RELATIONSHIP BETWEEN SOVEREIGN CREDIT DEFAULT SWAP AND STOCK MARKETS

The Case of East Asia

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Spring Semester 2013
Master Thesis, two-year, 15 hp
ACKNOWLEDGEMENTS

We would like to express the deepest gratitude to our supervisor Catherine Lions for her guidance and enormous contributions that make this piece of work a reality.

In addition, we would like to thank our families. Without their love and encouragement we would not have finished this thesis. Moreover, we should mention our biggest thanks and gratitude to our Heavenly Father, who is the source of all knowledge and wisdom what enabled us to complete our research work.

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SUMMARY

When adjusted to sovereign entities, the structural credit risk model assumes a negative (positive) relationship between sovereign CDS spreads and stock prices (volatilities). In theory both markets are supposed to incorporate new information simultaneously. Discrepancies from the theoretical relationship can be exploited by capital structure arbitrageurs. In our thesis we study the intertemporal relationship between sovereign CDS and stock index markets in East Asia during the period of 2007 – 2011. We detect a negative (by and large positive) relationship between the Asian CDS spreads and stock indexes (volatilities). Across the whole region the sovereign CDS market dominates the price discovery process. However, 4 out of 7 Asian countries (Japan, Korea, Malaysia and the Philippines) demonstrate a feedback effect. The stock markets of countries with higher credit spreads (Indonesia, the Philippines and Korea) appear to react more severely at heightened variance in the CDS market. When considered separately for turbulent vs. calm periods, we find that the lead-lag relationship between the Asian sovereign CDS and stock markets is not stable. Apart from that, both markets become more interrelated during periods of increased volatility. The dependency of Asian CDS spreads and stock indexes on the “fear index” detected in the frames of robustness check implies an integration of both markets into the global one. Therefore, while seeking for arbitrage opportunities in the respective Asian markets one should also take into account possible influences of broader global factors.

Keywords: sovereign credit risk, credit default swap, stock index, Merton model, price discovery, capital structure arbitrage, emerging market.
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1. INTRODUCTION

In this section we introduce the reader to the background of our research, discuss its main issues, state the research question and in line with it determines relevant research purposes, describe constraints of the research area, and finally present the structure of our thesis.

1.1 Background

Credit risk is the risk that a borrower will not be able to make required principal / interest payments or meet her contractual obligations, which in turn affects the lender’s financial status. Similarly sovereign credit risk arises when a government fails to meet its debt covenants or to fulfil its obligations in the form of guarantees (Pokorná & Teplý, 2011, p. 780). Sovereign credit risk is higher than credit risk of a firm, since a sovereign entity may also choose to default on its debt even though it is still able to service it (so-called technical default). Sovereign credit risk affects both risk premiums (e.g. borrowing costs) and a country’s ability to access global debt markets. The nature of sovereign credit risk renders to determine the capital flow and its cost structure across countries as well as diversify the risk of global debt portfolios (Longstaff, Pan, Pedersen, & Singleton, 2011, p. 75).

Sovereign credit risk came into the spotlight in the late 90s, when the financial world was hit by a series of emerging market crises (to name a few, Asian financial crisis, the Argentine turmoil and the Russian bond default). This period coincides with a take-off of sovereign credit derivatives that were used as a measure to hedge against increased sovereign risk.

Credit derivative allows detaching credit risk from the underlying debt and transferring it to a counterparty other than the lender. The invention of credit derivatives has made it possible not only to hedge, but also trade credit risk separately from the respective obligation. The credit derivative market is dominated by credit default swap (hereafter referred to as CDS). CDS contract provides a protection against a default by the corporate or sovereign entity on its debt obligations. The protection seller agrees to reimburse the protection buyer in case of a default event. In her turn the protection buyer obliges to make a series of quarterly payments (CDS premiums) on the notional amount to her counterparty until either the debt matures or a default occurs. Thus, CDS contract shifts credit risk between two parties, e.g. from the protection buyer to the protection seller. (J.P. Morgan & RMG, 1999).

CDS was the fastest-growing segment of the over-the-counter (OTC) derivatives business with the notional amount outstanding skyrocketing 68-fold from just below 1 trillion of U.S. dollars in 2001 to 62 trillion of U.S. dollars in 2007. However, in the aftermath of the financial turmoil the CDS market has shrunk to just around 40% of its historical high (ISDA, 2010, 2012).

Before the credit crunch trading on the CDS market was mainly concentrated on corporate credit risk that accounts for the major part of the market size. The rest credit risk contracts referred to predominantly emerging market sovereign entities. After the
global financial crisis that caused the global recession and contributed to a large extent to the sovereign European debt crisis the focus of sovereign CDS market was shifted to European reference entities with 60% of the overall market size\(^1\) and trading volume (Berg & Streitz, 2012).

Sovereign CDS on several Euro-zone debt issuers have become a hot topic not only in economic news, among regulators as well as financial actors trying to hedge against increased sovereign credit risk, but also for speculators and arbitrageurs trying to profit from mispricing of the credit risk instrument. However, we believe that the sovereign credit risk market of emerging countries that has been undergoing a dynamic development and has become more integrated with other asset classes is not less topical for financial actors seeking alpha. Of special interest is the relationship of sovereign credit risk with emerging equity markets which have grown in size and gained more liquidity on the background of a strong economic growth and financial development. Existence of sovereign CDS allows studying this link between both markets.

According to Merton model adjusted for sovereign debt issuers (Chan & Kim, 2004, p. 3) similarly to a firm’s credit risk, changes in a sovereign’s credit risk should not only affect CDS premiums on the underlying debt, but also the country’s equity (equity volatility). It is assumed that an increase in the country’s credit risk should cause a drop in its stock market (increase in its volatility). The insurance against such a sovereign credit risk should become more costly, e.g. CDS spread would widen. Moreover, the theory implies that new information on credit risk is simultaneously incorporated in both markets. This relationship as well as its evolution could provide a valuable insight for financial actors in emerging financial markets, who search for undiscovered arbitrage gains.

Since emerging countries are very different in economic and regulatory nature, it would be reasonable to focus on a particular region while studying the relationship between sovereign CDS and stock markets. With this regard we choose to concentrate on the striving Asian region (6 emerging East Asian countries and Japan\(^2\)).

The development of the Asian CDS market went hand in hand with the rapid growth of the underlying bond market since the financial crisis of 1997 that was supported by the local governments. In present the net notional outstanding of 6 East Asian countries and Japan account together to 28,0 billion of U.S. dollars (in comparison the Italian CDS market alone is 23,9 billion of U.S. dollars large). Although the Asian CDS market is yet relatively small comparing to its European peer, the attempts to standardize CDS contracts starting with fixing CDS coupons at the end of 2009 should increase the market volume and liquidity in the future. This makes the research on the relationship between sovereign CDS and stock markets for the region in focus of particular interest.

1.2 Problem discussion

A great number of research studies on credit derivatives concerns CDS on corporate bonds. Among the most remarkable papers that address relationship issues between

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1 net notional outstanding

2 These Asian countries are the top reference entities for sovereign CDS in the region.
corporate CDS and bond or/and share markets are Blanco, Brennan and Marsh (2004) and Zhu (2006), who draw a comparison of the credit risk pricing between investment grade corporate bond and CDS markets; Longstaff, Mithal and Neis (2003) and Norden and Weber (2009), who explore an intertemporal co-movement of the corporate CDS, bond and stock markets; Forte and Pena (2009), who analyze the dynamic relationship between stock implied credit spreads, CDS spreads and bond spreads.

The number of papers on sovereign CDS is comparatively lower. The research on CDS with the government debt as an underlying asset came under the spotlight of the financial literature mainly in the course of the Euro-zone debt crisis. The four following papers focus on the EU sovereign CDS: Palladini and Portes (2011) test the price discovery relationship (e.g. which market leads the other) between sovereign CDS premiums and bond spreads; Fontana and Scheicher (2010) try to define driving factors of difference between the two credit spreads for 10 EU countries; Arce, Mayordomo and Pena (2011) search for existence of market frictions that prevent arbitrage between CDS and bond markets in the EMU context; Coronado, Corzo and Lazcano (2011) study the relationship between 8 European sovereign CDS and relevant stock indices.

The other few papers on sovereign CDS focus on emerging markets. Here one should mention Ammer and Cai (2007), who analyze the impact of cheapest-to-delivery option on the relationship between CDS premiums and bond yield spreads; Levy (2009), who considers the effects of liquidity and counterparty risk on the basis spread; Adler and Song (2010), who test the parity relationship between CDS and bond spreads; Hassan, Ngene and Suk-Yu (2011), who seek for a link between financial integration and pricing discovery dynamics in both credit risk markets.

Since the size and role of credit derivative markets are growing on the financial stage of the emerging world, it is very important to understand not only how EM sovereign CDS are related to bonds, but also to such a traditional asset class as equity. As far as we know, there are only several papers that capture the link between sovereign CDS and relevant stock markets for emerging countries. Among them are Chan-Lau and Kim (2004), who research the interaction between sovereign CDS, bond spreads (EMBI+ as a proxy) and equities (MSCI as a proxy); Aktug (2011), who studies the interaction between CDS, national stock markets, foreign exchange and local currency government bonds during the subprime mortgage crisis. Given the small number of related studies there is still much space for further research in this area.

Since the concept “emerging market” is ambiguous and usually implies a number of countries with versatile developing economies from different regions it would be interesting to study the CDS-stock relationship concentrating on a specified region with relatively comparable economic conditions. To our knowledge, the study by Chan, Fung and Zhang (2008) with a regional focus on Asian CDS and stock markets for the period of January, 2001 to February, 2007 has been so far the only one in this respect. To contribute to the comparability of the regionally focused research on the relationship between sovereign CDS and stock markets over time and most importantly to its evolution, in our thesis we will extend the study by Chan et al. (2008) to the most recent period from 2007 to 2011, apply different statistical approaches to analyze the data, incorporate relevant volatility measures (stock return volatility, CDS spread volatility)

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3 Price discovery is one of the key functions of financial markets and implies that information inferred by investor trading is efficiently and timely incorporated into market prices (Lehman, 2002, p.259).
into the analysis, and increase the scope of the research area to the CDS-stock relationship depending on various market states (a calm financial market or market turmoil).

1.3 Research question

Based on the above stated we formulate our research question as follows:

What is the relationship between the Asian sovereign CDS and stock markets?

In order to answer the main research question we ask the following sub questions:

1. Is there a relationship between the Asian sovereign CDS spreads and stock indices?
2. Is there a relationship between the Asian sovereign CDS spreads and volatilities in the stock indices markets?
3. What is the relationship between the variances of Asian sovereign CDS and stock markets?
4. Which market takes a lead in the price discovery process?
5. How does the relationship between sovereign CDS spreads and stock indices (including the price discovery process) evolve over the selected time horizon of 2007 - 2011?

1.4 Research purpose

Consistent with the research question here we state the following purposes for our paper.

1. To seek for an empirical confirmation of the structural credit model adjusted to sovereign issuers (Chan-Lau & Kim, 2004) applying it to the Asian sovereign CDS premiums, respective stock indices and their volatilities.

2. To determine whether variances of the Asian sovereign CDS and stock indices markets are correlated. To study the strength of this correlation depending on a sovereign issuer credit quality.

3. To detect where the price discovery first takes place. Or to put it in another way, to determine, whether the Asian sovereign CDS market is the first to incorporate new information and thus leads the stock index one, or alternatively the Asian stock index market is dominant relatively to the sovereign CDS one.

4. To find out a possible change in the state, magnitude of the relationship between Asian sovereign CDS spreads and stock indices as well in the price discovery process depending on different market states (calm or turbulent markets). We strive to capture various market states dividing our whole time span into the following sub-periods: the pre-crisis period (January, 2007 – August, 2008), the crisis period (September, 2008 – August, 2009) and the post-Lehman period (September, 2009 – December, 2011). During the crisis period the markets were a subject of particularly increased volatility.
We believe that our research question and following consistent research purposes enable covering the issue of the relationship between Asian sovereign CDS and stock index markets comprehensively. The research question including sub questions addresses not only absence/existence of the interlink between both markets (CDS spread–stock index, CDS spread – stock index volatility, CDS spread variance-stock index variance), but also allows to question its evolution with the focus on a possible change over time and detect, which market, sovereign CDS or stock one, leads in the price discovery process. The research purposes mentioning briefly the theoretical as well as time framework of the research allow the reader a more detailed insight at the research question.

