84
Korea	26.87
Japan	22.10

Table 4.2 to 4.6: *The main descriptive statistics for each country's sovereign CDS and the stock index; splitting the samples into two time series: From 2016 to 2020 and only for the year 2020. We present 4 different variables and for instance: N225: Japan stock index;* $\Delta N225$*: the stock return; CDS: the sovereign CDS and* ΔCDS*: the sovereign CDS premium daily changes.*

Table 4.2: *Japan's sovereign CDS and the stock index*

Japan	2016-2020				2020			
	N225	$\Delta N225$	**CDS**	**ΔCDS**	**N225**	$\Delta N225$	**CDS**	**ΔCDS**
N	1305	1305	1305	1305	261	261	261	261
Mean	20767.470	0.0003	30.8819	-0.0235	22691.6600	0.0006	**22.1001**	-0.0182
Median	21292.290	0.0000	25.1660	0.0000	23088.8850	0.0000	18.4025	-0.0010
Maximum	27568.150	0.0773	47.3250	7.9340	27568.1500	0.0773	47.1940	7.9340
Minimum	14952.020	-0.0825	15.5800	-20.6200	16552.8300	-0.0627	15.5800	-5.0090
Skewness	-0.268	-0.2048	0.5148	-13.3023	-0.3178	0.2115	1.6279	2.1958
Kurtosis	-0.438	6.9397	-1.4270	414.0784	0.1560	4.8608	1.4838	20.6750

Table 4.3: *Korea's sovereign CDS and the stock index*

Korea	2016-2020				2020			
	KS11	$\Delta KS11$	**CDS**	ΔCDS	**KS11**	$\Delta KS11$	**CDS**	ΔCDS
N	1305	1305	1305	1305	261	261	261	261
Mean	2190.771	0.0003	42.8928	-0.0259	2222.8161	0.0010	**26.8721**	-0.0086
Median	2152.750	0.0004	41.8330	0.0000	2225.5300	0.0021	24.6505	0.0000
Maximum	2873.470	0.0825	81.1670	9.7840	2873.4700	0.0825	61.0920	8.8890
Minimum	1457.640	-0.0877	20.5820	-15.2140	1457.6400	-0.0877	20.5820	-15.2140
Skewness	0.326	-0.3922	0.3332	-0.1864	0.0105	-0.2814	1.9860	-1.3349
Kurtosis	-0.080	12.4446	-0.7943	17.6051	0.0939	5.7776	4.6879	20.1333

Table 4.4: *Indonesia's sovereign CDS and the stock index*

Indonesia	2016-2020				2020			
	JKSE	**ΔJKSE**	**CDS**	ΔCDS	**JKSE**	**ΔJKSE**	**CDS**	ΔCDS
N	1305	1305	1305	1305	261	261	261	261
Mean	5677.701	0.0002	126.6730	-0.1243	5240.7810	-0.0002	**119.8563**	0.0002
Median	5824.249	0.0000	117.5570	-0.0695	5121.4980	0.0000	103.6070	0.0000
Maximum	6689.287	0.0970	292.2500	50.7830	6325.4060	0.0970	292.2500	50.7830
Minimum	3937.632	-0.0681	58.7030	-49.5200	3937.6320	-0.0681	58.7030	-49.5200
Skewness	-0.431	-0.1200	0.9653	1.6083	0.2918	0.0798	1.0243	1.0944
Kurtosis	-0.850	11.7946	0.4948	32.0720	-0.7126	6.8493	0.0263	10.9105

Table 4.5: *Thailand's sovereign CDS and the stock index*

Thailand	2016-2020				2020			
	SET	**ΔSET**	**CDS**	**ΔCDS**	**SET**	**ΔSET**	**CDS**	**ΔCDS**
N	1305	1305	1305	1305	261	261	261	261
Mean	1549.478	0.0001	58.6014	-0.0752	1343.6455	-0.0003	**43.7632**	0.0439
Median	1575.910	0.0000	46.2260	0.0000	1336.2000	0.0000	41.5240	0.0000
Maximum	1838.960	0.0765	174.9990	25.6220	1600.4800	0.0765	93.9800	25.6220
Minimum	1024.460	-0.1143	20.7290	-16.2700	1024.4600	-0.1143	20.7290	-16.2700
Skewness	-0.599	-2.0899	1.6708	2.6797	0.0263	-1.6823	1.0676	2.4440
Kurtosis	-0.216	28.9098	2.2133	37.9086	0.0111	11.4681	1.9247	25.6899

Table 4.6: *Philippine's sovereign CDS and the stock index*

Philippines	2016-2020				2020			
	PCOMP	**ΔPCOMP**	**CDS**	**ΔCDS**	**PCOMP**	**ΔPCOMP**	**CDS**	**ΔCDS**
N	1305	1305	1305	1305	261	261	261	261
Mean	7427.574	0.0000	75.2201	-0.0553	6355.2673	-0.0003	**57.9567**	0.0077
Median	7629.640	0.0000	73.8450	-0.1625	6160.1350	0.0000	49.9490	-0.1620
Maximum	9058.620	0.0717	170.9750	46.1700	7840.7000	0.0717	170.9750	46.1700
Minimum	4623.420	-0.1432	32.9680	-41.8130	4623.4200	-0.1432	32.9680	-41.8130
Skewness	-0.932	-1.6383	0.3522	1.5637	0.3256	-1.9156	1.6117	0.9788
Kurtosis	0.569	19.4785	-0.6011	68.9722	-0.8374	12.7501	2.9117	23.8812

Figures 4.1 and 4.2 illustrate the graph of the movements during the period from 2016 to 2020 for both the CDS premium and the stock indexes of Korea and Philippines. Despite the fact that these two countries belonged to two groups with different levels of CDS premium, it is worth to note that spreads on the sovereign CDS widen when there exists a decrease in the credit risk or perceived by the market and narrowed when less credit risk is recognized. It can be seen clearly that in the period of covid-19 pandemic as the CDS premiums widen (the credit risk increases), the stock indexes slump (market risk also increases). The co-movements in both market are reversely correlated.

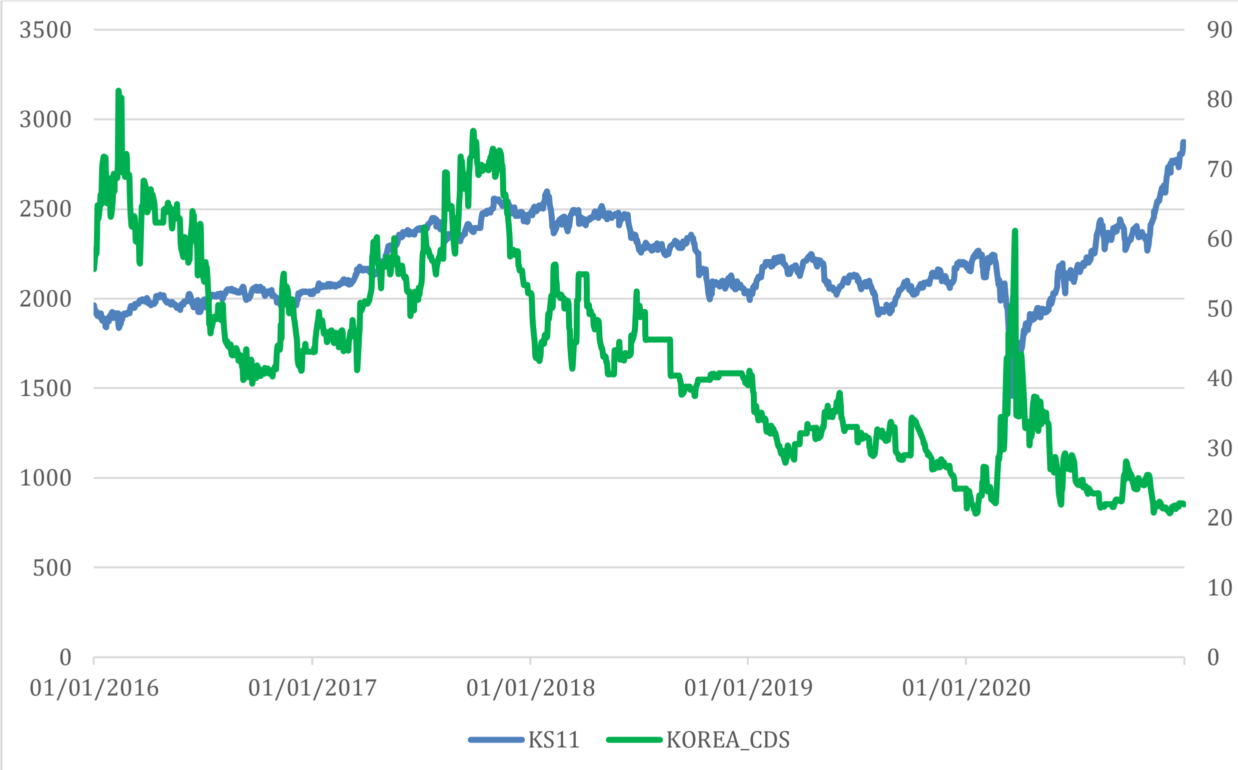

Figure 4.1: *Daily time series from Korea Sovereign CDS Spread and Korean Stock market (^KS11)*

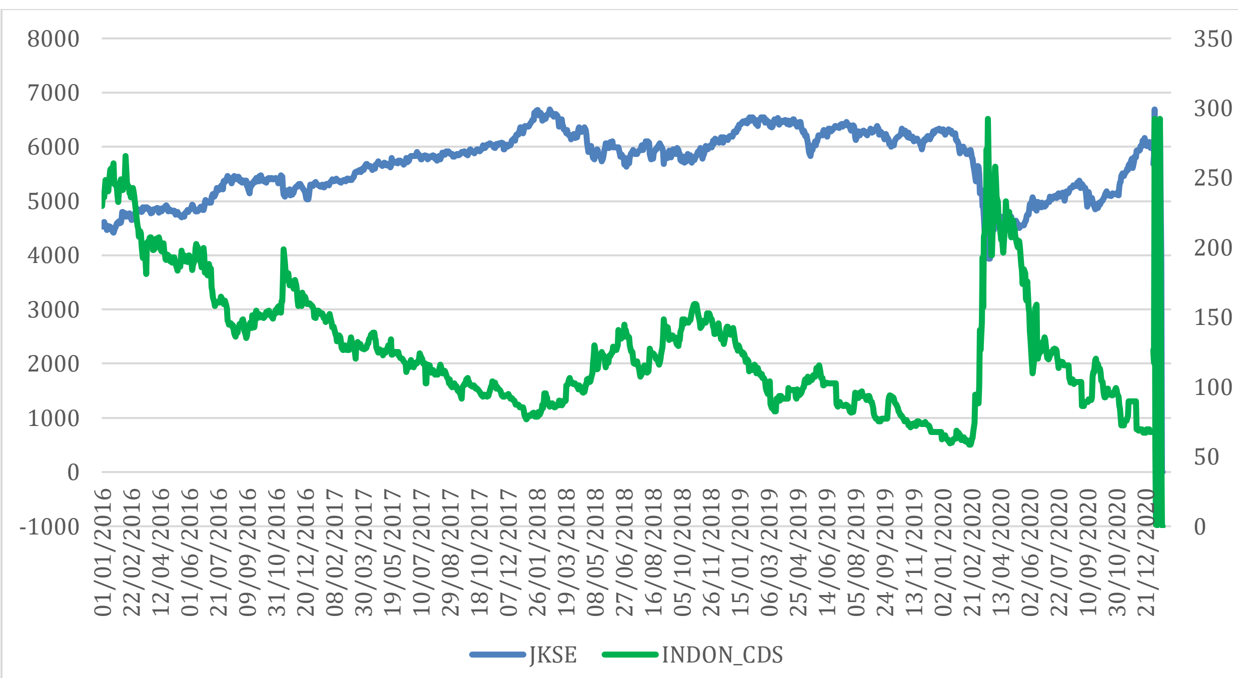

Figure 4.2: *Daily time series from Indonesia Sovereign CDS spread and Indonesia Stock Market (JKSE)*