1.5 Research gap and contribution

The relationship between corporate credit default swaps, bonds and equity prices has attracted an increasing academic attention since the credit risk market gained liquidity and the CDS started to be actively used as a financial instrument for hedging, trading or portfolio diversification purposes. However, in case of sovereign reference entities the link between respective sovereign CDS and traditional asset markets has been insufficiently studied for a long time. This might be due to relatively low sovereign CDS and bond spreads in developed countries, since sovereign bonds have been considered there as riskless. Moreover, for a long time trading activity on many sovereign CDS markets remained low and liquidity was limited (Arce et al., 2011). With the rise of the Euro-zone debt crisis sovereign CDS markets in the developed world have increasingly come under the spotlight. However, there have been so far only a few studies concerned with the relationship between sovereign CDS and stock markets for emerging countries. Moreover, we have found only one study by Chan et al. (2008) that explores the mentioned relationship for a particular region (Asia). In our thesis we will contribute to this research gap extending the study by Chan et al. (2008) to the most recent period and thus enabling the research comparability over time. Additionally we will investigate the relationship between Asian CDS and stock markets applying different statistical approaches. What especially distinguishes our study from that one by Chan et al. (2008) are includin volatility measures into the analysis and exploring the link between Asian sovereign CDS and stock markets during different market states.

1.6 Limitations

There exist several types of CDS. The credit protection can be issued on a single or multiple reference entities that in their turn can be a corporation, a bank or a sovereign. In our thesis we concentrate on a single-name CDS on a sovereign debt as an underlying asset.

CDS market participants apply the instrument pursuing various purposes. In our thesis we will look at the use of CDS from a speculative perspective at most. Thus, we will focus our research on arbitrage opportunities that an investor (in our case mainly a hedge fund) can extract from the portfolio containing a sovereign CDS and a stock index.

Our sample will be constituted from the Asian sovereign entities, which are among Top 1000 Reference entities of single-name CDS, and whose credit risk contracts are
frequently traded on the sovereign CDS market. Such a constraint enables us to focus on the most liquid Asian CDS and gain a better generalization on a specific regional level. Our final sample consists of 3 Northeast Asian and 4 Southeast Asian countries. The same Asian countries were covered in the study by Chan et al. (2008). Even though we manage to achieve a pretty narrow regional specification of our sample, we are still aware of possible versatility among the economic conditions of the countries in focus that, however, can be food for reflection in further research on the topic.

To our knowledge, in our thesis we study the time series of the most recent time period that hasn’t been addressed so far. Our time horizon stretches from the start of 2007 to the end of 2011, e.g. the period, when the Asian CDS and stock markets experienced a relatively turbulent evolution. Thus, the selected time span enables us to consider the time series behavior in the course of different market states. Moreover, we reckon that the length of the period in focus, e.g. 5 years (or to put it in another way, on average 1271 observations of CDS spreads and 1226 observations of stock index quotes for each country), should allow us generating robust statistical results.

With our research we target readers, who have solid knowledge in Advanced Finance, especially Alternative Investments. However, in order, to make the research also available for readers with a more general Business Administration background in the course of our thesis we try to do our best to explain complicated financial terms.

1.7 Disposition

The rest of the thesis is organized as follows. In the second chapter we will explain the methodology of our research and discuss sources of information that were used in the paper. The third chapter will familiarize the reader with credit default swap and review the relevant papers covering the theoretical background of our research. We will start the fourth chapter with raising hypotheses we are to test in the empirical part of the thesis. Further we will discuss how we collected data and composed our final sample and present summary statistics on the data. Thereafter, we will apply econometric models in consistence with the hypotheses and interpret results. In the concluding chapter we will provide an answer to the research question addressed in the Introduction chapter highlighting the main findings of our research, check our research on the compliance with the truth criteria and suggest topics for further research for the area in focus.
2. METHODOLOGY

In this chapter we introduce the reader to the authors’ background, highlight the reasons for choosing our thesis topic, argue about objectiveness of our research, consider our study from a particular perspective, elaborate on the philosophy of our research and the scientific approach along with relevant strategy for its conducting, classify the objectives of our research and work out its design, critically discuss the selection of the sources for our study, and finally express compliance with ethical and societal principles.

2.1 Authors’ background

The starting point of every research is the background of the researchers, who conduct it. According to Malterud (2001, pp. 483-484) the researcher background and position to some extent determine a research topic, its perspective, the relevant methodological framework, the way the research is designed, selection of appropriate findings and drawing inferences from them. Therefore further we briefly discuss our background.

Both authors are completing their Master in Finance program (2nd year) at USBE, Umea University. One of the authors already holds a Diploma degree in Economics in the speciality of Finance and Credit and currently works as an analyst at an investment research company. The other author holds a Bachelor degree in Accounting and Finance and also currently works as an accountant. Both authors express a due interest in credit derivative market and CDS as one of its broadly used product, in particular. The study of the sovereign CDS and its relationship to other asset classes could be of large importance for the authors’ targeted career as analysts in Fixed Income or Trading departments at an investment bank or at a hedge fund, where credit derivatives are an inevitable part of daily business.

2.2 Choice of research topic

Since one of the authors has already written her first Master thesis on the topic corporate CDS and its relation to such orthodox asset classes as equity and bonds she has offered to further focus on the research area and extend it to the sovereign CDS market. There has already been done a lot of research on the corporate CDS, whereas only a limited number of papers have put the sovereign credit risk contract under the spotlight of the academic literature so far. The attention to sovereign CDS has increased mainly in the course of the euro zone crisis when CDS spreads of PIIGS4 countries especially have significantly widened making their borrowing on the international financial market more costly. Although there has been written more research papers on sovereign credit protection contracts for the emerging market rather than those for the developed countries we still believe that this research area hasn’t been comprehensively addressed yet. The research topics on the EM sovereign CDS mainly concern its relation with relevant bond markets and often cover samples of emerging countries whose economic and political conditions can be hardly compared between each other.

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4 PIIGS stand for Portugal, Ireland, Italy, Greece, and Spain
Given the above stated, firstly both authors have agreed to focus the research topic on the less explored relation of the sovereign CDS with stock markets. Secondly, we concentrate our research regionally studying relationship between Asian sovereign credit risk and stock markets, what enables us to make a better generalization on the regional level. Thirdly, we choose the Asian region also for comparative purposes over time, since there has been already conducted a similar research on the topic covering the time period of 2001 – February, 2007.

2.3 Preconceptions

While writing a research it is very important to adhere to the line of objectivity trying to diminish too subjective conclusions. Since the data of our research are of secondary origin and has been processed and analyzed with econometric methods, which are a part of publicly available statistical software, we believe to maximally reduce the number of potential preconceptions. With regards to the theoretical part of our thesis we have studied quite a few sources in order to comprehensively cover the research area. We are also aware that the authors’ background could impose subjectivity of judgement to some extent. However, preconceptions turn into biases only then, when they were not highlighted in the research (Malterud, 2001, p. 484). Since we mentioned about our background in the previous subsection, we believe to avoid serious biases in our thesis.

2.4 Study perspective

The views on the same subject differ depending from which perspective it is addressed. While conducting a research the choice of data and methods are significantly influenced by its perspective. In our thesis determining the study perspective is of particular importance, since CDS is a financial instrument, which is concerned by various counterparties (reference entities that can be corporates, sovereigns, financial institutions or banks; professional investors (CDS sellers/buyers) that can be investment banks, other banks and security firms, hedge funds or non-financial customers; regulators; media) for multiple purposes (hedging, diversification, speculation, arbitrage, etc.). We focus on CDS issued on sovereign reference entities from the point of view of professional investors, hedge funds in particular, that use the credit protection with the purpose of capital structure arbitrage.

2.5 Research philosophy

Research philosophy addresses two key questions "What is the reality?" and "How can the reality be cognized" throughout the whole research study and affects the way in which it is shaped. Therefore, paradigms framing the research deserve a particular attention. Congruent with the first question is the concept of ontology that with regards to the social research means the assumptions or claims about the nature of social reality according to Blaikie (2007, p. 6). There exist two ontological considerations of the reality, e.g. objectivism and constructionism (Bryman & Bell, 2007, p. 22). Objectivism implies that the reality is external to social actors and cannot be influenced by them, whereas constructionism deems the reality to be formed by the perceptions and actions of social actors.
In our research we take an objectivist position on sovereign credit default swaps and stock indexes. We suppose that both asset classes are externally given to a single financial market participant and she cannot exert a significant influence on them.

Closely related to ontology epistemology is the second key concept within the framework of research philosophy. Epistemology raises the question about knowledge of the social reality, pursues to detect its sources of origin and limitations (Eriksson & Kovalainen, 2008, p. 14). Two opposing epistemological considerations are positivism and interpretivism (Saunders, Lewis & Thornhill, 2009, p. 113). Within the positivist framework the researcher position is comparable to that of the natural scientist. The social reality is externally given to the researcher and can be observed. On the background of the observed reality the researcher will most likely use already existing theories to generate hypotheses that will be further tested and accepted or rejected, thus creating new theoretical knowledge. Both the researcher and the social reality are independent entities and can’t be affected by the research subject, thus implying the certain objectivity of the research. (Remenyi, Williams, Money & Swartz, 1998, pp. 32-33). In contrast to positivism interpretivism draws a clear distinction between the stance of the social researchers and that of the natural scientist. According to the interpretivist orthodoxy the social reality must be considered not externally, but in close connection with social actors. The knowledge about the social reality is a product of subjective interpretation by an individual researcher. (Bryman & Bell, 2007, pp. 17-19).

We choose a positivist epistemological orientation for our research. Firstly, we believe that positivism is the most appropriate consideration, since the time series of sovereign CDS spreads and stock indexes are externally generated and value-free. They are independent from our subjective perceptions and there is hardly a possibility to manipulate them. We believe that processing the time series with externally given statistical tools we are able to conduct an objective research. Secondly, the observed measurable data makes us comfortable with applying already existing theory, in our case the adjusted Merton firm theory with regards to sovereigns, to make inferences and thus create law-like generalizations through putting forward hypotheses, testing them, and confirming or rejecting.

2.6 Research approach

The research approach explains the relationship between the research and relevant theory. In a business study the research approach can be classified as either inductive or deductive reasoning (Bryman & Bell, 2007, pp. 11-15).

Deductive reasoning implies applying already existing theories to put forward hypotheses. Guiding by the deductive approach the researcher moves from general to specific, e.g. first starts with literature review, then develops hypotheses, and finally following the collection and analysis of data confirms or rejects the hypotheses (Bryman & Bell, 2007, p. 11). In the frames of deductive reasoning arguments are based on laws, rules, and accepted scientific principles that facilitate generalization of findings (Bryman & Bell, 2007, p. 11; Saunders et al., 2009, pp. 126-127). The deductive research approach is usually associated with the quantitative strategy, where the
research is focused on quantification and measurement of numerical data (Kent, Flynn, Tobin, & Murdoch, 2012).

In contrast within inductive reasoning one arrives at general principles or laws by generalizing over specific cases. That means the researcher makes a series of observations and tries to expand them into a more general theory. This approach flows in the opposite direction, e.g. from specific to general. The researcher starts with literature review to develop concepts, then collects, analyzes and interprets data, and finally depending on the outcome develops a theory (Bryman & Bell, 2007, p. 14). The inductive approach is usually related to the qualitative research, which typically emphasises words rather than quantifications and measurements of numbers (Kent et al., 2012).

In line with the selected epistemological framework of our research, e.g. positivism, we use a deductive approach to conduct it. We apply already existing theory, e.g. structural model adjusted for sovereigns, to deduce relevant hypotheses about the relationship between sovereign CDS and stock markets, and test them empirically. Based on the generated results we accept or reject our hypotheses and further make inferences either confirming the theory or altering it.

2.7 Research strategy

As Bryman and Bell (2007, p. 28) pointed out, a research strategy implies a general orientation for conducting a business study. There are two types of research strategies: quantitative and qualitative. Within the framework of quantitative research numerical data are collected and analyzed. The focus here lies on relatively large-scale and representative sets of data. Qualitative research is associated with collecting and analysing information in a non-numerical form. Guiding with the qualitative research strategy the researcher thoroughly studies smaller amounts of information and tries to understand phenomena in-depth and within specific contexts. Fundamentally these two research strategies have different characteristics in terms of ontological and epistemological aspects. Commonly quantitative research relates to objectivism and positivism; whereas the qualitative one is in accordance with the constructionist and interpretive considerations (Bryman & Bell, 2007, p. 28).