4.3 Analysis of the empirical results

4.3.1 Lead-lag relationship between sovereign CDS and stock market

In this section, we analyse the co-movement of the sovereign CDS spread and the stock market returns at the aggregate level. To be specific, our objective is to elaborate the current stock market returns and sovereign CDS spread changes with a two dimension Vector Autoregressive Model (VAR). A VAR model is appropriate for the analysis of the co-movement of markets since it captures lead-lag relationships within and between stationary variables in a simultaneous multivariate framework. We estimate the following two dimension VAR model:

$$R_t = \alpha_1 + \sum_{p=1}^{p} \beta_{1p} R_{t-p} + \sum_{p=1}^{p} \gamma_{1p} \Delta CDS_{t-p} + \varepsilon_{1t}$$

$$\Delta CDS_t = \alpha_2 + \sum_{p=1}^{p} \beta_{2p} R_{t-p} + \sum_{p=1}^{p} \gamma_{2p} \Delta CDS_{t-p} + \varepsilon_{2t}$$

With R_t : the stock index return at time t; ΔCDS_t : sovereign CDS spread change in t; p: the lag order index; ε_t : the disturbance term in t.

For the above model specification, we have to determine the lag structure and the maximum lag order – p. For each country, we found the optimal lag by computing the Akaike information criterion (AIC) and the Schwart Bayesian information criterion (BIC).

The results of the VAR models for the five Asia countries, with the corresponding optimal lag length, is found in Tables 4.7 to 4.11. The entire time series sample is split into 2 different and non-overlapped subsets to capture a more detailed insights of the relationship between the daily change sovereign CDS spread and the daily stock index return.

Table 4.7: *Japanese model's statistics*

JAPAN	2016-2019				2020				2016-2020			
Dep.Var	R_t		ΔCDS_t		R_t		ΔCDS_t		R_t		ΔCDS_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.031	**-0.074**	1.748	0.038	0.063	0.024	4.436	-3.864	0.028	-0.031	1.698	-3.100*
R_{t-2}	0.031	0.014	1.750	-0.704	0.063	**0.141**	4.407	**-12.271**	0.028	**0.061**	1.700	**-5.043**
R_{t-3}	0.031	0.039	1.743	0.111	0.062	-0.042	4.325	**-16.359**	0.028	0.032	1.692	**-5.152**
R_{t-4}	0.031	-0.053	1.744	1.261	0.063	**-0.154**	4.436	3.530	0.028	**-0.062**	1.696	1.389
R_{t-5}	0.031	-0.009	1.742	0.407	0.064	-0.119	4.485	4.759	0.028	-0.027	1.698	0.416
ΔCDS_{t-1}	0.001	0.0001	0.031	-0.001	0.001	-0.002	0.064	**-0.148**	0.0005	-0.001	0.028	-0.043
ΔCDS_{t-2}	0.001	- 0.0002	0.031	-0.001	0.001	**-0.002**	0.062	0.033	0.0005	-0.001	0.028	0.037
ΔCDS_{t-3}	0.001	- 0.0003	0.031	- 0.0004	0.001	-0.005	0.060	-0.037	0.0005	**-0.002**	0.028	-0.021
ΔCDS_{t-4}	0.001	0.0002	0.031	-0.002	0.001	-0.0001	0.062	**0.332**	0.0005	0.0001	0.028	**0.150**
ΔCDS_{t-5}	0.001	0.0003	0.031	-0.001	0.001	0.001	0.064	0.068	0.0005	0.0004	0.028	0.020
Const	0.0004	0.0003	0.020	-0.025	0.001	0.0005	0.064	-0.001	0.0003	0.0003	0.021	-0.017
Obs		1039		1039		256		256		1300		1300
R^2	0.011		0.001		0.178		0.242		0.030		0.047	
F statistic	1.155		0.071		5.290		7.814		3.924		6.383	
GC test		0.9824		0.9783		0.00012				0.0006283		

Table 4.8: *Korean model's statistics*

KOREA	2016-2019				2020				2016-2020			
Dep.Var	R_t		ΔCDS_t		R_t		ΔCDS_t		R_t		ΔCDS_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.033	-0.037	5.990	-10.085	0.076	-0.130	8.530	-8.747	0.031	**-0.069**	4.555	-6.357
R_{t-2}	0.033	**0.079**	6.001	-2.472	0.077	**0.273**	8.640	**-48.039**	0.031	**0.189**	4.574	**-22.824**
R_{t-3}	0.033	0.039	5.994	1.513	0.081	0.036	9.077	-9.471	0.031	**0.062**	4.632	-0.738
R_{t-4}	0.033	-0.056	5.984	11.354	0.079	-0.094	8.874	13.810	0.031	**-0.062**	4.594	13.855
R_{t-5}	0.033	-0.022	5.983	-1.266	0.078	**-0.156**	8.773	**30.418**	0.031	-0.042	4.592	**10.724**
ΔCDS_{t-1}	0.0002	**-0.0004**	0.033	0.033	0.001	**-0.002**	0.076	-0.052	0.0002	**-0.001**	0.031	0.013
ΔCDS_{t-2}	0.0002	0.0003	0.033	-0.062	0.001	0.001	0.075	**-0.337**	0.0002	**0.001**	0.031	-0.138
ΔCDS_{t-3}	0.0002	-0.0001	0.033	**0.074**	0.001	-0.001	0.078	0.021	0.0002	-0.0003	0.031	0.061
ΔCDS_{t-4}	0.0002	-0.0002	0.033	-0.015	0.001	-0.0001	0.075	-0.107	0.0002	-0.0001	0.031	-0.034
ΔCDS_{t-5}	0.0002	0.0002	0.033	-0.092	0.001	**-0.002**	0.075	**0.176**	0.0002	**-0.001**	0.031	-0.006
Const	0.0002	0.0001	0.041	**-0.036**	0.001	0.001	0.119	0.023	0.0003	0.0003	0.041	-0.030
Obs		1039		1039		256		256		1,300		1,300
R^2	0.019		0.025		0.136		0.175		0.050		0.043	
F statistic	1.980		2.781		3.840		5.204		6.801		5.781	
GC test		0.2784		0.07321				0.0007938				0.0001

Table 4.9: *Indonesian model's statistics*

INDO	2016-2019				2020				2016-2020			
Dep.Var	R_t		ΔCDS_t		R_t		ΔCDS_t		R_t		ΔCDS_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.033	-0.035	14.118	-18.094	0.073	-0.031	42.351	22.605	0.031	-0.028	15.970	- 3.089
R_{t-2}	0.033	-0.065	14.112	-2.954	0.072	-0.124	41.656	-76.161	0.031	**-0.090**	15.874	- 34.239
R_{t-3}	0.033	-0.064	14.102	-6.668	0.073	0.084	42.438	-22.360	0.031	0.008	16.018	- 15.001
R_{t-4}	0.033	**-0.075**	14.105	16.228	0.072	-0.036	41.433	31.401	0.031	-0.048	15.861	**22.469**
R_{t-5}	0.033	-0.016	14.966	-10.148	0.070	0.073	40.834	13.413	0.031	0.019	15.684	1.965
ΔCDS_{t-1}	0.0001	**-0.0003**	0.033	**0.072**	0.0001	**-0.0004**	0.074	0.052	0.0001	**-0.0003**	0.031	0.023
ΔCDS_{t-2}	0.0001	-0.0000	0.034	**-0.127**	0.0001	**-0.0003**	0.068	0.080	0.0001	**-0.0002**	0.030	0.015
ΔCDS_{t-3}	0.0001	-0.0001	0.034	0.038	0.0001	0.00	0.068	**0.147**	0.0001	-0.0001	0.030	**0.128**
ΔCDS_{t-4}	0.0001	-0.0001	0.033	-0.043	0.0001	0.00004	0.068	**-0.353**	0.0001	- 0.00001	0.030	**-0.253**
ΔCDS_{t-5}	0.0001	- 0.00001	0.033	-0.043	0.0001	**-0.0003**	0.072	**0.161**	0.0001	**-0.0002**	0.031	**0.117**
Const	0.0002	0.0003	0.102	-0.173	0.001	-0.0002	0.576	0.009	0.0003	0.0001	0.142	-0.119
Obs	1039		1039		256		256		1,300		1,300	
R^2	0.024		0.028		0.099		0.226		0.045		0.115	
F statistic	2.541		2.926		2.685		7.139		6.048		16.776	
GC test		0.6093		0.01128		0.371		0.005415		0.1399		

Table 4.10: *Thailand model's statistics*

THAILAND	2016-2019				2020				2016-2020			
Dep.Var	R_t		ΔCDS_t		R_t		ΔCDS_t		R_t		ΔCDS_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.033	0.022	7.623	-6.362	0.066	-0.098	11.466	12.393	0.029	**-0.063**	5.717	3.575
R_{t-2}	0.033	0.048	7.621	-3.158	0.066	0.108	11.452	1.159	0.029	**0.098**	5.710	-3.057
R_{t-3}	0.033	-0.029	7.617	**-15.595**	0.0665	**0.135**	11.368	7.795	0.029	**0.077**	5.713	1.935
R_{t-4}	0.033	-0.023	7.631	14.739	0.065	-0.010	11.381	- **26.993**	0.029	-0.033	5.690	**-12.254**
R_{t-5}	0.033	0.031	7.601	-11.668	0.066	**0.188**	11.488	5.681	0.029	**0.145**	5.704	2.851
ΔCDS_{t-1}	0.0001	- 0.00001	0.032	-0.001	0.0004	-0.0003	0.066	- 0.025	0.0001	- 0.0002	0.029	-0.022
ΔCDS_{t-2}	0.0001	**0.0004**	0.032	**-0.1**	0.0004	0.001	0.066	0.096	0.0001	**0.001**	0.029	-0.006
ΔCDS_{t-3}	0.0001	-0.0002	0.032	0.040	0.0004	-0.001	0.066	0.123	0.0001	**- 0.0004**	0.029	**0.081**
ΔCDS_{t-4}	0.0001	-0.0001	0.032	**0.065**	0.0004	0.0004	0.066	- 0.016	0.0001	0.0002	0.029	0.027

ΔCDS_{t-5}	0.0001	0.0001	0.032	**-0.09**	0.0004	0.0001	0.066	- 0.104	0.0001	0.0001	0.029	**-0.080**
Const	0.0002	0.0002	0.049	**-0.120**	0.001	-0.0002	0.194	0.050	0.0003	0.0001	0.055	-0.082
Obs		1039		1039		256		256		1,300		1,300
R^2	0.014		0.034		0.131		0.059		0.070		0.020	
F statistic	1.449		3.605		3.693		1.548		9.731		2.633	
GC test		0.04303		0.01954		0.1477		0.1414		0.2787		

Table 4.11: *Philippine model's statistics*

PHILIPPINE	2016-2019				2020				2016-2020			
Dep.Var	R_t		ΔCDS_t		R_t		ΔCDS_t		R_t		ΔCDS_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.032	**-0.068**	6.234	10.282*	0.073	**-0.211**	23.457	21.315	0.030	**-0.134**	7.910	**20.502**
R_{t-2}	0.032	-0.056	6.239	-2.254	0.074	0.041	23.833	**-57.755**	0.030	-0.010	**7.966**	**-27.689**
R_{t-3}	0.032	0.030	6.238	-3.606	0.073	0.134	23.581	23.037	0.030	**0.087**	7.968	8.438
R_{t-4}	0.032	-0.033	6.227	0.805	0.073	-0.041	23.548	28.243	0.030	-0.037	7.945	11.048
R_{t-5}	0.031	0.023	6.154	-0.569	0.069	**-0.149**	22.321	21.957	0.030	-0.046	7.722	5.135
ΔCDS_{t-1}	0.0002	**-0.001**	0.032	**0.135**	0.0002	**-0.001**	0.075	-0.081	0.0001	**-0.001**	0.030	-0.031
ΔCDS_{t-2}	0.0002	-0.0002	0.033	-0.057	0.0003	-0.0004	0.081	-0.077	0.0001	**-0.0004**	0.031	-0.033
ΔCDS_{t-3}	0.0002	0.0001	0.032	**0.078**	0.0003	-0.0002	0.080	**0.184**	0.0001	-0.0001	0.031	**0.150**
ΔCDS_{t-4}	0.0002	0.0002	0.032	-0.020	0.0003	0.0002	0.080	-0.037	0.0001	**0.0003**	0.031	**-0.066**
ΔCDS_{t-5}	0.0002	0.0001	0.032	-0.0132	0.0002	**-0.001**	0.077	**0.193**	0.0001	-0.001	0.031	**0.118**
Const	0.0003	0.0001	0.058	-0.067	0.001	-0.0004	0.377	0.004	0.0003	-0.0001	0.088	-0.051
Obs		1039		1039		256		256		1,300		1,300
R^2	0.044		0.026		0.208		0.134		0.098		0.071	
F statistic	4.692		2.702		6.440		3.801		14.068		9.815	
GC test		0.635				0.0337						

The VAR results are displayed on the above table with the characteristics of each Asia countries and the lead-lag analyses are based on the foundation of statistically significant coefficients. Regarding the entire period (2016-2020), for all countries analyzed, the sovereign CDS market leads the stock market except for Japan, where the stock market was leading in incorporating new information. If we examine the different time-series, it is notable to highlight that the role of the sovereign CDS market outweigh the effects of the stock market. To be more specific, for example, in Indonesia case during the period from 2016 to 2020, the stock market depended on the first, second and fifth lags of the sovereign CDS changes while the sovereign CDS change only depend on the fourth lag of the stock return. We observed the same results in Korea, Thailand and

Philippines cases. However, there exists a reverse pattern in the case of Japan where the sovereign CDS change fully depends on the first and second lags of the stock return.

In the first sub period from 2016 to 2019, the sovereign CDS change took a leading role with respect to the stock market while the latter did not depend on any sovereign CDS lags. During the year 2020, the leading role of the sovereign CDS spread still remained unchanged and it can be seen that the stock returns depended on the first, second and fifth lags of the sovereign CDS change. Korea, Indonesia and Philippines are the typical example of this pattern. However, in Thailand, the stock market depended on its own third and fifth lags, and the sovereign CDS change was likely affected by the fourth lag of the stock index return. The relationship between the sovereign CDS market and the stock market was not apparent in Thailand in the year 2020.

As can be seen from those tables, the value of the model R^2 witnessed an increase over the analyzed sub period, especially when the data of 2020 is used. This result indicates the improved suitability of the estimated model during this period. Furthermore, with regard to almost all of the significant coefficients cases, there is a correct negative pattern which indicates an increase in the credit risk with a fall in the stock market returns.

However, the estimated coefficients from the VAR model are not really helpful to analysis the effects of the lead-lag relationship. Since in the real situation, the model may have more variables and more lags, and it is difficult to interpret the coefficients. Therefore, one way to deal with this issue is to carry our further steps to check whether or not there exists the "Granger causality" between the variables and to examine the impulse response functions. Before doing that, we have to check the stationary of our model by examining the unit roots of each country' models. As the results showed in the Table 4.8 after running "roots" functions on R-studio, all the unit roots of the each country' models are less than 1 and it means that the model is stable.

Model of each country	Roots of the characteristic polynomial
Japan	0.6622 0.6455 0.6272 0.6272 0.5387 0.5387 0.5309 0.5309 0.3529 0.1441
Korea	0.6445 0.6445 0.6279 0.6279 0.5963 0.5963 0.5885 0.5885 0.5304 0.5304
Indonesia	0.8108 0.8108 0.6468 0.6468 0.4872 0.4872 0.4856 0.4856 0.4159 0.4159
Thailand	0.742 0.742 0.7052 0.66 0.66 0.6224 0.6224 0.5675 0.5675 0.567
Philippine	0.7467 0.7467 0.6427 0.6427 0.5373 0.5373 0.4639 0.4639 0.3643 0.3508

Table 4.12: *Roots of the characteristic polynomial*

The Granger Causality test is a statistical hypothesis test which is applied for determining whether one time series is useful in forecasting another. A variable X is said to Granger-cause a variable Y if the projections of the value of Y based on its own past values and on the past values of X are more significant than the predictions of Y based on only its own past values. The null hypothesis of Granger Causality is that the lags of the variable X do not Granger cause the variable Y. We run the Causality of vars packages on R-studio and the p-values of Granger Causality test for each country are presented on the Table 4.11. It is worth noting that during the whole period from 2016 to 2020 the leading role of the sovereign CDSs is clearly appreciated. To be more specific, for example, in the model of Indonesia, the p-values are pretty small, closely equal to 0 and it means that we can reject the null hypothesis: "The sovereign CDSs spread does not Granger cause the stock return". This result indicates that the sovereign CDS spread Granger cause the stock return of Indonesia's stock market. We also find the evidence that the sovereign CDS market takes the lead in 4 out of the 5 analyzed countries. When we analyzed the sub periods, especially in the year 2020, the sovereign CDS spread still plays a leading role with respect to the stock returns. However, regarding the Thailand case, we cannot reject the null hypothesis and it means that there is no evidence for the cause-and-effect relationship between the sovereign CDS market and the stock market.

Finally, we examine the impulse responses of both stock market and sovereign CDS market if there exists some future shocks to each input variables. The impulse response function is one the most essential structural analysis tools which is used to trace the reaction of a dynamic system to the external change. By running the "IRF" function of the packages "VARS", we examine the responses of the Sovereign CDS market to the stock market and vice versa in 180 days ahead. The results are interpreted by graphs presented on the Figures 4.3 to 4.12 below:

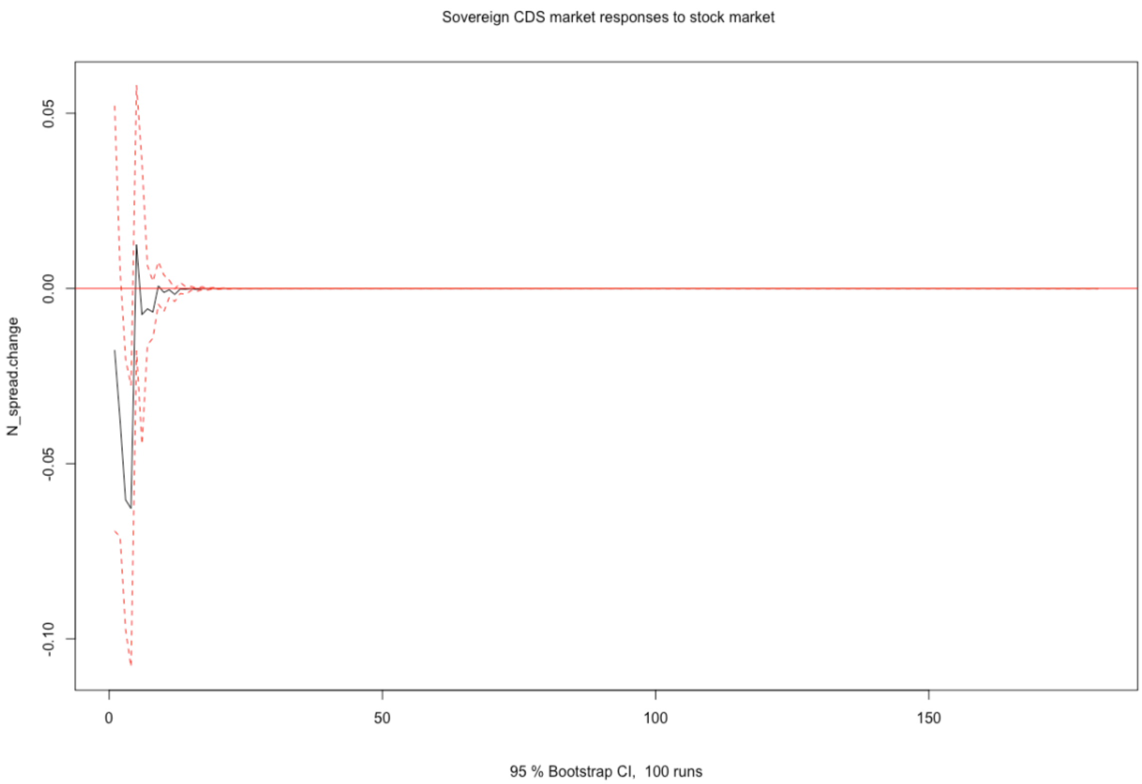

Figure 4.3: *Japanese sovereign CDS's response*

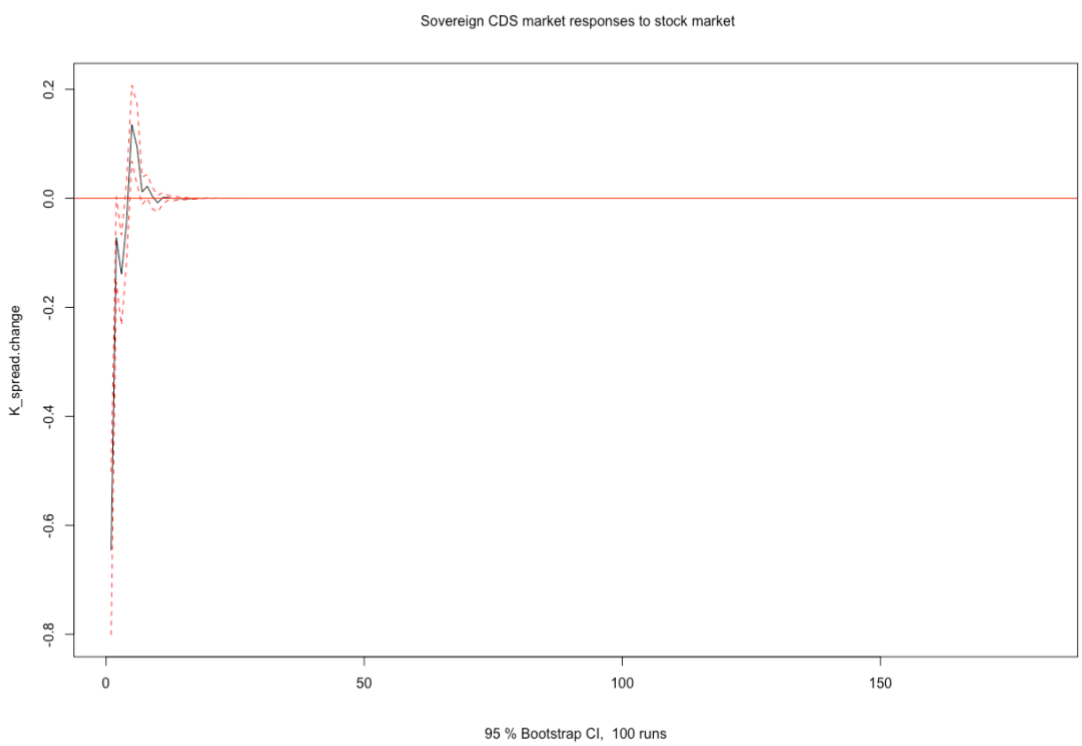

Figure 4.4: *Korean sovereign CDS's response*

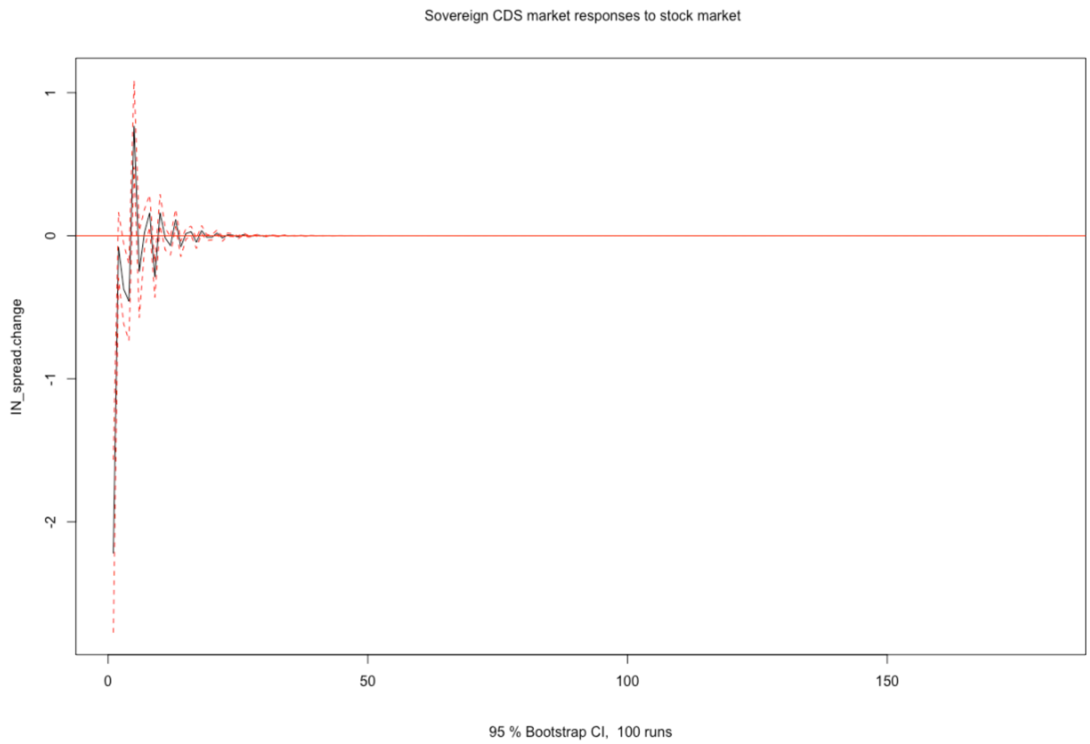

Figure 4.5: *Indonesian sovereign CDS's response*

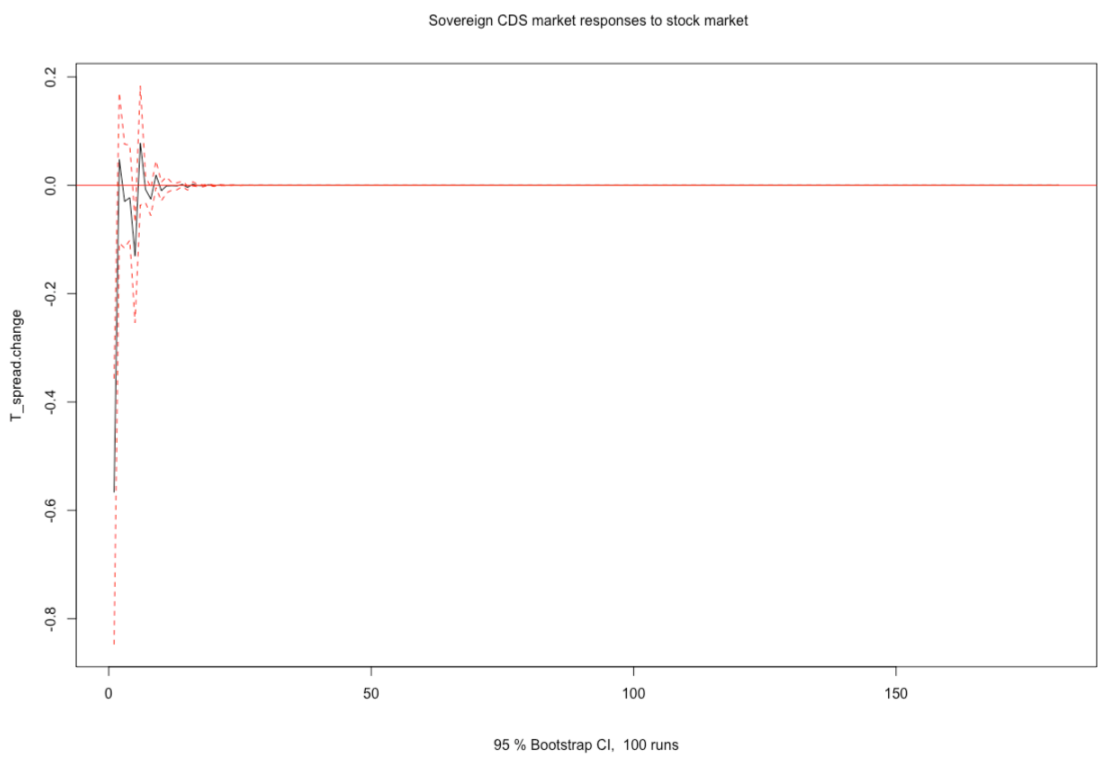

Figure 4.6: *Thailand sovereign CDS's response*

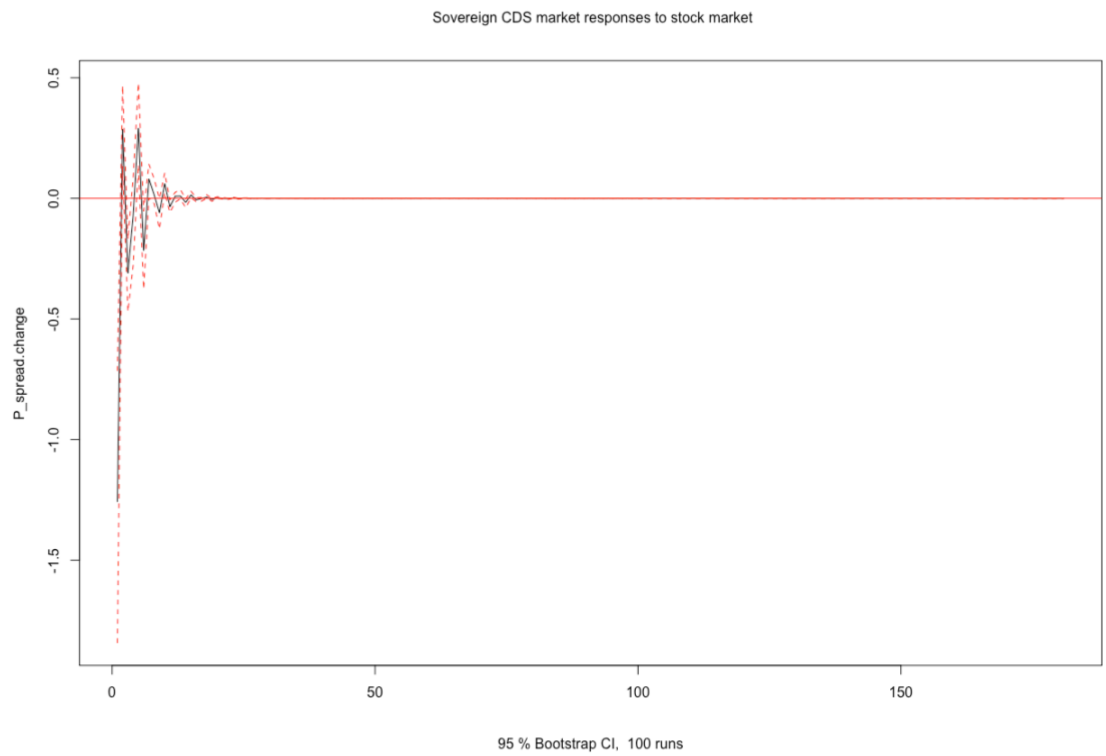

Figure 4.7: *Philippine sovereign CDS's response*

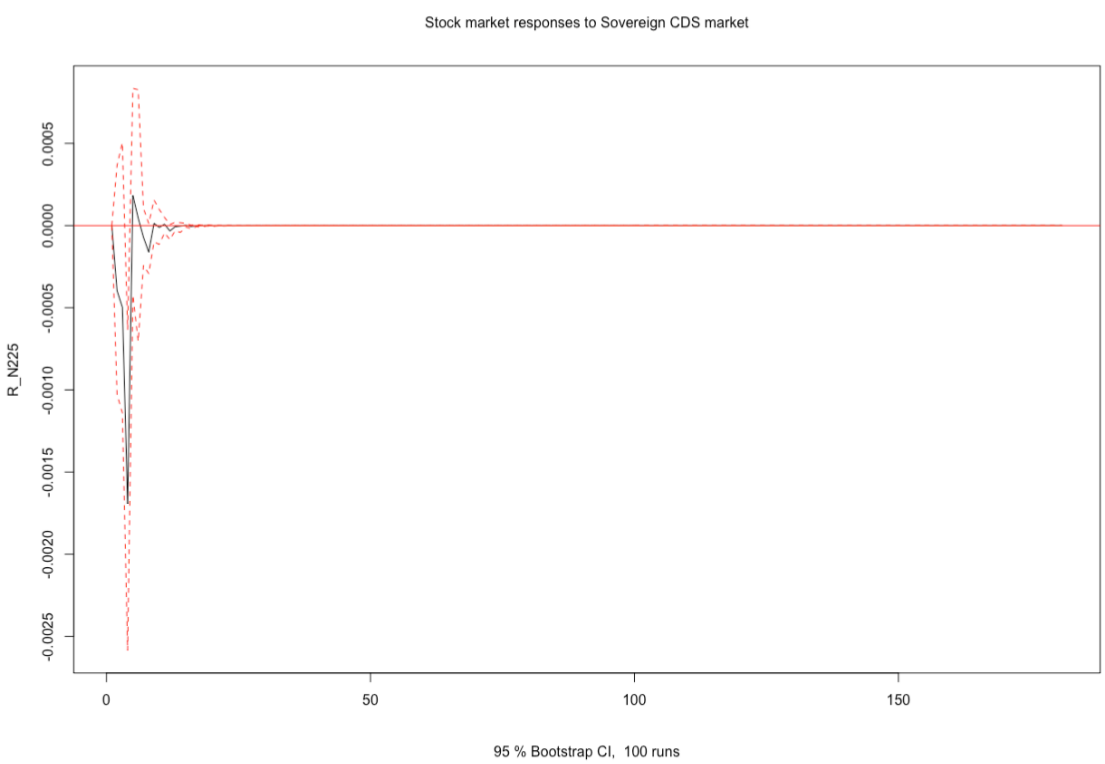

Figure 4.8: *Japanese stock market's response*

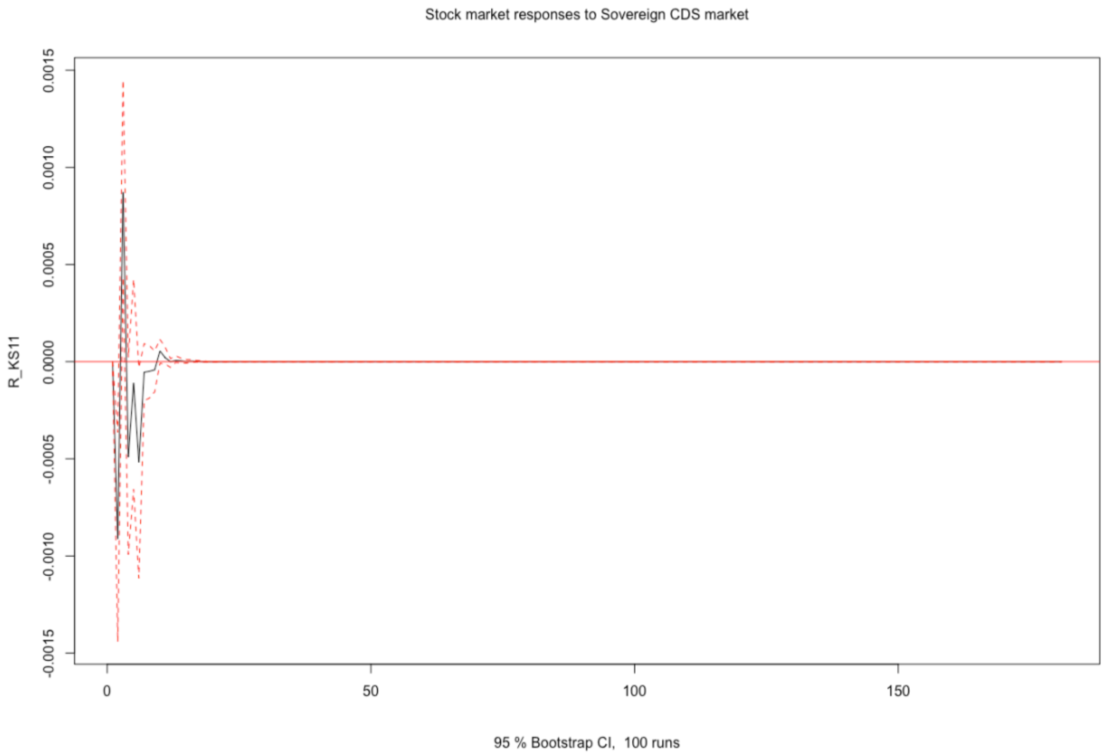

Figure 4.9: *Korean stock market's response*

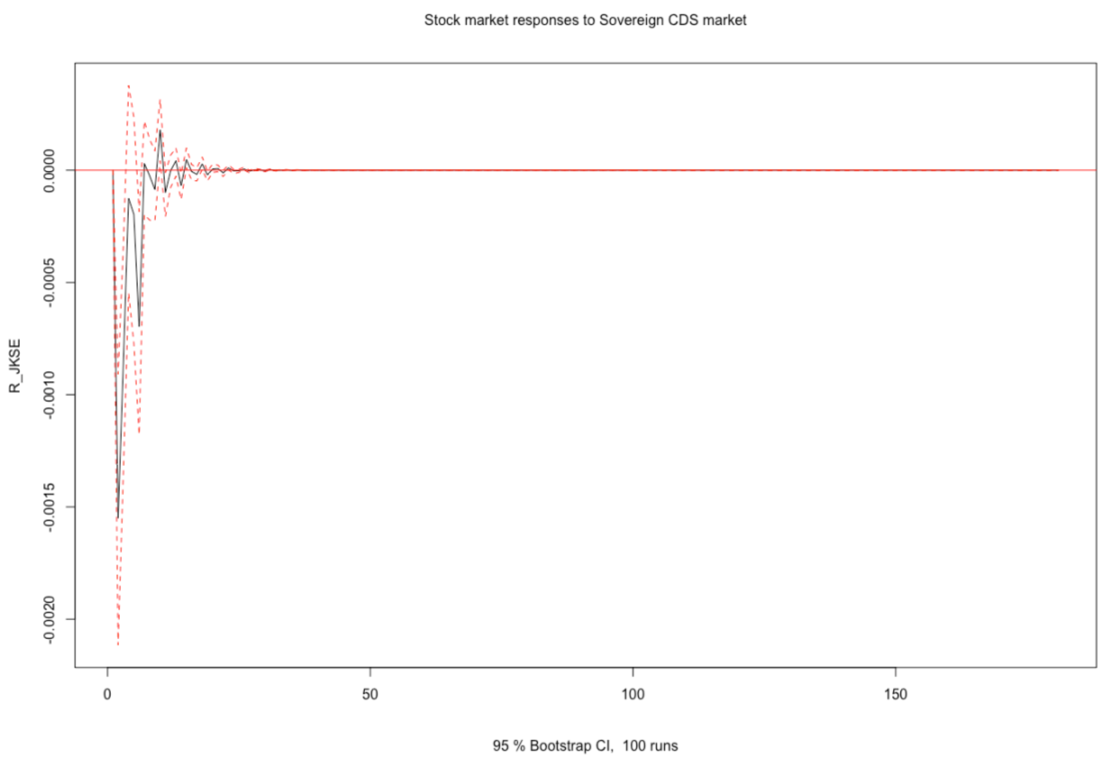

Figure 4.10: *Indonesian stock market's response*

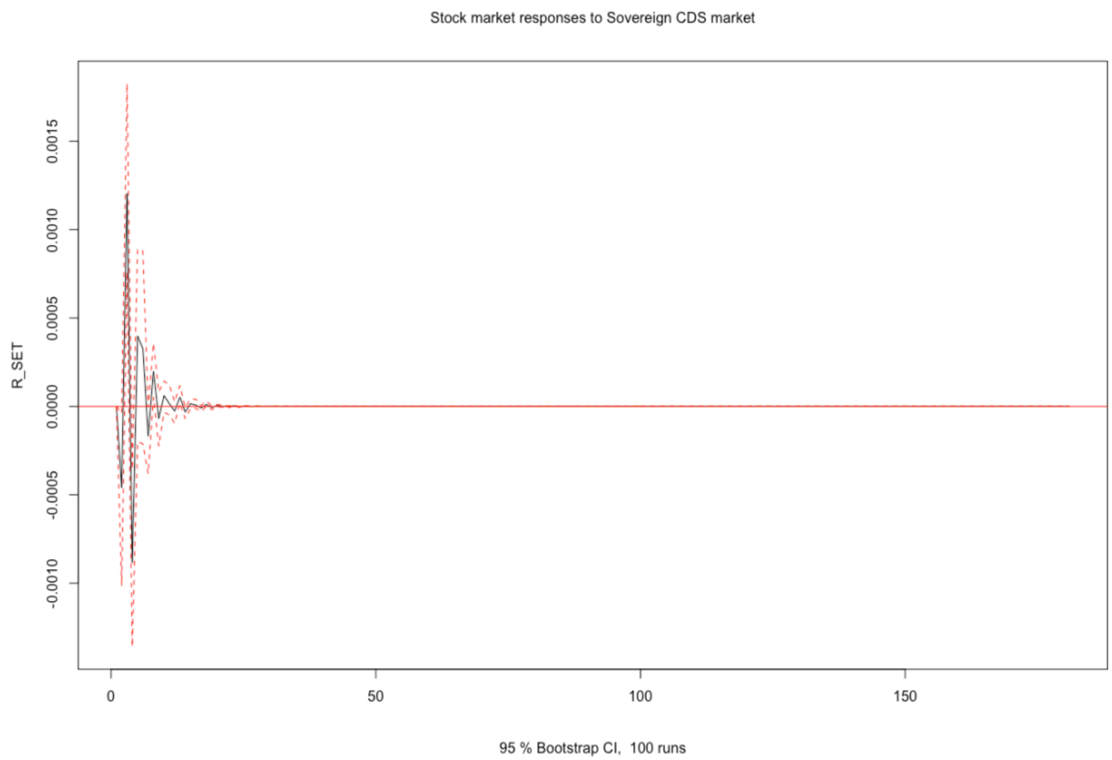

Figure 4.11: *Thailand stock market's response*

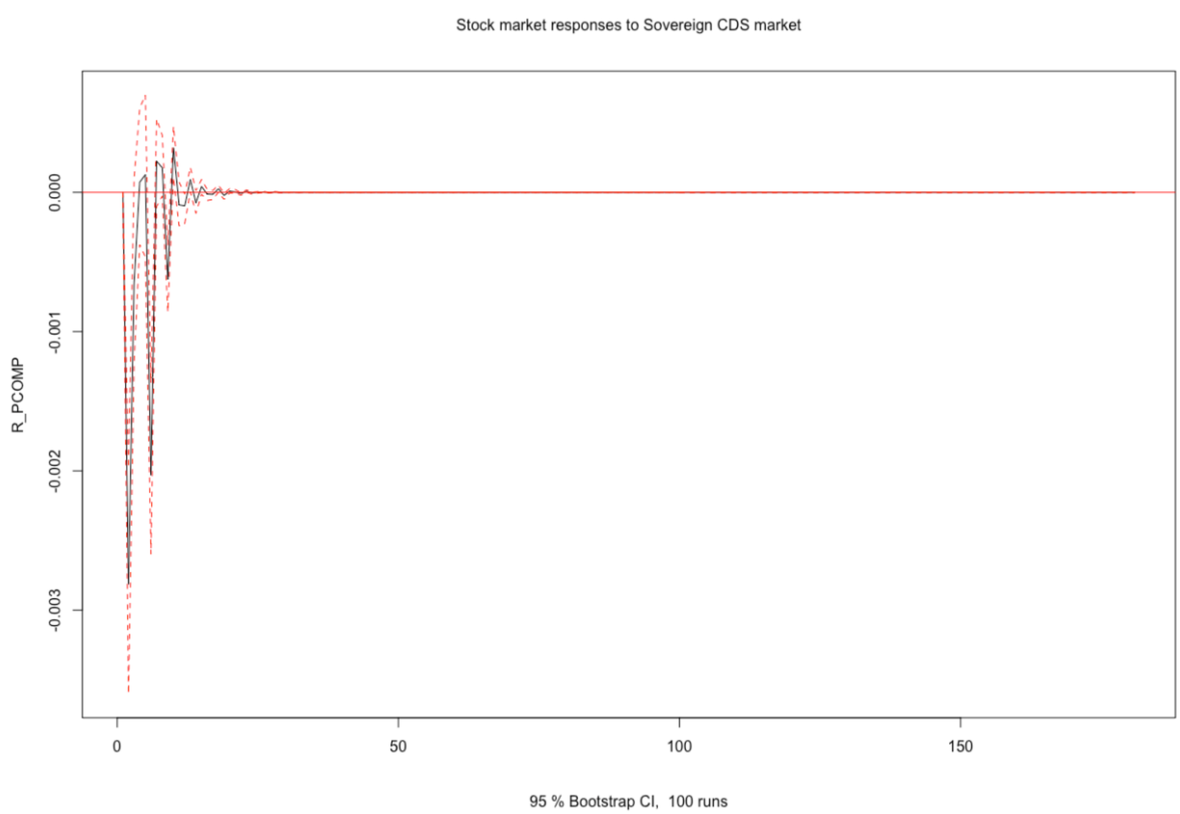

Figure 4.12: *Philippines stock market's response*

Looking at the IRF graph of the impulse response of the sovereign CDS market, the black line is the impulse response while the dot red lines are simply the 95% confident interval. The impulse response lines are always lying within the 95% confident intervals. It can be seen from the graph that when there exists shocks to the stock market, the CDS spread will increase and it reaches peak after 10 to 15 days. However, regarding the next period, the pattern fluctuates across the timelines and it converges to zero in the long run. The impulse response of the sovereign CDS with respect to the shocks to the stock market is not statistically significant due to the "0" line falls within the 95% confident interval.

Regarding the response on the stock market, in the short run, the impulse response witnesses a sharp decline to the negative side when there exists shocks to the sovereign CDS market. After that, the response bounces back to increase to positive side before converging to 0. The impulse response of the stock market is not statistically significant since the "0" line still lies in the 95% confident interval.

To sum up, in the short run, we can forecast the impulse response of the sovereign CDS and the stock market when shocks arise in each market. When the shocks cause the increase of the spread of the sovereign CDS, its effects also cause the decrease of the stock market return and vice versa. It is highlighted that the sovereign CDS market still takes the leading role in incorporating new information with respect to the stock market. However, the analyses do not have any statistically significant meaning in the long term period.