We will conduct our research using the quantitative method, which is in line with the research question, selected ontological and epistemological considerations as well as research approach. Our research question addresses the relationship between Asian sovereign CDS spreads and stock index returns. This relationship can be measured only using time series of both asset classes of substantial (statistically significant) length and processing them with statistical and econometric tools, what is an inherent feature of the quantitative strategy. Additionally the quantitative method is justified in our research, since credit default swap spreads and stock indices are externally given and independent to us, what implies the objective reality. Moreover, we study the link between the asset classes in focus in a value-free way using the deductive approach. Finally our findings
satisfy reliability and validity criteria\(^5\), which are the quality criteria within the quantitative strategy.

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<tr>
<th>Method</th>
<th>Quantitative</th>
<th>Qualitative</th>
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<td>Reality is objective and singular (separate) from the researcher</td>
<td>Reality is subjective and multiple, as observed by the study participants</td>
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<tr>
<td>Researcher is independent from the research object</td>
<td>Researcher interacts with the research object</td>
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<td>Facts are value-free and unbiased</td>
<td>Facts are value-laden and biased</td>
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<td>Deductive (testing theory)</td>
<td>Inductive (generating theory)</td>
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<tr>
<td>Cause and effect</td>
<td>Mutual simultaneous shaping of factors, e.g. examining a phenomenon as it is</td>
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<tr>
<td>Static design – categories isolated before the study or developed prior to the study</td>
<td>Emerging design – categories identified during the research process</td>
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<td>Context-free</td>
<td>Context-bound</td>
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<td>Generalisations leading to prediction, explanation and understanding</td>
<td>Patterns and theories developed for understanding</td>
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<td>Accurate and reliable through validity and reliability</td>
<td>Accurate and reliable through verification</td>
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Table 1: Characteristics of quantitative and qualitative methods.
Source: Anderson, 2006; Ary, Jacobs, Sorensen and Razavieh, 2009, pp. 24-26; Bryman and Bell, 2007, pp. 28-29; Authors.

2.8 Classification of research objective and research design

Within positivist deductive and quantitative framework consistent with our research question and purposes we set 3 different kinds of objectives: descriptive, explanatory, and normative. According to the first descriptive objective we intend to provide the reader with a general understanding of credit default swap, CDS market as well as relevant theories. With the second explanatory objective we strive to explain already existing theory based on empirical evidence testing the relationship of Asian sovereign CDS and stock markets. Finally, we set our third normative objective to draw inferences from the test output and generalize them in the form of a law.

Business Administration research similarly as any other kind of social research needs to have a particular structure to start data collection and analysis. The research design addresses this issue and must be worked out in such a way that with the obtained

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\(^5\) Our findings are evaluated according to the quality criteria such as reliability and validity in the concluding part of the thesis.
evidence the researchers could maximally diminish or completely avoid biases when answering the research question (De Vaus, 2001, p. 9). To put it in another way, we need to define the type of evidence, with which we can answer the research question unambiguously.

Our research is designed as longitudinal and cross-sectional. According to Menard (1991, p. 4) the longitudinal research possesses the following features:

- data collected for each variable cover two or more distinct periods;
- the analysis focus is the same or at least comparable from period to period;
- data are compared either between or among the periods.

The cross-sectional design cross-analyzes variables within the data. In the cross-sectional framework the data describing variables in focus are collected at one point in time. In order to obtain results, which are not biased due to external changes as time elapses, the cross-sectional research should be done during a limited time span (Trochim, 2006).

We analyze intertemporal relationship of two variables, e.g. sovereign CDS spreads and stock indices, as well as their derivatives (changes, returns, and variances) based on simultaneously collected time series from the sample of Asian countries with the most liquid CDS contracts.

2.9 Choice of secondary sources and databases

Data collection is a process of gathering data from different sources that can be classified into primary and secondary (Ghauri & Gronhaug, 2005, p. 91). Primary sources refer to the original data collected by the researcher for the particular research purpose and include experiments, observations, questionnaires, and interviews. Secondary sources refer to the data that have already been collected by someone else other than the researcher and can be originally destined for other than the researcher’s purposes. Secondary data can be available from a variety of sources such as books, journal and newspaper articles, essays and dissertations, online data sources (for example, internet sites, web pages, online catalogues), etc.

In our thesis we use secondary sources of information exceptionally. This choice is justified by the selected methodological framework of the research that supposes objectiveness and independency of the researcher from the studied object. We use both numerical and verbal secondary data. The numerical data for the empirical part of the thesis (Asian sovereign CDS spreads, stock index quotes as well as VIX time series) were gathered from one of the largest secondary financial data provider Bloomberg that will be described below. For the methodology and theory sections we selected highly qualitative secondary verbal data sources such as books, articles from newspapers and renowned scientific and business journals (to name a few, Journal of Finance, Journal of Financial Services Research, International Journal of Finance and Economics, Journal of Financial Markets, etc.) as well as working and discussion papers. They were accessed either as hard copies from the Umea University library or digital copies at the http://www.ub.umu.se, Google Scholar and generally through the Internet.
While searching for the secondary verbal sources of information we guided mainly by the following keywords: sovereign credit risk, credit default swap, stock index, Merton model, price discovery, capital structure arbitrage, emerging market.

We use the Bloomberg database to collect data on sovereign CDS spreads and stock indices for the empirical part of our thesis. Bloomberg is an online database providing business news, descriptive information, current and historical financial quotes, research and statistics on different asset classes across the world. As a leading credit derivatives platform Bloomberg covers more than 2000 single name CDS, indices and tranches delivered by 5pm London and 5pm New York time through its integrated CMA DataVision, which is consensus data sourced from 30 buy-side firms, including global investment banks, hedge funds, and asset managers. The database was accessed at the internship place of one of the author’s with permission.

2.10 Criticism of secondary sources

Secondary data sources can be criticized for a series of limitations. Saunders et al. (2009, pp. 269 -272) indicate the following constraints:

- Secondary data can be collected for purposes other than those stated by the researcher, thus being inconsistent with the research question and objectives of the study. Another issue is that secondary data may be collected from an inappropriate or not a representative sample. Additionally intervals or units of measurement can be unsuitable for a cross-sectional analysis.

- The aggregation and definition of data may be unsuitable. As a part of the compilation process data must be aggregated in some way. However, data aggregation for the original purpose may differ from that provided for by the research question and objectives when using it as a secondary source. Definitions of original data may be also different from those ones made by the researcher or be revised over time. Moreover, the sources the researcher use may represent interpretations of those who produced them rather than offer an objective picture of reality.

- The original purpose of data collection may be affected by its representation. When the researcher uses data that are presented as a part of , for example a report, she also needs to be aware of the initial purpose of that report and the impact it may have on the data representation. This is especially an issue for internal organizational documents and external documents such us published companies reports.

- A due control of data quality may lack. Even if secondary data sets that are available from data archives of institutional establishments have a higher quality than self-collected data, still in some cases it may be insufficiently controlled.

We took into consideration the above listed limitations of secondary sources while collecting data for our research. As mentioned in the subsection Choice of Secondary Sources and Databases in our thesis we used highly reputable databases and sources in the area of Finance and Economics, which are also frequently referenced in the academic literature. The numerical and verbal secondary data in our thesis are carefully
selected, edited, and kept up-to-date to meet high standards set for the selected databases and sources.

Despite its constraints the use of secondary data sources has also several advantages. As opposed to the primary data sources they appear to be cheaper and more easily and quickly obtainable. Another virtue of secondary data is that the collection of these data is usually associated with a higher expertise and professionalism, which may not be always the case when self-collecting primary data for smaller research projects (Boslaugh, 2007, pp. 3-4).

2.11 Ethical and societal considerations

An ethical issue comes at a variety of stages in business and management research and cannot be ignored, since it is related directly to its integrity and discipline (Bryman & Bell, 2011, p. 122). While conducting a study the researcher represents herself and should comply with a series of ethical principles (Saunders et al., 2009, pp. 183-184).

How can one conduct her research in an ethical way? In order to answer this question the researcher has to understand the basic concepts of ethical principles (Bryman & Bell, 2011, p. 128):

- no harm to participants;
- informed consent, e.g. the researcher is required to seek permission in order to collect and use information;
- maintaining confidentiality or privacy, e.g. the researcher has professional and moral obligations to keep all the information confidentially;
- avoiding deception.

While carrying out the research we committed ourselves to comply with the above listed ethical principles, so that it is free from any ethical violations.

As stated by the Economic and Social Research Council (ESRC, 2012, p.3): “Ethical review should always be proportionate to the potential risk, whether this involves primary or secondary data. Whilst the secondary use of some data sets may be relatively uncontroversial, and require only light touch ethics review, novel use of existing data and especially data linkage, as well as some uses of administrative and secure data will raise issues of ethics. Research involving primary data collection will always raise ethical issues that must be addressed”.

As mentioned before the authors collected the verbal data for the thesis from such secondary sources as books, journals, newspapers, essays, dissertations, and online data sources. All these secondary data sources are publicly available without any access restrictions. The numerical secondary data were obtained from the Bloomberg database at the internship place of one of the authors with permission. Since we collected and analyzed the secondary data within objective considerations, subjectivity or misinterpreting has no place in our research, so that personal biases can be disregarded. This assures our findings to be trustworthy and far from any falsification.
3. THEORETICAL FRAMEWORK

This chapter introduces the reader to the concepts of credit derivative and credit default swap, provides an overview of both credit derivative and CDS markets, examines the derivative markets in Asia as a whole with a focus on the Asian CDS market in particular, and finally presents the theoretical and empirical literature describing the relationship between CDS and stocks as a basis for further analysis.

3.1 Credit derivative

3.1.1 General aspects

Derivative is an agreements used to shift risk and the value of which is conditioned on a particular underlying asset. Similar to other derivatives a credit derivative is an instrument, which is designed to transfer a part or all of the credit risk of an underlying obligation without a change in its ownership (Kiff, Elliott, Kazarian, Scarlata & Spackman, 2009, p. 4). The value of a credit derivative is derived from the credit performance of one or more debt obligations (for example, loans, mortgages, bonds) of underlying corporate or sovereign entities (Mengle, 2007, p. 1). Thus, cash flows related to a credit derivative are linked to financial losses arising from a default of reference credit securities (Giesecke, 2011, p. 2).

The nature of a credit derivative resembles a bilateral insurance contract, in which one-party acquires a protection against default losses and the other party sells that protection (Giesecke, 2011, p. 2). For instance, a fixed income investor may be willing to hedge against the default risk of a bond and enters into a credit derivative agreement. The seller of this credit derivative, usually a hedge fund or an insurance company, obliges to reimburse the buyer in case of default. Thereby the selling counterparty speculates on the full and timely repayment of the bond and gains investment exposure without actually having to own it.

Being originally designed for the purpose of hedging and diversification, credit derivative is also used for credit risk trading. The instrument allows isolating the credit risk from an underlying asset to transfer and allocate it among different market participants. Other advantages of credit derivatives are possibility to sell off credit risk without the borrower’s consent and to tailor as well as originate synthetic credit risk (Cox & Kaveripatnam, 2007, p. 141). However, the instruments are also not without their flaws exposing their parties to considerable asset allocations and increased operational risk.

3.1.2 Credit derivative market

Credit derivative was invented by a J.P. Morgan employee Peter Hancock in 1993. Having emerged literally from scratch the credit derivative market grew to 180 billion USD measured by the notional amount outstanding 3 year later, which skyrocketed to over 1 trillion in 2001 and rose 52-fold to the all time high of 62 trillion USD in 2007 based on combined data from British Bankers’ Association (BBA), Bank of International Settlement (BIS), International Swaps and Derivative Association (ISDA),
and Risk Magazine. In the following years the notional amount outstanding started to decrease partly caused by so-called “tear up” and “compression” operations designed to eliminate redundant offsetting contracts (Kiff et al., 2009, p. 3). According to DTCC (2013) at present there are 2,14 million contracts covering a gross 24 trillion USD worth of credit products.

Credit derivatives can be classified into single-name and multi-name products. The overview of the credit derivatives, which exist at present is presented in the table below.

<table>
<thead>
<tr>
<th>Credit derivative</th>
<th>Single-name</th>
<th>Multi-name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit default swap</td>
<td>Basket default swap</td>
<td>Synthetic CDO (collateralized debt obligation)</td>
</tr>
<tr>
<td>Total return swap</td>
<td></td>
<td>CDX and iTraxx indexes</td>
</tr>
<tr>
<td>Credit-linked note</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit-sensitive note</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: State-of-the-art types of credit derivatives.
Source: Sundaram, 2013.