4.3.2 An analysis of a 3-dimensional VAR model

In this section, we implement an additional check of the robustness of the results in order to identify whether or not a potential variable is omitted. We run the 3-dimensional VAR model including the historical volatility measured within 100 trading days of the stock indexes of the five analyzed Asian countries: Japan, Korea, Indonesia, Thailand and Philippines. Regarding some researched literatures, for example Norden and Weber (2009), they used the implied volatility to a run 3-dimensional VAR model because the implied volatility represents an important determinant of the credit spread. The implied volatility, generally known as the projected volatility, is often used to determine how volatile the market will be going forward. However, one important point is to highlight that the effects of implied volatility should not be considered as science, and therefore it does not give a projection of how the market will move in the future. On the contrary, historical volatility gauges the variations of the underlying securities by measuring the price changes over the predetermined time period. Regarding the intuition of the VAR model, the characteristics of the historical volatility are likely statistically significant to determine the lead-lag relationship between the sovereign CDS market and the stock market. Furthermore, it is not available for us to collect the data of implied volatility for all five Southest Asian countries during the examined period.

We estimate the following 3-dimensional VAR model as following:

$$R_t = \alpha_1 + \sum_{p=1}^{p} \beta_{1p} R_{t-p} + \sum_{p=1}^{p} \gamma_{1p} \Delta CDS_{t-p} + \sum_{p=1}^{p} \delta_{1p} \Delta vol_{t-p} + \varepsilon_{1t}$$

$$\Delta CDS_t = \alpha_2 + \sum_{p=1}^{p} \beta_{2p} R_{t-p} + \sum_{p=1}^{p} \gamma_{2p} \Delta CDS_{t-p} + \sum_{p=1}^{p} \delta_{2p} \Delta vol_{t-p} + \varepsilon_{2t}$$

$$\Delta Vol_t = \alpha_3 + \sum_{p=1}^{p} \beta_{3p} R_{t-p} + \sum_{p=1}^{p} \gamma_{3p} \Delta CDS_{t-p} + \sum_{p=1}^{p} \delta_{3p} \Delta vol_{t-p} + \varepsilon_{3t}$$

With R_t : the stock index return at time t; ΔCDS_t : sovereign CDS spread change in t; p: the lag order index; Δvol_t: the change in historical volatility of country i at time t; ε_t : the disturbance term in t.

These tables present the coefficients and the p-values after running the 3-dimensional VAR model on R-studio software. The p-value for the Granger Causality test (GC test) is only highlighted in those cases in which the p-value is significant at a 10% level.

Table 4.13: Japanese model's statistic - The coefficients and the p-values on R-studio software

JAPAN	2016-2020						2020					
Dep.Var	R_t		ΔCDS_t		ΔVol_t		R_t		ΔCDS_t		ΔVol_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.036	-0.038	2.679	-3.650	1.028	1.799	0.085	0.025	5.509	-3.585	2.334	0.998
R_{t-2}	0.036	-0.009	2.679	**-6.695**	1.028	-0.417	0.084	0.131	5.499	**-19.002**	2.330	3.157
R_{t-3}	0.036	**0.099**	2.662	**-6.443**	1.021	0.816	0.085	0.141	5.515	**-21.525**	2.336	1.073
R_{t-4}	0.036	-0.044	2.671	3.482	1.024	-1.935	0.087	-0.049	5.649	3.191	2.393	-3.261
R_{t-5}	0.036	-0.045	2.665	-3.057	1.022	-0.120	0.087	-0.136	5.659	-6.555	2.398	-1.175
ΔCDS_{t-1}	0.0005	-0.0001	0.036	**-0.073**	0.014	0.025	0.001	-0.0004	0.081	**-0.235**	0.034	**0.076**
ΔCDS_{t-2}	0.0005	0.0003	0.036	0.016	0.014	0.003	0.001	-0.0004	0.081	-0.040	0.034	-0.011
ΔCDS_{t-3}	0.0005	**-0.002**	0.036	**-0.081**	0.014	0.002	0.001	**-0.005**	0.077	**-0.244**	0.032	-0.037
ΔCDS_{t-4}	0.0005	0.0002	0.036	**0.101**	0.014	0.009	0.001	0.001	0.079	**0.174**	0.034	0.046

ΔCDS_{t-5}	0.0005	0.001	0.036	0.006	0.014	0.015	0.001	**0.003**	0.079	0.047	0.034	0.037
ΔVol_{t-1}	0.001	**0.002**	0.094	-0.110	0.036	**0.226**	0.003	0.002	0.204	-0.362	0.086	**0.600**
ΔVol_{t-2}	0.001	-0.002	0.096	0.181	0.037	**0.099**	0.004	-0.002	0.204	**0.764**	0.102	-0.081
ΔVol_{t-3}	0.001	0.00004	0.097	0.113	0.037	0.031	0.004	-0.002	0.249	0.055	0.106	-0.0003
ΔVol_{t-4}	0.001	-0.002	0.097	-0.024	0.037	0.024	0.004	-0.004	0.25	0.092	0.106	-0.011
ΔVol_{t-5}	0.001	0.001	0.094	**-0.230**	0.036	0.001	0.003	0.003	0.209	**-0.685**	0.088	0.114
Const	0.0004	0.0003	0.033	-0.026	0.012	-0.004	0.001	-0.0001	0.083	-0.003	0.035	0.011
Obs	787		787		787		155		155		155	
R^2	0.050		0.059		0.096		0.195		0.404		0.404	
F statistic	**2.685**		**3.238**		**5.472**		**2.240**		**6.289**		**6.283**	
GC test R_t				0.00539		0.0264				0.0005451		0.001042
GC test ΔCDS_t		0.008154				0.0264						
GC test ΔVol_t		0.008154		0.00539						0.0005451		0.001042

Table 4.14: Korea model's statistic - The coefficients and the p-values on R-studio software