Although multi-name credit derivatives have demonstrated a dynamic growth single-name products still kept their dominance according to the market share.

![Figure 1: Evolution of credit derivative market.](chart.png)

The participant structure of the credit derivative market includes banks, hedge funds, insurance companies, pension and mutual funds and some others (BBA, 2006).
According to Rule (2001, p. 124) one can distinguish between end-buyers of protection, who use the instrument to hedge against credit risk; end-sellers, who seek their portfolio diversification; and intermediaries, who are liquidity providers for end-buyers/sellers and trade for their own account. The intermediaries represented by large dealer banks are the biggest players in the market. Net-buyers of credit derivatives are mainly middle-sized commercial banks. Along with insurance companies, pension and mutual funds they also act as net-sellers of credit risk protection. Hedge funds are end-customers in the credit derivative market on buy and sell sides.

3.1.3 Regulations as driving force

In the beginning the growth of the credit derivative market was slow due to lacking standard legislation (Cox & Kaveripatnam, 2007, pp. 142-143). The introduction of standardised International Swaps and Derivatives Association (ISDA) definitions in 1999 that were amended and published in 2003 has become an important driving factor for the market development. Fixing maturities and payment dates for CDSs have reduced risk of maturities mismatch between credit risk contracts. Other standards like, for example, credit fixing\(^6\) for the three most liquid European credit default swap indexes such as iTraxx indexes have increased transparency and accelerated a contract settlement. The Novation Protocol launched by ISDA in 2005 has contributed to the uniformity of the process, when obtaining consents for transferring interests in credit derivative transactions, and diminished backlogs of outstanding confirmations.

Persisted tightness in credit conditions and ailing state of a number of financial institutions during the global financial crisis forced market participants to shift business onto exchanges and into clearing houses (Heaney, 2009, p. 9). Additionally, since 2009 a series of modifications have been done on the way of CDS standardization and unification of pricing methods (Markit, 2009). These changes mainly aimed at restoring confidence in the credit risk instrument, rebuilding liquidity, reducing the counterparty risk and providing greater market transparency.

One of the most prominent regulations that has recently become effective in the EU is ban on naked short selling and naked sovereign CDS buying (EUR-Lex 2012: 236). According to this regulation market participants are not allowed to acquire CDS on sovereign debt from the European Economic Area if they don’t have a meaningful exposure to it except of for the purposes of market-making and primary-dealer operations. The ban aims at diminishing the risks of negative spirals for sovereign debt as well as failures in settlements resulted from naked short selling and CDS buying. However, IMF (2013) argues that this regulation could negatively affect financial markets drying up liquidity and increase the costs of debt raising.

3.2. Credit default swap

\(^6\) A benchmark that helps to determine exercise values for credit derivative contracts by providing a certain number used as a settlement rate.
3.2.1 General aspects

Credit default swap is a bilateral agreement, in which one party called protection buyer commits to pay a periodic premium to another party known as protection seller in return for a reimbursement for credit event by a reference entity (ISDA, 2013). The reference entity is an external party on which protection is issued and is not involved into the transaction directly. In a simple case it can be a company or a government. CDS premiums also known as spreads are expressed in basis points per annum of the notional amount and as a rule quarterly paid. CDS mechanism is demonstrated below.

Figure 2: Mechanism of credit default swap.
Source: ISDA, 2013; Authors.

Credit events are usually determined through a negotiation between both counterparties at the beginning of the transaction. There is a standardized set of credit events introduced by ISDA in 1999 and later amended, which are also deemed to be the most common (Geen, 2012):

- Failure to timely meet debt payments (subject to payment requirement).
- Bankruptcy for corporate entities.
- Repudiation or moratorium\(^7\) (subject to payment/default requirement). These credit events imply that the reference entity disclaims, disaffirms or challenges the validity of its obligation. They are common emerging market corporate CDS and sovereign contracts.

\(^7\) The latter is for sovereign reference entities only.
- Debt restructuring (subject to payment/default requirement). Restructuring is defined as a credit event when it affects debt holders in a material adverse way. This can be either a decrease in the debt principal or annuity; a payment postponement or deferral; change in debt seniority; change in currency or any other payment composition other than the currency permitted.

- Obligation acceleration or obligation default (subject to payment/default requirement). These two kinds of credit events are associated with technical defaults such as covenant violation. They are rarely included into a CDS contract.

All the above listed credit events except bankruptcy are caused by a specific event that happens to an obligation. Bankruptcy takes place when a specific event occurs to the reference entity itself. Thus, apart from insolvency the definition of bankruptcy may also include other actions by the corporate entity such as, for example, shareholder/board meeting to consider the filing of a liquidation petition.

If the credit event specified in the CDS contract happens the protection seller’s obligation to compensate the buyer becomes due. Depending on the agreement between the two parties the CDS contract can be settled either by physical delivery or in cash (Hull & White, 2000, p. 3). Physical settlement implies that the CDS buyer delivers the bond to the seller in return for its par value (as a rule within 30 business days). In case of cash settlement dealers determine the mid-market price of the reference obligation within some specified number of days (usually 5 days) after the credit event. The protection seller is required then to pay the difference between the par value of the bond and the defined market price.

Apart of the credit risk of the reference entity OTC CDS contracts are subject to a counterparty risk (ISDA, 2013). This is the risk of default by the protection seller before meeting her obligations. Companies must hold a specified (according to the ISDA Master Agreement) amount of capital against counterparty credit exposure. Additionally the protection seller usually posts a collateral that is dependent on the market value of the CDS contract and her creditworthiness. If both parameters change in an unfavourable way for the CDS holder the seller receives a margin call to put additional collateral.

One can distinguish between three types of CDS (ECB, 2009, pp. 9-10). The most simple is the single-name CDS that is issued on a single corporate or sovereign reference entity. The CDS contract pooling several single-name credit risk protections is known as CDS index (which is a standardized product). Within the CDS index the notional amount of each reference entity is equally weighted. Inclusion of the most frequently traded single-name CDSs into the indexes strengthens their liquidity. Unlike the single-name credit risk protections CDS indexes are not terminated upon the occurrence of a credit event. They are further traded, but with decreased notional amounts. The list of CDS indexes, whose prices are daily updated by Markit, is presented in the table below. Similar to CDS indexes are CDS index tranches or synthetic CDOs. Within this credit risk protection each tranche addresses a certain segment of losses distributed for the underlying CDS index if a credit event takes place.

The final type of CDS is the basket CDS covering a portfolio of 3 to 100 reference entities. With this regard they remind indexed products. However, basket CDSs are
classified under the different type, since they are more customized and flexibly negotiated in terms of prices and volumes.

CDS is often associated with an insurance contract. However, Stulz (2010, p. 74) argues that within the CDS contract the buyer doesn’t have to hold the underlying debt to acquire a protection on it, whereas the insurance policy usually assumes a direct economic exposure to the object insured of its holder. Additionally, in contrast to the insurance contract the CDS one is actively traded over the counter.

<table>
<thead>
<tr>
<th>Markit Index</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDX</td>
<td>Represents the most liquid baskets of names covering North American Investment Grade, High Yield, and Emerging Markets single-name CDS</td>
</tr>
<tr>
<td>iTraxx</td>
<td>Rule based CDS index, which is comprised of the most liquid names in each of the respective market, Europe, Asia, Australia and Japan</td>
</tr>
<tr>
<td>LCDX</td>
<td>The North American benchmark for first lien leverage loans CDS</td>
</tr>
<tr>
<td>iTraxx LevX</td>
<td>Based on European Loan credit derivatives and is constructed from the universe of European corporates</td>
</tr>
<tr>
<td>iTraxx SovX</td>
<td>Sovereign CDS index covering countries across the globe</td>
</tr>
<tr>
<td>MCDX</td>
<td>References U.S. municipal credits covering revenue and general obligations</td>
</tr>
</tbody>
</table>

Table 3: Overview of Markit CDS indexes.

3.2.2 Credit default swap market

The emergence of CDS market dates back to the early 90’s, when the instrument was invented by a J.P. Morgan employee Blythe Masters. After ISDA had made the first steps to standardize the credit risk instrument introducing its definitions in 1999 the market started its rapid growth. Within the over-the-counter (OTC) derivatives business CDS was the fastest-growing segment. Its notional amount outstanding skyrocketed 68-fold from just below 1 trillion of U.S. dollars in 2001 to an all-time high of 62 trillion of U.S. dollars in 2007. However, in the aftermath of the financial turmoil the CDS market has shrunk to just around 40% of its 2007 size (ISDA, 2010, 2012).

According to the participant structure dealers being the major player represent 54% of the CDS notional outstanding (BIS, 2013). CDS contracts with central counterparties account to 17% of the market, whereas other banks and securities firms are 19% of notional outstanding. Finally, hedge funds hold about 3% of market share followed non-financial customers (1%).

Broken down by the CDS type at the end of 2011 the single-name CDS dominated the market with 57%, followed by multi-name CDS and tranches accounting to 35% and 8% of notional amount outstanding respectively (DTCC, 2013).
As shown in the figure above multi-name CDSs and single-name CDSs on corporate reference entities have more than halved from their 2007 and mid-2008 highs measured by the gross notional amount outstanding. However, this doesn’t mean that the credit protection has lost its popularity as a result of the financial turmoil. Trading volumes kept on rising. The plunge in the gross notional amounts outstanding was caused by trade compression and the move to central counterparties in the CDS market (Vause, 2010, p. 59).

Comparing to CDS on corporate reference entities sovereign single-name CDS are yet relatively small. However, this segment is rapidly growing. In the late 90s a series of emerging market crises contributed to the emergence of the market for sovereign credit risk. Originally so-called Brady bond futures contracts (for 3 countries Argentina, Mexico, and Brazil) served as a means of hedging or trading the sovereign credit risk. In the early 2000s sovereign CDSs were introduced as an alternative. At the end of 2012 the instruments accounted for only about 12% of the whole CDS market (BIS, 2013). However, since 2008 the sovereign CDSs have demonstrated a considerable growth (CAGR 2008–2012\(^8\) of +16%) compared to the contraction of other segments (CAGR 2008–2012 of -14%). The dynamic development of the sovereign CDS market in the recent years can be probably explained by the necessity to hedge derivative counterparty credit risk exposure that must disclosed in greater details under the new accounting rules (IMF, 2013).

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\(^8\) Compound annual growth rate.
According to the table above sovereign CDS have displaced the credit protections written on companies from the Top 10 Ranking according to both gross and net (only GE was ranked # 7) notional amounts outstanding by the end of 2012. However, according to IMF (2013) the sovereign CDS market is still very small (6%) related to the total government debt outstanding.

Before the global financial turmoil trading in the sovereign credit risk market was mainly concentrated on emerging countries. But since the end of 2009 deteriorating credit quality of a number of Euro-zone sovereigns has triggered a shift in the investment focus towards the developed world. Berg and Streitz (2012) found that advanced European economies dominate the CDS market measured by net notional amounts outstanding. However, speculative-grade sovereign reference entities are more actively traded measured by the proportion of trading volume in the net notional amount outstanding. When scaled by gross notional amounts outstanding as of end-2011 sovereign credit default swaps on emerging countries still constituted a larger share relative to their cumulative sovereign debt (19%) as compared with developed countries (3%) (IMF, 2013).
Similar as in the whole CDS market dealers dominate the sovereign segment. Besides market-making they use sovereign credit default swaps to hedge against their sovereign exposures. Dealers are usually subject to counterparty risk in derivative contracts with sovereigns, since the latter don’t post collateral to cover the mark-to-market risks of their OTC positions in derivative trades. Other financial institutions (including banks as end-customers) and security firms, followed by hedge-funds are by far important.
players in the sovereign CDS market (BIS, 2013). As shown in the figure above non-dealer banks and security firms are net-sellers of sovereign credit risk protections similar to their position in the segment for corporate CDSs. Until the beginning of 2010 hedge funds have collected sovereign CDS premiums, whereas thereafter they became net-buyers. Hedge funds appear to hold larger exposures in sovereign rather than corporate credit risk protections. However, the data available doesn’t allow to find out for which purposes sovereign CDS are used by hedge funds, e.g. as a means to hedge positions in sovereign debt or to speculate on sovereign credit spread widening entering naked CDS contracts (IMF, 2013).

3.3 Asian derivative market

It is interesting to mention that the first Asian derivative contract was a commodity future, which was invented for the purpose of rice trading in Japan, and dates back to the 17th century. The Asian derivative markets have been growing rapidly over the last decade and are partially migrating from the OTC (over-the-counter) to ETD (exchange-traded derivative) markets (Fratzscher, 2006).