Korea	2016-2020						2020					
Dep.Var	R_t		ΔCDS_t		ΔVol_t		R_t		ΔCDS_t		ΔVol_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.04	**-0.096**	5.536	-8.437	0.970	**-7.0**	0.098	-0.136	9.564	-7.189	2.541	**-10.200**
R_{t-2}	0.042	**0.224**	5.824	**-32.424**	1.021	**-2.776**	0.107	**0.359**	10.462	**-57.770**	2.780	-3.691
R_{t-3}	0.042	**0.150**	5.919	1.241	1.037	**-3.120**	0.116	**0.263**	11.275	-13.664	2.996	-5.153
R_{t-4}	0.042	0.012	5.897	**16.623**	1.033	**-3.804**	0.116	0.088	11.253	20.775	2.990	**-9.152**
R_{t-5}	0.041	-0.011	5.722	**13.731**	1.003	**-3.232**	0.112	-0.130	10.912	**30.303**	2.899	-3.923
ΔCDS_{t-1}	0.0003	-0.0004	0.039	-0.037	0.007	-0.005	0.001	-0.001	0.098	-0.083	0.026	-0.010
ΔCDS_{t-2}	0.0003	**0.001**	0.039	**-0.202**	0.007	0.012	0.001	0.002	0.098	**-0.335**	0.026	0.008
ΔCDS_{t-3}	0.0003	**-0.001**	0.039	0.036	0.007	-0.001	0.001	-0.001	0.096	-0.094	0.025	0.006
ΔCDS_{t-4}	0.0003	0.0002	0.038	0.065	0.007	**-0.015**	0.001	0.0004	0.091	0.065	0.024	**-0.058**
ΔCDS_{t-5}	0.0003	**-0.001**	0.038	0.019	0.007	-0.009	0.001	**-0.003**	0.093	0.162	0.026	-0.002
ΔVol_{t-1}	0.001	**0.005**	0.208	-0.367	0.036	**0.225**	0.003	0.006	0.324	-0.356	0.086	**0.249**
ΔVol_{t-2}	0.002	**0.003**	0.214	**0.478**	0.038	**0.102**	0.003	0.007	0.338	0.536	0.090	0.043
ΔVol_{t-3}	0.002	0.002	0.213	**-0.96**	0.037	**0.197**	0.004	0.004	0.341	**-1.185**	0.091	**0.230**
ΔVol_{t-4}	0.002	0	0.217	0.050	0.038	-0.015	0.004	-0.0002	0.361	0.120	0.096	-0.076
ΔVol_{t-5}	0.001	-0.002	0.204	0.030	0.036	0.068*	0.003	**-0.007**	0.334	0.038	0.089	0.160
Const	0.0004	0.00001	0.050	-0.042	0.009	0.004	0.001	-0.001	0.137	0.099	0.036	0.001
Obs	787		787		787		155		155		155	
R^2	0.113		0.125		0.354		0.288		0.409		0.524	
F statistic	**6.558**		**7.310**		**28.179**		**3.748**		**6.420**		**10.196**	
GC test R_t										0.001557		0.0001334
GC test ΔCDS_t												0.0001334
GC test ΔVol_t										0.001557		

Table 4.15: Thailand model's statistic - The coefficients and the p-values on R-studio software

Thailand			2016-2020				2020					
Dep.Var	R_t		ΔCDS_t		ΔVol_t		R_t		ΔCDS_t		ΔVol_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.036	**-0.153**	6.180	-9.373	1.176	**3.524**	0.086	**-0.259**	10.622	-13.831	3.174	6.139
R_{t-2}	0.037	0.046	6.252	2.319	1.190	**-3.543**	0.089	0.020	10.959	2.433	3.275	-3.813
R_{t-3}	0.037	0.003	6.241	**-16.312**	1.188	2.276	0.088	0.009	10.915	**-25.199**	3.262	2.843
R_{t-4}	0.037	0.020	6.298	**-18.287**	1.198	**-4.612**	0.090	0.030	11.152	**-28.951**	3.332	**-6.667**
R_{t-5}	0.037	**0.218**	6.361	-8.595	1.210	**-4.105**	0.092	**0.289**	11.360	-15.215	3.395	**-7.071**
ΔCDS_{t-1}	0.0002	- 0.0001	0.037	-0.037	0.007	0.003	0.001	-0.001	0.086	0.032	0.026	-0.013
ΔCDS_{t-2}	0.0002	0.0002	0.036	**-0.093**	0.007	0.009	0.001	0.001	0.084	-0.050	0.025	0.018
ΔCDS_{t-3}	0.0002	- 0.0001	0.036	**-0.105**	0.007	0.001	0.001	0.0005	0.078	**-0.367**	0.023	-0.0001
ΔCDS_{t-4}	0.0002	**-0.001**	0.035	**0.131**	0.007	**-0.015**	0.001	-0.001	0.084	0.083	0.025	-0.029
ΔCDS_{t-5}	0.0002	0.0003	0.035	**-0.091**	0.007	-0.006	0.001	0.001	0.084	-0.113	0.025	-0.015
ΔVol_{t-1}	0.001	- 0.0004	0.188	-0.096	0.036	**0.214**	0.002	-0.002	0.285	-0.176	0.085	**0.280**
ΔVol_{t-2}	0.001	-0.002	0.189	0.104	0.036	**0.085**	0.002	-0.002	0.289	0.272	0.086	0.083
ΔVol_{t-3}	0.001	**0.004**	0.186	-0.331	0.035	-0.005	0.002	0.004	0.286	-0.150	0.086	-0.039
ΔVol_{t-4}	0.001	0.001	0.183	**0.493**	0.035	**0.142**	0.002	0.001	0.283	0.328	0.085	**0.189**
ΔVol_{t-5}	0.001	**-0.002**	0.182	0.105	0.035	**0.122**	0.002	-0.001	0.278	0.013	0.0853	0.096
Const	0.0003	0.0001	0.058	**-0.119**	0.011	0.004	0.001	-0.001	0.173	-0.063	0.052	0.002
Obs	787		787		787		155		155		155	
R^2	0.108		0.087		0.201		0.201		0.227		0.282	
F statistic	**6.254**		**4.901**		**12.929**		**2.328**		**2.716**		**3.638**	
GC test R_t				0.02109		0.00114				0.657		
GC test ΔCDS_t						0.00114		0.000876				0.7023
GC test ΔVol_t				0.02109				0.000876		0.657		0.7023

Table 4.16: Philippines model's statistic - The coefficients and the p-values on R-studio software

Philippine			2016-2020				2020					
Dep.Var	R_t		ΔCDS_t		ΔVol_t		R_t		ΔCDS_t		ΔVol_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.039	**-0.168**	9.213	7.405	1.392	**3.142**	0.101	**-0.326**	26.107	-23.618	4.731	7.046
R_{t-2}	0.040	0.054	9.291	**-31.134**	1.404	-0.337	0.107	0.151	27.452	**-87.870**	4.975	-3.605
R_{t-3}	0.039	**0.102**	9.178	**20.825**	1.387	**-6.324**	0.106	0.188	27.364	22.720	4.959	**-14.766**
R_{t-4}	0.040	-0.037	9.290	9.961	1.403	**-3.164**	0.105	0.006	26.990	24.184	4.891	**-10.740**
R_{t-5}	0.038	**-0.109**	8.882	7.236	1.342	-0.622	0.093	-0.181	23.933	20.448	4.337	-0.381
ΔCDS_{t-1}	0.0002	**-0.001**	0.038	-0.030	0.006	0.002	0.0004	**-0.001**	0.094	-0.127	0.017	0.004
ΔCDS_{t-2}	0.0002	**-0.0004**	0.038	-0.074	0.006	0.008	0.0004	-0.001	0.095	-0.145	0.017	0.007
ΔCDS_{t-3}	0.0002	0.0003	0.036	**-0.017**	0.006	0.002	0.0004	0.0004	0.091	-0.126	0.017	-0.010
ΔCDS_{t-4}	0.0002	**0.0005**	0.036	**-0.087**	0.005	**-0.037**	0.0003	**0.001**	0.09	-0.174	0.016	**-0.066**

ΔCDS_{t-5}	0.0002	**-0.001**	0.037	**0.181**	0.006	0.003	0.0004	-0.001	0.091	**0.295**	0.017	-0.002
ΔVol_{t-1}	0.001	-0.001	0.248	0.207	0.038	**0.074**	0.002	**-0.004**	0.514	0.403	0.093	0.124
ΔVol_{t-2}	0.001	0.0004	0.239	**1.351**	0.036	-0.026	0.002	0.001	0.487	**1.042**	0.088	-0.078
ΔVol_{t-3}	0.001	-0.002	0.241	**-1.539**	0.036	**0.090**	0.002	-0.001	0.493	**-1.491**	0.089	0.050
ΔVol_{t-4}	0.001	**0.002**	0.251	**-1.166**	0.038	**0.142**	0.002	0.003	0.516	**-1.434**	0.094	0.118
ΔVol_{t-5}	0.001	0.002	0.258	-0.364	0.039	**0.166**	0.002	0.003	0.537	-0.449	0.097	**0.201**
Const	0.0004	-0.0005	0.101	-0.081	0.015	-0.004	0.002	-0.002	0.414	-0.222	0.075	-0.026
Obs	787		787		787		155		155		155	
R^2	0.132		0.216		0.159		0.317		0.410		0.248	
F statistic	**7.805**		**14.154**		**9.689**		**4.297**		**6.441**		**3.060**	
GC test R_t												0.000104
GC test ΔCDS_t								0.000626				0.000104
GC test ΔVol_t								0.000626				

Table 4.17: Indonesia model's statistic - The coefficients and the p-values on R-studio software