One can distinguish among five main types of derivative instruments traded in the Asian markets. Those are FOREX (foreign exchange) derivative products, equity derivatives, interest rate derivatives, commodity derivatives and credit derivatives (Fratzscher, 2006). FOREX derivative turnover is very substantial in the main OTC markets, whereas equity derivatives are the fastest growing products on exchange.

FOREX derivative products on major currencies are overwhelmingly traded in the OTC markets in Tokyo, Singapore, and Hong Kong, whereas the offshore markets located mainly in Singapore host trading of FOREX derivative contracts on minor as well as non-convertible currencies. It is worth mentioning that the combined Asian foreign exchange markets are large and have a turnover equal to one third of worldwide markets.

Among other Asian derivative instruments equity derivatives that are mainly traded in the ETD markets in Korea, India and Hong Kong have witnessed the most rapid growth, which often doubled every two to three years. Among the Asian equity derivatives options and index futures are the most liquid products with a significant participation of institutional investors and foreign investors. Over 44% of worldwide ETD equity turnover is currently taking place on Asian exchanges. Thus, the turnover ratios of 40 and 150 times outstanding stock for futures and options respectively considerably exceed the average global turnover ratio of 25.

In contrast to the large equity derivative markets in Asia the size of interest rate derivative market, which accounts for less than 5% of the world market, is relatively small. The interest rate derivative contracts in Asia are becoming more standardized and are migrating from the OTC with customized products towards the ETD markets. For instance, Korea has shifted its government bond derivatives onto the exchange. However, some Asian countries still keep both regulated and unregulated markets. Tokyo and Singapore remain two dominant locations for trading OTC swaps denominated mostly in JPY and USD currencies and exchange-traded futures.
Japan with its first rice future being historically a pioneer in the Asian commodity derivative market has given its lead in trading volumes to the tiger economies such as China and India, which have exhibited an impressive growth recently. For instance, according to the Futures Industry Association the Shanghai Futures Exchange, which lists futures contracts on a number of metals (gold, copper, aluminium, steel rebar, steel wire rod, natural rubber, and zinc) as well as fuel oil tripled its volumes to 434.9 million contracts even in the year of global financial turmoil. By the number of contracts traded, China has already overtaken the U.S. as the world’s largest commodity futures market according to China Futures Association. However, in spite of the impressive growth of the Asian commodity derivative markets, they haven’t yet used their whole development potential, which is mainly stipulated by historical factors. Even though, commodity derivatives account for less than 10% of turnover on the exchanges

The other main derivative instrument in Asia, which is rapidly expanding in volume, is credit derivative. It is estimated that 10% of the worldwide 6 trillion dollar credit derivative market is located in Asia, mostly in Tokyo and Hong Kong. Similarly to the European and American credit derivative markets the Asian one is dominated by credit default swap, which accounts for a half of the OTC market. The Asian credit derivative markets have been characterized by relatively low transparency and high leverage that cause an increased concern from the regulators (Fratzscher, 2006).

The first single-name CDS contract issued by an Asia-Pacific borrower dates back to the late 1990s. The first regional indexed CDS, which were iTraxx Japan as well as iTraxx Asia ex-Japan, started to be traded in the market in July, 2004. The trading was relatively limited in the first few years, but after the reconstitution of indices in response to a surge in bond issuance by new large borrowers in the region starting in the fourth quarter 2006 has soared. The liquidity obtained in the index market has also spread out in the market for single-name CDS contracts. Consequently, the Asian CDS market started to emerge as a potentially earnest market in its own right. (Shim & Zhu 2010, p. 1).

Similarly as the European and American CDS markets the market for credit risk trading in Asia has also grown rapidly in the past decade. However, in comparison to Europe and the United states the CDS market in Asia is still relatively small and illiquid. The Asia-Pacific CDS market still provides a limited access to international investors. The reason behind this peculiarity is that the domestic bond market with its debt obligations denominated mainly in local currencies has a tendency to accept only an issuer with the highest rating (Remolona & Shim, 2008, p. 59). Therefore, the domestic bond buyers may not need or show little interest to have a credit risk protection in the form of CDS contracts. However, considered from the international investor perspective highly rated debt issues in Asia rated by domestic agencies might not receive the same rating notch, when assessed by international rating agencies. For example, depending on the state of economy an Asian rating agency may give a superior AAA rating to a domestic bond, while in the international bond market it is often rated several notches lower, A or BBB. Thus, foreign investors would be interested in hedging the concurrent credit risks.

In 2012 the OTC derivative market in Asia* accounted to 42,6 trillion of U.S. dollars in notional outstanding (Celent, 2013). Since its contraction in the aftermath of the

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* Australia, China, Hong Kong, India, Indonesia, Malaysia, New Zealand, Singapore, South Korea, and Taiwan.
financial crisis the annual turnover has revived and reached 186 trillion of U.S. dollars (CAGR 2008 – 2012 of 2%). In the past 4 years FX derivatives contributed at most (80%) to the turnover growth in the Asian OTC market, followed by interest rate derivatives (17%). Whereas CAGR 2008 – 2012 of FX derivative segment accounted to 3%, the rest OTC market grew at or less than 1%.

Figure 5: Asian OTC derivatives (excl. portfolio compression).
Source: Celent, 2013.\(^\text{10}\)

In 2012 76% of turnover in the Asian OTC derivative market was generated with FX derivatives and 18% with interest rate derivatives. The shares of equity linked, commodities and credit derivatives are in single digits. The Asian OTC derivative market is dominated by dealers (57%), followed by non-dealer banks and security firms, whereas the engagement of real sector is marginal.

3.4 Literature review

The theoretical linkage between credit risk sensitive securities can be deduced from two contradictory credit models. One, known as a reduced-form credit model, describes the relationship between CDS and bond spreads and was firstly introduced by Jarrow and Turnbull (1995). The other one, known as a structural credit model, captures the co-movements of stock and bond prices in the frames of option pricing theory and was developed by Merton (1974).

3.4.1 Relationship between CDS premia and bond yield spreads

The central assumption of the reduced-form model is risk neutral pricing, e.g. price of any credit sensitive instrument is estimated using a risk-free rate and default probability, which can be calculated based on publicly available information. Duffie (1999) and Hull and White (2000) extended this model to the CDS valuation demonstrating a theoretical equilibrium between CDS and bond yield spreads. Under a number of

\(^{10}\) Based on central banks, BIS, IMF, World Bank, news sources.
assumptions\textsuperscript{11}, among them no constraints on a bond short-selling in the repo market and a zero recovery rate for a defaulted bond, Duffie (1999, pp.74-75) argues on credit default swap valuation as follows. An investor acquiring a protection against credit risk on an underlying obligation (bond) with the same maturity can alternatively short sale the latter and invest his/her profit in a default-free security. In a non-default case the securities simply expire at par and no net cash flow is caused. If a default does take place before the maturity date the investor receives the difference between the market value of the default-free security and that of the risky obligation. Since this difference is equal as that in the CDS agreement, under no arbitrage conditions the equivalence of the CDS premium and the bond spread (bond yield – risk-free rate) should be the logical conclusion.

For high grade corporate entities this theoretical relationship between both credit spreads is confirmed for the long run in the studies by Hull, Predescu and White (2004), Blanco et al. (2004), Zhu (2006). Similarly with regards to the sovereign credit markets Palladini and Portes (2011) provide an empirical evidence of the credit spreads equivalence for 6 Euro-area countries, which, however, doesn’t hold in the short run. Ammer and Cai (2007) and Hassan et al. (2011) prove a linear long-run equilibrium relation in sovereign credit risk markets to hold for a number of emerging countries, but the former also point out at discrepancies from the theoretical parity in the short run. Arce et al. (2011) find a persistent departure from the equivalence relation between CDS and bond spreads in the Eurozone countries during the crisis period (unlike the pre-crisis one) that can be explained by existence of market frictions. Levy (2009) first detects no parity between the EM sovereign credit spreads, but manage to restore it adjusting for liquidity effects. Analogically Adler and Song (2010) document no equivalence between EM CDS premia and bond spreads for the majority of their sample, but can prove the opposite adjusting for the non-par price by constructing ‘implied bond yield spreads.

\textbf{3.4.2 Relationship between equity and bond prices}

The Merton theory considers a company’s equity\textsuperscript{12} with a non-zero debt as a European call option on its assets (Merton, 1974, p.454). Thus speaking in the option theory terms, the company value is the underlying asset; the equity is the option price; the debt value is the strike price; and the option expiry date is the financial obligation due date. Shareholders take the possession of the company value only after the debt is fully redeemed. If the debt value exceeds the equity value on the expiration date (spot price - strike price < 0), the option is valueless, or out-of-the-money. In contrast if the company equity value is above that of debt, the option expires in-the-money.

Deeming the company’s asset value based on the information available on the balance sheet as a sum of its equity and debt the structural model allows gaining a valuable insight on the relationship between stock and bond prices (Merton, 1974, p.453). On the date the debt is due the company value is reduced for the notional amount of its debt (equity). If the asset value is negative after the debt subtraction, the company defaults.

\textsuperscript{11} The other key assumptions include par floating rate risk-free and risky bonds; no transaction costs and tax effects; termination payment at the immediately following coupon date upon the occurrence of a credit event; no payment of the accrued CDS premium at default.

\textsuperscript{12} The structural credit model assumes the equity to be a common stock that doesn’t pay dividends.
Moreover, the Merton model points out at the positive direction of this relationship, when an increase in a stock price is accompanied with a rise in a bond price (or alternatively a fall in a bond yield). This relationship is stronger in magnitude for companies with a high debt ratio (high default risk). (Chan-Lau & Kim, 2004, p. 9) Thus, for highly indebted companies even insignificant fluctuations in their asset values can lead to a default event.

With regards to bond yields the structural credit model implies the dependency of the risk premium (the difference of the bond yield and the risk-free rate) on the following variables (Merton, 1974, pp. 454-455):

- the equity volatility that is transformed into the volatility of the company operations;
- debt-to-firm value ratio, where debt value is the present value discounted at the risk-free rate (or alternatively, equity price and leverage ratio).

An example of the empirical research on the stock-bond theoretical relationship described in the Merton model is Kwan (1996). He found out a negative contemporaneous correlation between the stock returns and bond yield changes of the same company. Additionally Kwan (1996) detected a lead-lag relationship between both credit sensitive securities dominated by the stock returns. Campbell and Taksler (2002) are among the first to provide empirical evidence on the link between the equity volatility and corporate bond yields with the strong explanatory power of the former.

### 3.4.3 Relationship between corporate CDS and stock markets

The argumentations behind structural and reduced-form theories allowed a number of researchers, among them Longstaff et al. (2003), Blanco et al. (2004), Norden and Weber (2009), Bystroem (2005), Forte and Pena (2009), to infer a negative relationship between CDS spreads and stock prices and test it empirically.

We would like to especially stress the paper by Bystroem (2005), who pioneered the research on a link between indexed CDS and stock index markets with a focus on the European sectoral iTraxx CDS indexes. The researcher discovers the stock index prices to move in the opposite direction with the iTraxx CDS spreads and dominate the CDS index market. He also detects inefficiency of the iTraxx CDS index market based on the outcome of the autocorrelation test.

Most importantly, the study by Bystroem (2005) is among the first to disclose a positive link between CDS index premiums and stock index return volatilities: with an increase (decrease) in stock volatility the indexed CDS spreads tend to widen (tighten). Thus, the paper provides an empirical confirmation of the importance of equity volatility within the Merton model.

### 3.4.4 Relationship between sovereign CDS and stock markets

However, it was not until 2004 when Chan-Lau and Kim justified the CDS-stock relationship with regards to sovereigns. The researchers base their argumentation on the Merton model of corporate debt focusing on the default risk as a linkage between stock
and bond prices. Chan-Lau and Kim (2004, p. 25) point out to the different strength of this linkage for lower-graded and higher-graded issuers. In case of the former, an increase in the risk of default affects a plunge in company stock prices, since the shareholders’ risk that the company goes bankrupt rises. Simultaneously the price of a bond decreases, as the complete debt repayment becomes increasingly jeopardized. This relationship is, however, much more insignificant for higher-rated issuers, since their default is less likely.

To make the Merton theory of firm applicable for sovereign issuers Chan-Lau and Kim (2004, p.9) determine two key asset values, namely “default value” and “no-payment value”. They argue that for companies the “default value” equaling to the face value of debt and zero correspondingly coincides with the “no-payment value”. In contrast, for sovereigns the “default value” is above the notional debt value and the “no-payment value” is positive due to existence of the “willingness-to-pay” factor. The latter implies that a sovereign may opt to default on its obligations even if its assets still exceed the debt amount to be due. To put it in another way, even if the country defaults or reject to serve its debt, its asset value can be still higher than that of its debt. Hence, for a sovereign the default risk is much higher than for a company for any asset value, but overall the relationship between stock prices and CDS spreads is analogous that allows applying the Merton theory for sovereign issuers as well.

However, empirically Chan-Lau and Kim (2004) didn’t confirm the equilibrium relationship between sovereign CDS and stock markets for their EM sample that can be probably explained by the volatile debt ratio in the considered countries causing non-linearity of the relationship. They also obtained mixed results for price discovery in the credit risk markets. Among the few other papers, which study the co-movement of the sovereign CDS and stock markets are Coronado et al. (2011), Aktug (2011), and Chan et al. (2008).

Coronado et al. (2011) explore how the above discussed theoretical relationship between sovereign CDS and stock markets holds for 7 Eurozone countries and the U.K. They find a clear negative lead-lag relationship between both markets dominated by the stock indices for the whole period and note that the strength of this linkage is dependent on the state of either market: it increases in the crisis periods. However, they also mention that the sovereign CDS market takes over the leadership in the price discovery during the Eurozone debt crisis. Additionally the authors studied a correlation between the stock index volatilities and sovereign CDS spreads that turned out to be strongly positive for the countries with higher credit risk premiums and weakly positive for those with lower credit spreads.

Besides studying the price discovery process in the sovereign CDS and national stock markets for 5 major emerging countries Aktug (2011) includes in his research corresponding local currency government bonds and foreign exchange markets. He notes that during the whole turmoil period local currency government bonds and foreign exchange markets lead the other two that contradicts the previous literature on corporate studies. Moreover, he finds that the markets surprisingly appear to be more integrated during the crisis time.

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13 Brazil, China, Indonesia, Mexico, and Turkey.
Chan et al. (2008) explored the dynamic relationship between the markets in focus for the Asian region\textsuperscript{14}. During the period of 2001 – start of 2007 they detect a strong negative correlation between the Asian sovereign CDS spreads and stock indices except for China. The researchers deem a capital structure arbitrage between the respective Thai, Korean and Chinese (since 2005) markets as feasible according to the cointegration test results. For the rest Asian countries they fail to document a long-run equilibrium relationship assuming its lack to be caused by low default risk for Japan and time varying debt to asset ratios for the others. Alternatively, imperfections preventing arbitrage between the CDS and stock index markets could gain non-cointegration results. One more explanation is based on a risk premium for emerging countries, which is priced differently in the two markets. Additionally Chan et al. (2008) found out the CDS market to lead the stock market for the majority of the sample conjecturing a more advanced development of the former (fewer constraints, greater liquidity, and active participation of institutional investors with an information advantage). The bidirectional lead-lag relationship was discovered only for two countries, whereas the Korean stock index was the only to firstly incorporate new information. Based on their results Chan et al. (2008) advise the market participants investing in Asian equities to take a close look at the sovereign CDS markets.

For our research about the relationship between sovereign CDS and stock markets we will take the argumentations by Chan-Lau and Kim (2004) with regards to the applicability of the Merton theory of firm to sovereign CDS issuers as a theoretical background. To put forward our hypotheses in the next section, additionally we will focus on the following main points raised in the studies listed below:

<table>
<thead>
<tr>
<th>Focal point</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>contemporaneous relationship between CDS spreads (CDS spread changes) and stock indices (stock index returns)</td>
<td>Bystroem (2005); Chan et al. (2008); Coronado et al. (2011)</td>
</tr>
<tr>
<td>link between stock index return volatilities and CDS spreads</td>
<td>Bystroem (2005)</td>
</tr>
<tr>
<td>dominance in the price discovery process of either sovereign CDS or stock index markets</td>
<td>Chan et al. (2008); Coronado et al. (2011)</td>
</tr>
<tr>
<td>contemporaneous relationship between variances of sovereign CDS and stock index markets; lead-lag relationship between sovereign CDS spread changes and stock index returns; evolution of the relationship (including the price discovery process) depending on the market state (calm vs. turbulent)</td>
<td>Coronado et al. (2011)</td>
</tr>
</tbody>
</table>

Table 5: Relationship between sovereign CDS and stock markets in the literature. Source: Authors.

\textsuperscript{14} In this context the following Asian countries are covered: China, Japan, Korea, Indonesia, Malaysia, the Philippines and Thailand.
Within this theoretical framework we strive to make an empirical contribution to the research on sovereign CDS-stock markets relationship for the Asian region initiated by Chan et al. (2008). We address our empirical research to the investor focusing on the Asian sovereign credit risk seeking to profit from a possible interplay between the sovereign CDS and equity markets.

3.5 Hypotheses

Within the theoretical framework of our thesis and in line with the previous empirical findings on the topic subdued to our research question “What is the relationship between the Asian sovereign CDS and stock markets?” we formulate the following hypotheses:

**Hypothesis 1: Sovereign CDS spreads and stock indices are interrelated and move in the opposite directions both at levels and changes.**
This hypothesis is based on the structural credit model extended to sovereign debt issuers. It has been already confirmed in the study by Bystroem (2005) with regards to the relationship of iTraxx CDS indices and made-up stock indices, but also in the studies by Chan et al. (2008) and Coronado et al. (2011) with regards to the relationship between sovereign CDS spreads and corresponding stock indices. Hereby we assume that an increase (decrease) in a stock index price is accompanied by a fall (rise) in a CDS premium. The same argument should hold for the relation between stock returns and CDS spread changes.

**Hypothesis 2: Volatility in the stock market is positively correlated to credit risk prices.**
As provided by the Merton model and in line with Bystroem (2005), who confirmed a positive correlation between iTraxx CDS index spreads and historical stock index volatilities at levels, we expect the correlation as a measure of contemporaneous relationship between the Asian sovereign CDS spreads and historical volatilities of corresponding stock indices to be positive.

**Hypothesis 3: The relation between CDS and stock index variances is positive and more profound for sovereigns with a higher risk premium.**
Increased sovereign CDS variance should go hand in hand with heightened turbulence in the stock index markets and vice versa. Hereby we also strive to check if the findings by Coronado et al. (2011) concerning a stronger correlation in risk for riskier Eurozone sovereign entities hold for the emerging East Asian region and Japan.

**Hypothesis 4: The sovereign CDS market dominates the price discovery process.**
Thereby we imply that CDS changes should explain stock index returns for the majority of our sample, and thus be first to incorporate new information. We state this hypothesis in line with Chan et al. (2008), who found the Asian sovereign CDS market to lead the stock index market due to fewer constraints, broader investor base and information advantage in the CDS market.

**Hypothesis 5: The intensity of the linkage between the sovereign CDS and stock index markets is state-dependent: it enhances during periods of increased turbulence.**
We assume that in course of the financial turmoil (which we define as the crisis period of enhanced volatility on the financial markets sparked by the bankruptcy of Lehman...
Brothers) both markets appear to be stronger interrelated. Thus, during the crisis period widening CDS spreads (plummeting stock index returns) should cause drops in stock index returns (spikes in CDS spreads) for a greater number of sovereigns comparing to non-crisis time.

Hypothesis 6: The price discovery process in both markets is subject to change over time.

Chan et al. (2008) carried out their analysis of the price-discovery process on the static basis and provided a measurement for the whole period. However, Longstaff (2010) claims that the price discovery process can vary depending on the financial market state. Thus, with our last hypotheses we address the issue of dynamic relationship between the sovereign CDS and stock index markets. Additionally, according to the paper by Coronado et al. (2011), where they detect different causality relationship for the European countries sample during the Eurozone crisis period in contrast to the whole period, we admit that it is also possible in our case for the dominance in the price discovery to change.
4. EMPIRICAL ANALYSIS

4.1 Data collection, conditions and sample composition

Since in our thesis we intend to study the relationship of sovereign CDS and stock markets with the focus on the Asian region, first we select appropriate Asian countries as sovereign entities underlying the most liquid CDS contracts. On the publicly available site of the Depository Trust and Clearing Corporation (DTCC) under the section OTC Derivatives – Deriv/Serv and further sub section Repository Reporting OTC Data we choose the Market Activity Report “Top 1000 Single Names: Aggregated Transaction Data by Reference Entity” listing top 1000 reference entities of single-name CDS for the period of June 20, 2011 to September 19, 2011. The report covers both sovereign and corporate debt issuers and contains data on the region of corresponding reference entity, total number of clearing dealers and average monthly clearing dealers, average daily notional in U.S. dollars, average number of trades per day, restructuring, and, finally, information on inclusion of a particular reference entity in a broad credit derivative index. Out of this list we pick out Asian countries as reference entities, which underlie the most liquid sovereign single-name CDS that are actively traded on the sovereign credit derivative markets. As a result, our sample constitutes of 3 Northeast Asian countries, e.g. Japan, China and Korea, and 5 Southeast Asian countries, e.g. Indonesia, the Philippines, Thailand, Malaysia, and additionally Vietnam. This sample

<table>
<thead>
<tr>
<th>Reference Entity</th>
<th>Index Constituent (Yes/No*)</th>
<th>Total Number of Clearing Dealers</th>
<th>Average Monthly Clearing Dealers</th>
<th>Average Daily Notional** (USD EQ)</th>
<th>Average Number Trades/Day</th>
<th>Restructuring %</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAPAN</td>
<td>Yes</td>
<td>14</td>
<td>13,7</td>
<td>300000000</td>
<td>23</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>PEOPLE'S REPUBLIC OF CHINA</td>
<td>Yes</td>
<td>17</td>
<td>15,7</td>
<td>250000000</td>
<td>24</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>REPUBLIC OF KOREA</td>
<td>Yes</td>
<td>16</td>
<td>15,3</td>
<td>175000000</td>
<td>24</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>REPUBLIC OF INDONESIA</td>
<td>Yes</td>
<td>15</td>
<td>13,3</td>
<td>125000000</td>
<td>14</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>REPUBLIC OF THE PHILIPPINES</td>
<td>Yes</td>
<td>15</td>
<td>14</td>
<td>125000000</td>
<td>12</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>KINGDOM OF THAILAND</td>
<td>Yes</td>
<td>15</td>
<td>13,7</td>
<td>500000000</td>
<td>7</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>MALAYSIA</td>
<td>Yes</td>
<td>15</td>
<td>14</td>
<td>500000000</td>
<td>6</td>
<td>&gt; 95%</td>
</tr>
<tr>
<td>SOCIALIST REPUBLIC OF VIETNAM</td>
<td>Yes</td>
<td>14</td>
<td>11</td>
<td>150000000</td>
<td>2</td>
<td>&gt; 95%</td>
</tr>
</tbody>
</table>

*stands for the inclusion/exclusion of the sovereign reference entity in/from one of the broad market indices traded on the credit derivative market.

**The average daily notional implies the amount executed across the entire maturity spectrum for each of the reference entity.

Table 6: Aggregate transaction data for the Asian countries in focus.
Source: DTCC, 2013; Authors.
is also in line with that of selected by Chan et al. (2008), what provides a ground for comparison of the former research findings to some extent.

The table above contains aggregate transaction data for a corresponding Asian country for the period of June 20, 2011 to September 19, 2011 sorted by the average daily notional in a descending order.

After drawing a sample of Asian sovereign reference entities we collect data on their CDS spreads as CDS closing prices (mid-price between bid and ask quotes) with a daily frequency from Bloomberg. We download CDS spreads series with 5-year maturity, since it is deemed as the most commonly traded maturity on the sovereign CDS market (Palladini&Portes, 2011, p.14). Moreover, in order to achieve data uniformity, all underlying sovereign debt obligations by our CDS spread series are denominated in a single currency U.S. dollar, which is also a common currency of denomination for the sovereign CDS. CDS spread time series are generated for the time period of 01.01.2007 – 31.12.2011, which is long enough and incorporates different market states (turbulent or calm) to address our hypotheses stated in the previous section.