Indonesia	2016-2020						2020					
Dep.Var	R_t		ΔCDS_t		ΔVol_t		R_t		ΔCDS_t		ΔVol_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.040	-0.015	21.440	-37.999	3.576	3.375	0.098	-0.166	62.324	-12.461	12.064	7.712
R_{t-2}	0.040	**-0.097**	21.347	-37.290	3.561	-5.495	0.099	-0.127	62.908	-117.118	12.177	-9.367
R_{t-3}	0.040	0.015	21.543	5.018	3.594	-1.050	0.101	0.094	63.993	-48.244	12.387	-1.759
R_{t-4}	0.039	0.027	21.012	**-49.956**	3.505	-3.269	0.093	0.044	59.001	-104.307	11.421	-5.169
R_{t-5}	0.038	0.037	20.689	-5.897	3.451	-0.679	0.089	0.142	56.497	0.536	12.936	0.985
ΔCDS_{t-1}	0.0001	**-0.0003**	0.040	**-0.149**	0.007	0.001	0.0002	**-0.001**	0.099	-0.143	0.019	0.007
ΔCDS_{t-2}	0.0001	**-0.0004**	0.040	-0.042	0.007	-0.001	0.0002	**-0.001**	0.101	-0.019	0.019	-0.002
ΔCDS_{t-3}	0.0001	-0.0001	0.041	0.079	0.007	-0.003	0.0002	-0.0001	0.108	0.026	0.021	-0.003
ΔCDS_{t-4}	0.0001	-0.0001	0.041	**-0.231**	0.007	-0.007	0.0002	0.0001	0.106	**-0.431**	0.020	-0.009
ΔCDS_{t-5}	0.0001	-0.0001	0.041	0.073	0.007	-0.004	0.0002	-0.0001	0.106	0.043	0.021	0.001
ΔVol_{t-1}	0.0004	-0.00005	0.217	0.079	0.036	0.025	0.001	0.0001	0.437	0.050	0.085	-0.002
ΔVol_{t-2}	0.001	-0.001	0.637	0.211	0.106	0.072	0.007	-0.003	4.703	1.293	0.910	0.491
ΔVol_{t-3}	0.001	0.001	0.648	-0.129	0.108	0.113	0.007	0.008	4.722	-1.169	0.914	0.036
ΔVol_{t-4}	0.001	**-0.001**	0.648	0.018	0.108	**0.289**	0.007	-0.0003	4.739	0.313	0.917	0.294
ΔVol_{t-5}	0.001	0.002	0.636	-0.071	0.106	-0.045	0.007	0.004	4.707	0.566	0.911	-1.057
Const	0.0003	0.0002	0.188	**-0.126**	0.031	-0.032	0.001	-0.001	0.846	0.152	0.164	-0.116
Obs	787		787		787		155		155		155	
R^2	0.061		0.106		0.023		0.185		0.210		0.023	
F statistic	**3.367**		**6.097**		1.236		**2.102**		**2.459**		**0.218**	
GC test R_t						0.9681				0.01264		0.9948
GC test ΔCDS_t		0.1078				0.9681		0.7038				0.9948
GC test ΔVol_t		0.1078						0.7038		0.01264		

The 3-dimensional VAR model's results are displayed from Table 4.13 to Table 4.17 with the characteristics of each Asia countries and the lead-lag analyses are based on the foundation of statistically significant coefficients. Since the stock prices enter into the formula to compute the historical volatility, the results of 3-dimensional VAR model can be possibly expected to be consistent with previous 2-dimensional VAR model. Regarding the entire period (2016-2020), for all countries analyzed, the sovereign CDS market leads the stock market except for Japan, where the stock market was leading in incorporating new information. Moreover, in Korea and Thailand cases, the historical volatility is totally depended on its first to the fifth lags of the stock market. On the other hands, in Japan case, we found no evidence of the dependence of the historical volatility on both the stock market and the sovereign CDS market or as can be seens that the historical volatility only depended on its own lag. If we examine the different time-series, especially in 2020, it is notable to highlight that the role of the sovereign CDS market outweigh the effects of the stock market. The stock market plays a leading role in incorporating new information with respect to the historical volatility. There is no the evidence of a leading role of the historical volatility measured within 100 trading days and we can confirm that the results of the 2 dimensional VAR model are corroborated.

Regarding the results of Granger causality test, we found the evidence in 4 out of 5 countries that the p-values are smaller than 0.05 and it means that we can reject the null hypothesis. In other words, we can notice that the stock market Granger cause the sovereign CDS and the historical volatility and the sovereign CDS market also Granger cause the stock market and the historical volatility. However, for Indonesia in the period from 2016 to 2020, the p-values are greater than 0.05 and we cannot reject the null hypothesis. Therefore, it means that we found no evidence of the cause-and-effect relationship between the stock market, the sovereign CDS market and the historical volatility in Indonesia.

4.3.3 An analysis with a Panel data model

In the last section, in order to present a complete insight into the relationship between the sovereign CDS market and the stock indexes, we will test for the differences in behavior in countries with lower credit quality and countries with higher credit quality. Therefore, we will split the sample into 2 groups: countries with higher credit quality (Japan, Korea) and countries with lower credit quality (Indonesia, Thailand and Philippines). We run the analysis of the Vector Autogressive Panel Model (PVAR) and the structure is described below:

$$R_{it} = \alpha_i + \sum_{p=1}^{p} \beta_p R_{t-p} + \sum_{p=1}^{p} \gamma_p \Delta CDS_{t-p} + \varepsilon_{it}$$

$$\Delta CDS_{it} = \alpha_i + \sum_{p=1}^{p} \beta_p R_{t-p} + \sum_{p=1}^{p} \gamma_p \Delta CDS_{t-p} + \varepsilon_{it}$$

With R_i being the stock return of country i at the time t; ΔCDS_i being the change of the sovereign CDS spread of country i at the time t; *p:* the lag order of the index and ε_i being the disturbance term of country i at time t. In order to reduce the burden of the large data issue, we will run the analysis of PVAR with the monthly data of both the stock market and the sovereign CDS market of each countries. For each groups of countries, we found the optimal lag by computing the Akaike information criterion (AIC) and the Schwart Bayesian information criterion (BIC). Due to the lacking of the data of the examined period, we run the PVAR model with the lags equal to 1,2 and 3 and then we use the model selection procedure of Andrew and Lu (2001) to select the optimal lag length by comparing the value of AIC and BIC. With the values of AIC and BIC equal to 1302.73 and 1221.892 respectively, we select the model with 2 lags over the model with 1 and 3 lags.

Table 4.18: Aggregate lead-lag relationship of the sovereign CDS market and the stock index with the fixed effects panel analysis. Coefficients and p-values from the fixed effects model of each groups of countries are shown; the overall R^2 of two equations in each panel model is also given in the Table. The first table is the data of all the countries; and the second and the third tables refer to the countries with higher credit spread (which are Japan and Korea) and the countries with lower credit spread (which are Indonesia; Thailand and Philippines) respectively.

Table 4.18: Aggregate lead-lag relationship of the sovereign CDS market and the stock index

All the countries	2016-2020				2020			
Dep.Var	R_t		ΔCDS_t		R_t		ΔCDS_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.047	0.00005	0.0047	0.000032	1.1366	0.6238	6.8532	-10.6125
R_{t-2}	0.0052	0.00003	0.0039	0.000015	3.3627	-1.5126	7.3768	13.6604
ΔCDS_{t-1}	0.0326	-0.0282	0.0040	0.0052	3.7230	-0.7207	8.7621	1.3849
ΔCDS_{t-2}	0.0686	-0.0640	0.0025	0.0031	2.0020	-0.9965	11.1445	4.3498

Const	0.0057	0.0002	-0.0001	0.0001	6.1088	0.5553	0.9110	0.0806
Obs	300		300		60		60	
R^2	0.0156		0.089		0.0357		0.1182	

Table 4.19: Asian countries with lower spreads

	2016-2020				2020			
Dep.Var	R_t		ΔCDS_t		R_t		ΔCDS_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.033	-0.037	4.860	-10.085	0.063	0.024	4.436	-3.864
R_{t-2}	0.033	**0.079**	6.001	-2.472	0.063	**0.141**	4.407	**-12.271**
ΔCDS_{t-1}	0.045	-0.001	0.005	0.013	0.001	-0.002	0.064	**-0.148**
ΔCDS_{t-2}	0.0367	**0.001**	0.0036	-0.138	0.001	**-0.002**	0.062	0.033
Const	0.0032	0.0003	0.041	-0.036	0.003	0.0005	0.064	-0.001
Obs	120		120		24		24	
R^2	0.011		0.035		0.042		0.078	

Table 4.20: Asian countries with higher spreads

	2016-2020				2020			
Dep.Var	R_t		ΔCDS_t		R_t		ΔCDS_t	
	Coeff	p-val	Coeff	p-val	Coeff	p-val	Coeff	p-val
R_{t-1}	0.030	**-0.134**	7.820	**19.502**	0.073	**-0.211**	14.968	21.315
R_{t-2}	0.030	-0.010	7.656	**-26.752**	0.074	0.041	15.833	**-40.755**
ΔCDS_{t-1}	0.0014	**-0.0035**	0.031	0.025	0.0045	0.001	0.066	0.096
ΔCDS_{t-2}	0.0015	**-0.0021**	0.030	0.027	0.0038	-0.001	0.066	0.123
Const	0.0025	0.0001	0.142	-0.119	0.001	-0.0002	0.576	0.009
Obs	180		180		36		36	
R^2	0.027		0.0365		0.038		0.092	

When we split the panel model into two groups – countries with higher credit spread (Indonesia; Thailand and Philippines) and countries with lower credit spread (Japan, Korea), it becomes more apparent that the sovereign CDS market takes the leading role with respect to the stock indexes. Furthermore, during the year 2020, the worldwide economic was severe affected by the spread of the covid-19 pandemic, the leading role of the sovereign CDS market was strengthened by the turbulences of the financial market. Last but not least, we also can highlight the more modest role of the CDS market in countries with lower credit spread.

4.4 Conclusions

This study contributes to the literature giving a broader insight on the relationship between the sovereign CDS market and the stock indexes of some Asian countries, using daily data from 2016 to 2020.

Firstly, using a VAR model to analyze the country-specific market co-movements, we find the result similar to the previous research and literatures, that there exists a significant negative correlation between the sovereign CDS market and the stock indexes. It means that when there was an increase in the sovereign CDS spread, it also existed a decrease in the stock market returns. We also find the leading role of the sovereign CDS market with respect to the stock index in incorporating new information. Secondly, the historical volatility of the stock index is found to be considerably related to the movement of the sovereign CDS market, indicating a close link between both markets. The leading role of the sovereign CDS market is significantly strengthened by analyzing the panel VAR model for the higher credit premiums countries (Indonesia, Thailand and Philippines). Furthermore, we also found a weaker correlation between both markets in the countries with lower credit premiums (Japan and Korea).

With regard to the previous literatures, like Norden and Weber (2009) or Longstaff (2003), we run the VAR framework to examine the lead-lag relationship between the sovereign CDS market and the stock indexes. If the public and the private information are not incorporated concurrently, the lead-lag relationship between the prices of the two markets can be observed. We found that the change in the sovereign CDS spread leads the change in the stock index return during the examined period.

Secondly, in order to handle the omitted variable problem we estimate a three dimensional VAR model, adding the historical volatility measured within 100 trading days of the stock market. We find the evidence that the sovereign CDS market still plays a leading role with respect to both the stock market and the historical volatility. There is not a clear role of the historical volatility with respect to the sovereign CDS market and the stock market in incorporating new information.

Finally, we analyzed a panel VAR model to test for the differences in behavior in countries with lower credit quality and countries with higher credit quality. Therefore, we split the sample into 2 groups: countries with higher credit quality (Japan and Korea) and countries with lower credit quality (Thailand; Indonesia and Philippines). The panel's results are similar to the previous results: the sovereign CDS market apparently leads the change of the stock index return and especially in the year 2020, its leading role is strengthened by the turbulence of the financial market which was harshly affected by the pandemic.

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