<table>
<thead>
<tr>
<th>Country</th>
<th>Index Name</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAPAN</td>
<td>Nikkei 225</td>
<td>price-weighted average of 225 top-rated Japanese companies listed in the First Section of the Tokyo Stock Exchange</td>
</tr>
<tr>
<td>PEOPLE’S REPUBLIC OF CHINA</td>
<td>Shanghai SE Composite</td>
<td>capitalization-weighted index; the index tracks the daily price performance of all A-shares and B-shares listed on the Shanghai Stock Exchange</td>
</tr>
<tr>
<td>REPUBLIC OF KOREA</td>
<td>KOSPI Index</td>
<td>capitalization-weighted index of all common shares on the Korean Stock Exchange</td>
</tr>
<tr>
<td>REPUBLIC OF INDONESIA</td>
<td>Jakarta Composite Index</td>
<td>modified capitalization-weighted index of all stocks listed on the regular board of the Indonesia Stock Exchange</td>
</tr>
<tr>
<td>REPUBLIC OF THE PHILIPPINES</td>
<td>Philippine SE Index – PSEi</td>
<td>capitalization-weighted index composed of stocks representative of the Industrial, Properties, Services, Holding Firms, Financial and Mining &amp; Oil sectors of the PSE</td>
</tr>
<tr>
<td>KINGDOM OF THAILAND</td>
<td>Bangkok SET Index</td>
<td>capitalization-weighted index of stocks traded on the Stock Exchange of Thailand</td>
</tr>
<tr>
<td>MALAYSIA</td>
<td>FTSE Bursa Malaysia KLCI (former: Bursa Malaysia KLCI Index)</td>
<td>comprises of the largest 30 companies by full market capitalization on Bursa Malaysia’s Main Board</td>
</tr>
<tr>
<td>SOCIALIST REPUBLIC OF VIETNAM</td>
<td>Vietnam Stock Index / VN-Index</td>
<td>capitalization-weighted index of all the companies listed on the Ho Chi Minh City Stock Exchange</td>
</tr>
</tbody>
</table>

Table 7: Asian stock indexes.
Source: Bloomberg; Authors.
The next step of our data collection is selecting a proxy for the equity market for each Asian country in our sample. Since sovereigns unlike corporations don’t issue stocks we focus on the main stock indices for each country respectively (see the table above).

Similarly to collecting CDS spread time series we download stock index ones from Bloomberg for the period of 01.01.2007 – 31.12.2011. We choose U.S. dollar as a currency of denomination in order to make a cross-country comparison possible and neglect currency effects.

When converting VN-Index data series from the original currency of denomination VND into USD in Bloomberg we get daily index prices in a 1-digit cent area. Unfortunately, USD-denomination doesn’t allow us to track the stock index movement over time in contrast to VND-denomination. Therefore, we have to remove Vietnam from our sample.

Thus, our final sample consists of the most actively traded sovereign CDS and corresponding main stock index time series for 7 Asian countries during the 5 year period (2007 –2011). We believe that the liquidity and length of our time series provide a good basis for a further robust statistical analysis.

4.2 Data description

Further we will first present a graphical depiction and later a basic summary statistics on the sampled data.

![Graph of CDS spreads of Asian countries during the period of 2007 – 2011.](image)

**Figure 6:** CDS spreads of Asian countries during the period of 2007 – 2011.
Source: Bloomberg, Authors.

On the graph above we demonstrate CDS spreads of seven Asian countries during the period of 01.01.2007 – 31.12.2011. The CDS spread of Japan is the lowest and moved
in a single-digit area until the end of 2007. Thereafter the credit risk (measured as CDS spread) of Japan started to grow slowly. Since 2010 the CDS spread of Japan exceeded that of China at the first time and was above the Chinese credit risk measure during 233 trading days. Since 2011 the Japanese CDS spread surmounted the Malaysian one on 100 trading days. The cause for the considerable increase in Japanese CDS premium lies in investor fears about the poor fiscal health of the country. Thus, for example the public debt of the country equaled to 225,8% of GDP in 2010 and estimated 208,2% in 2011 making it the most world indebted country after Zimbabwe (CIA, 2012).

Indonesia and the Philippines are the countries with the highest credit risk among the other Asian sovereigns in the sample. Until spring 2008 their credit spreads were quite similar, whereas since April, 2008 the spread between their risk premiums started to grow with Indonesia outpacing peaked at 1243,836 bp on 23.10.2008 (difference of 503,022 bp with that of the Philippines). The triple-digit difference between the respective spreads persisted until summer, 2009. Thereafter, the credit risk measures of both countries began to converge again, albeit exhibiting an average difference of -30,624 bp since late September, 2011. The CDS spreads of all the considered Asian countries with an exception of Japan reached their highest points at the end of October at the beginning of the financial meltdown caused by the bankruptcy of Lehman Brothers on September 15th, 2008. It is interesting to note that the CDS spreads of 5 out of these 6 Asian countries (China, Malaysia, the Philippines, Indonesia, Thailand) peaked on the same trading day, namely 24.10.2008 with Korea following one trading day later. Contrary to these 6 countries the CDS spread of Japan widened only moderately, albeit in March, 2009 in the second peak wave of Asian CDS spreads the Japanese credit spread reacted more uniformly. The CDS spread of Japan reached its spike (157,209 bp) on 05.10.2011 in the course of deepening Eurozone crisis. One-two trading days before this date the other Asian countries in the sample had also demonstrated their third highest CDS premiums. This time the Asian markets were hit by the news about fruitless debt-strapped Greece’s attempts at austerity and ailing economic situation in Europe (Sparkes & Strydom, 2011). Anyway, as seen from the graph overall the Asian credit risk markets reacted more severely amid the financial meltdown fired up by the Lehman Brothers bankruptcy than in the course of the Eurozone debt crisis.

To find some statistical support for our inferences from the above graph we apply descriptive statistics to our CDS spread series that is summarized in the table below. Table 8 also contains credit ratings of each Asian country respectively.

From the table below one can see that our sample includes both the countries with a speculative grade rating (lower BBB-), e.g. the Philippines and Indonesia, and the countries whose debt is rated as an investment grade, e.g. the rest of the sample. Correspondingly to their lower credit ratings the average CDS spreads of the Philippines (197,75bp) and Indonesia (238,56bp) are the highest among the other Asian countries. For the countries with a rating above BB+ the credit risk on the CDS market is priced lower. However, within the investment grade group it is interesting to note that although Korea has the highest credit rating comparing to Malaysia and Thailand, its average CDS spread appears to exceed those of these two countries.
In Appendix 1 we present CDS spreads and stock indexes denominated in U.S. dollars in the period of 01.01.2007 – 31.12.2011 on the same graphic for each Asian country in the sample correspondingly. The visual depiction of the data shows existence of inverse relationship between the Asian credit risk and stock markets. The interdependence of the Asian CDS and equity markets seems to enhance during the turbulence times.

### Table 8: Descriptive statistics of sovereign CDS spreads.

Source: Bloomberg; Authors.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>AA-</td>
<td>2010-12-16</td>
<td>1278</td>
<td>10,08</td>
<td>276,30</td>
<td>79,11</td>
<td>52,55</td>
</tr>
<tr>
<td></td>
<td>A+</td>
<td>2008-07-31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>2006-07-27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>AA-u</td>
<td>2011-02-25</td>
<td>1206</td>
<td>2,13</td>
<td>157,21</td>
<td>51,59</td>
<td>38,38</td>
</tr>
<tr>
<td></td>
<td>AA-</td>
<td>2011-01-27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AA</td>
<td>2007-04-23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td>A</td>
<td>2005-07-27</td>
<td>1282</td>
<td>13,75</td>
<td>674,88</td>
<td>122,16</td>
<td>98,89</td>
</tr>
<tr>
<td>Malaysia</td>
<td>A-</td>
<td>2003-10-08</td>
<td>1274</td>
<td>12,35</td>
<td>491,59</td>
<td>99,62</td>
<td>67,89</td>
</tr>
<tr>
<td>the Philippines</td>
<td>BB</td>
<td>2010-11-12</td>
<td>1284</td>
<td>93,21</td>
<td>824,78</td>
<td>197,75</td>
<td>89,85</td>
</tr>
<tr>
<td></td>
<td>BB-</td>
<td>2005-01-17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>BB+</td>
<td>2011-04-08</td>
<td>1283</td>
<td>92,26</td>
<td>1248,35</td>
<td>238,56</td>
<td>167,56</td>
</tr>
<tr>
<td></td>
<td>BB</td>
<td>2010-03-12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BB-</td>
<td>2006-07-26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>BBB+</td>
<td>2006-10-31</td>
<td>1291</td>
<td>28,00</td>
<td>489,56</td>
<td>119,45</td>
<td>65,93</td>
</tr>
</tbody>
</table>

#### 4.3 Empirical tests

For testing our hypotheses we selected a number of statistical tests that will be described below.

**Tests for Hypothesis 1** “Sovereign CDS spreads and stock indices are interrelated and move in the opposite directions both at levels and changes”: In order to determine whether sovereign CDS spreads of Asian countries are interrelated with corresponding stock indices we will apply the simple linear Pearson and the nonparametric Spearman rank correlation tests to the original time series of both variables. Pearson correlation is a measure of the linear relation between values of the two variables. It doesn’t take into account the difference between measurement units. The Pearson correlation results are valid in case if the normal distribution assumption is met and all values of the explanatory variable have the same variability of the residual values. (StatSoft, 2012). Because of possible non-normal distribution of our data series, given, however, a monotonous relation we apply the Spearman rank correlation test that allows circumventing these assumptions, since it is sensitive only to the ordinal (rank order) arrangement of values. However, one should mention that the Spearman rank correlation is also not flawless, as it appears less sensitive (StatSoft, 2012).
For testing a contemporaneous relationship between Asian sovereign CDS and stock indices, but also for a further regression analysis it is important to test our original time series for a condition of stationarity that implies constant mean, variance and covariance by time shifts (Ruppert, 2004, p.102). In case the condition is not met we will make the data stationary by taking differences of the 1st order (if needed of the 2nd order) and test hypothesis 1 on the basis of modified time series. We will apply a simple graphical depiction to find out if our data are stationary. The stationarity assumption is to be complied with when the mean remains unchanged over time.

**Tests for Hypothesis 2** “Volatility in the stock market is positively correlated to credit risk prices”: To test our second hypothesis lying in the frames of Merton model we first need to generate time series of historical daily volatilities of stock indices for each Asian country. We will calculate these historical volatilities applying 1-month, 3-month, 6-month and 12-month windows. We will implement our daily volatility calculations guiding by the following argumentation (Lundquist, 2010). Since standard deviation is the most frequently used measure of volatility, we need to first recall the general variance estimation. The formula of the sample variance is:

\[
\sigma^2 = \frac{1}{n} \sum (y_t - \mu)^2,
\]

where \( \sigma^2 \) is the variance; \( n \) is the sample size; \( y_t \) is the logged index return at time \( t \) ranging from 1 to \( n \); \( \mu \) is the sample mean.

However, since the mean values of logged stock index returns across a sample are normally very close to zero, we can apply a simplified variance formula, e.g.:

\[
\sigma^2 = \frac{1}{n} \sum (y_t)^2
\]

We exchange \( n \) with \( m \) of different length to calculate historical volatility for different windows (moving average method). Thus, our final formula of daily historical volatility of logged stock index return is:

\[
\sigma_t = \text{SQRT}\left(\frac{1}{m} \sum (y_k)^2\right),
\]

where \( k \) ranges from \( t-m \) to \( t-1 \).

Having generated historical daily volatilities of Asian stock indices we will test their relation with corresponding sovereign CDS spreads applying Pearson and Spearman rank correlation tests that were highlighted above.

**Tests for Hypothesis 3** “The relation between CDS and stock index variances is positive and more profound for sovereigns with a higher risk premium”: To test our assumption about positive correlation between variances of Asian sovereign CDS spreads and stock index returns we first need to construct time series of these variances. We will estimate daily variances of CDS spreads and stock indices applying a popular in financial econometrics GARCH (p, q) model proposed by Bollersev (1986), where GARCH stands for a generalized autoregressive conditional heteroskedasticity. According to GARCH the variance for the consequent period is a function of the weighted average of the long-term average variance, the variance predicted for the current period and the squared residual in the current period (Fabozzi, 2008, p.4). This model takes an account of heterogeneous variance in time-series data and covers volatility clustering. We deem \( p \), the autoregressive term, and \( q \), the moving average
term, to be equal to 1 respectively. The GARCH model is a good suite for volatility description if time series are characterized by substantial skewness and kurtosis values, what we suppose to take place in our case.

After generating time series of both variances we will examine their contemporaneous relationship applying the Pearson and Spearman correlation tests.

**Tests for Hypothesis 4** “The sovereign CDS market dominates the price discovery process”: To test this hypothesis we will apply Granger causality test within the vector autoregressive model (VAR) on the basis of stationary time series. Vector autoregression that allows testing a lead-lag relationship between CDS spread changes and logged stock returns was also addressed in the studies by Chan et al. (2008), Norden and Weber (2009), and Coronado et al. (2011). This model appears to be the most suitable for time series that possess the property of stationarity only starting from the first difference. Chan et al. (2008) and Norden and Weber (2009) additionally apply the vector error correction model (VECM) to the original time series, since some of them were found to be cointegrated at levels.

Our two dimensional VAR model can be described with the following equations:

\[ R_t = a + \sum b_{rp} R_{t-p} + \sum c_{rp} \Delta CDS_{t-p} + \epsilon_{rt}, \]

\[ \Delta CDS_t = a_{cds} + \sum b_{cds p} \Delta CDS_{t-p} + \sum c_{cds p} R_{t-p} + \epsilon_{cdst}, \]

where \( R_t \) and \( \Delta CDS_t \) stand for the logged stock index return and CDS spread change at time \( t \) respectively; \( p \) refers to the lag order; \( a, b \) and \( c \) are regression coefficients; \( \epsilon_t \) denotes the disturbance term at time \( t \).

When applying the VAR model one should pay a due attention to the structure and maximal order of lags. In our paper similar to Norden and Weber (2009) we assume a consequent lag structure and intuitively reckon 5 days, e.g. a trading week, to be enough for new information on the financial markets in focus to be fully incorporated in prices. We will test our initial assumption applying both the Akaike and Schwarz Bayesian information criteria.

A proper application of VAR model assumes a lack of serial correlation in residuals at all lags. Since Durbin-Watson statistics that allows checking for residuals autocorrelation at the first lag is easily available in SPSS, we include it in our regression output. As a rule of thumb, residuals are deemed to be non-correlated when the statistic is close to 2. For the lags above 1 we implement a Lagranger-Multiplier test that is suitable for the detection of a higher order autocorrelation in residuals.

Running the VAR model we will simultaneously implement the Granger causality test to study the price discovery process. The Granger causality test was applied in several studies on a lead-lag relationship between credit risk and stock markets. In contrast to the Gonzalo and Granger methodology that was applied in Chan et al. (2008) this test does not require the time series to be stationary at levels\(^{15} \). Due to the absence of the cointegration condition the Granger causality test can be used for a larger time horizon incorporating different market states. However, as stated in Palladini and Portes (2011)

\(^{15} \)The time series must be integrated of order 1.
one of the key drawbacks of Granger causality test is a possibility of the outcome to be biased in case of the non-normality of residuals. Additionally, the Granger causality does not always imply a genuine causality. It can take place, when one variable is merely followed by another. However, given all the possible flaws of the Granger test we proceed to apply it in our analysis of the price-discovery, because of the SPSS constraints on the availability of the other appropriate series analysis tools.\(^{16}\)

**Tests for Hypothesis 5** “The intensity of the linkage between the sovereign CDS and stock index markets is state-dependent: it enhances during periods of increased turbulence”: To test this hypothesis we will apply the two dimensional VAR model as described above to our time series having divided them previously into 3 subperiods: pre-crisis, crisis, and post-Lehman periods. We will measure intensity of the relationship comparing the number of statistically significant regression coefficients demonstrating the negative link between both markets among the determined time spans.

**Tests for Hypothesis 6** "The price discovery process in both markets is subject to change over time": To test whether the dominance in the price discovery process of either variable (CDS spread or stock index return) varies among different market states, we will apply the Granger causality test as described above to each indicated subperiod respectively.

### 4.4 Hypotheses testing and result discussion

Firstly, we examine if the Asian sovereign CDS spreads and stock indices are interrelated at levels applying Pearson and Spearman correlation tests. Both correlation measures presented in Table 9 appear to be significant and negative at 1% level. On average the correlation of both types exceeds 50% in absolute value. This points out at the existence of a strong negative relation between CDS spreads and stock indexes of the Asian countries in the sample. In other words, when stock prices are high, CDS spreads should be low and vice versa. According to the correlation coefficients Korea exhibits the strongest adverse interdependence between its CDS and equity markets (Pearson: -0.806; Spearman’s rho: -0.690), whereas Thailand’s linear correlation at -0.301 and rank correlation at -0.084 correspondingly are the smallest ones. Unlike Chan et al. (2008) who found a positive correlation between the Chinese CDS spread and stock market of 0.30 for the period of January, 2001 – February, 2007, for the period of January, 2007 – December, 2011 the correlation between the respective Chinese markets is negative (-0.616***/-0.635**). We dare to assume that this change in the correlation sign might point out on the progress in the Chinese stock market development as a better indicator of economic fundamentals.

Further we will test our original time series for the property of stationarity. According to the graphs in Appendix 1 our CDS spread and stock index series don’t exhibit a constant mean and therefore are not stationary. Hence, we take the first difference of CDS spreads and logged stock index returns (e.g. the difference between the natural logarithm of two subsequent stock index series) and repeat our simplified stationarity

\(^{16}\) SPSS does not include the cointegration test on its function list.
test. As shown on the graphs in Appendices 2 and 3 the CDS spread changes and logged stock index returns seem to demonstrate a constant mean and thus are stationary.

<table>
<thead>
<tr>
<th>Country</th>
<th>Correlation at levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson</td>
</tr>
<tr>
<td>China</td>
<td>-0.616**</td>
</tr>
<tr>
<td>Japan</td>
<td>-0.592**</td>
</tr>
<tr>
<td>Korea</td>
<td>-0.806**</td>
</tr>
<tr>
<td>Malaysia</td>
<td>-0.525**</td>
</tr>
<tr>
<td>the Philippines</td>
<td>-0.691**</td>
</tr>
<tr>
<td>Indonesia</td>
<td>-0.625**</td>
</tr>
<tr>
<td>Thailand</td>
<td>-0.301**</td>
</tr>
</tbody>
</table>

**significant at 1% confidence level

Table 9: Correlation between CDS spreads and stock indexes.
Source: Authors.

However, to support our conclusions we also check the difference of the 2nd order for the stationarity condition and compare the 1st difference and 2nd difference variances. The variance of the 2nd order exceeds that of the 1st order for all data series in the sample. Therefore we proceed with the CDS spread changes and logged stock index returns for our further analysis.

The summary statistics for CDS spread changes and logged stock returns along with Pearson and Spearman rank correlations is presented in the table below.

<table>
<thead>
<tr>
<th>Country</th>
<th>CDS spread change</th>
<th>Logged stock index return</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>-67.29</td>
<td>56.58</td>
<td>0.922</td>
</tr>
<tr>
<td>Japan</td>
<td>-18.75</td>
<td>40.42</td>
<td>0.959</td>
</tr>
<tr>
<td>Korea</td>
<td>-185.30</td>
<td>111.40</td>
<td>10.940</td>
</tr>
<tr>
<td>Indonesia</td>
<td>223.81</td>
<td>316.80</td>
<td>23.25814</td>
</tr>
<tr>
<td>Malaysia</td>
<td>-113.96</td>
<td>99.30</td>
<td>0.912</td>
</tr>
<tr>
<td>the Philippines</td>
<td>-169.33</td>
<td>139.14</td>
<td>0.992</td>
</tr>
<tr>
<td>Thailand</td>
<td>-83.74</td>
<td>95.30</td>
<td>0.952</td>
</tr>
</tbody>
</table>

**significant at 1% confidence level

Table 10: Descriptive statistics and correlation for CDS spread changes and stock index returns.
Source: Authors.

Both simple linear and rank correlations between the 1st difference of CDS spreads and logged stock returns appear negative and significant at 1% level. Korea demonstrates the strongest correlation between the time series in focus, whereas China’s correlation is the smallest along the sample. The Pearson correlation for the other Asian countries varies in the range of -0.3 to -0.4, whereas Spearman’s rho in the range of -0.3 to -0.5.

We also test the Pearson and Spearman rank correlations for lagged CDS spread changes and logged stock index returns with order 1 correspondingly. The results that are presented in the table below differ along the sample. Thus, the lagged CDS spread changes and logged stock index returns seem to demonstrate a constant mean and thus are stationary.
changes and logged stock index returns of Philippines, Thailand and Malaysia are negatively related according to both correlations, whereas the lagged stock index returns of Malaysia are also adversely linked to the 1st difference of CDS spreads. Korea is the only Asian country that exhibits a one-way cross-serial negative correlation between logged stock index returns at lag 1 and CDS spread changes. This statistics may imply that CDS markets of some Asian countries react at new information from respective stock markets with a delay.

<table>
<thead>
<tr>
<th>Country</th>
<th>Logged stock index return lag1 - CDS spread change</th>
<th>CDS spread change lag 1 - Logged stock index return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson</td>
<td>Spearman's rho</td>
</tr>
<tr>
<td>China</td>
<td>0.057</td>
<td>0.012</td>
</tr>
<tr>
<td>Japan</td>
<td>-0.087**</td>
<td>-0.01</td>
</tr>
<tr>
<td>Korea</td>
<td>-0.145**</td>
<td>-0.091**</td>
</tr>
<tr>
<td>Indonesia</td>
<td>0.011</td>
<td>-0.033</td>
</tr>
<tr>
<td>Malaysia</td>
<td>-0.099**</td>
<td>-0.095**</td>
</tr>
<tr>
<td>the Philippines</td>
<td>-0.055</td>
<td>-0.056</td>
</tr>
<tr>
<td>Thailand</td>
<td>-0.017</td>
<td>-0.063</td>
</tr>
</tbody>
</table>

**significant at 1% level

Table 11: Correlation between lagged stock index returns and CDS spread changes (alternatively, lagged CDS spread changes and stock index returns).
Source: Authors.

For testing our second hypothesis about a positive link between historical volatilities in the Asian stock markets and credit risk spreads we will first generate time series of historical daily volatilities of stock indices guiding by the formula presented in the section Empirical Tests. We use SPSS to apply the formula to our time series in focus, where we first set the logged stock index returns to the power of 2. Then we run the SPSS function Prior Moving Average with the order of 1 and various spans (21, 63, 126 and 252 days corresponding to a trading month, quarter, half a trading year and the whole trading year). Finally, we take a square root to obtain the standard deviation value. Here we should mention that while implementing calculations of standard deviation as a proxy of the historical volatility, we notice that our time series have some missing data points. This prevents us from generating continuous variance series using the MA method. In order to deal with the issue, we deem the missing data points to be equal to the mean value of the two nearest points.

After generating daily historical volatility series of stock indices we test their correlation with the sovereign CDS spreads. The results of simple Pearson and Spearman rank correlations are summarized in Table 12 for each Asian country.

We can report a significant positive correlation between CDS spreads and stock index volatilities for all the considered windows for five countries, e.g. Korea, Indonesia, Malaysia, the Philippines and Thailand. With this regard the Pearson correlation appears to be the strongest for 6-month historical volatility (except for Malaysia) lying within the range of 0.8 – 0.9 at 1% significance level. Additionally CDS spreads of China are
<table>
<thead>
<tr>
<th>Country</th>
<th>stock index volatility</th>
<th>correlation with CDS spread</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pearson</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1MVol</td>
<td>-0.029</td>
<td></td>
</tr>
<tr>
<td>3MVol</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>6MVol</td>
<td>0.141**</td>
<td></td>
</tr>
<tr>
<td>1YVol</td>
<td>0.317**</td>
<td></td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1MVol</td>
<td>0.065*</td>
<td></td>
</tr>
<tr>
<td>3MVol</td>
<td>0.024</td>
<td></td>
</tr>
<tr>
<td>6MVol</td>
<td>0.027</td>
<td></td>
</tr>
<tr>
<td>1YVol</td>
<td>-0.194**</td>
<td></td>
</tr>
<tr>
<td><strong>Korea</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1MVol</td>
<td>0.758**</td>
<td></td>
</tr>
<tr>
<td>3MVol</td>
<td>0.821**</td>
<td></td>
</tr>
<tr>
<td>6MVol</td>
<td>0.884**</td>
<td></td>
</tr>
<tr>
<td>1YVol</td>
<td>0.629**</td>
<td></td>
</tr>
<tr>
<td><strong>Indonesia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1MVol</td>
<td>0.672**</td>
<td></td>
</tr>
<tr>
<td>3MVol</td>
<td>0.772**</td>
<td></td>
</tr>
<tr>
<td>6MVol</td>
<td>0.830**</td>
<td></td>
</tr>
<tr>
<td>1YVol</td>
<td>0.639**</td>
<td></td>
</tr>
<tr>
<td><strong>Malaysia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1MVol</td>
<td>0.347**</td>
<td></td>
</tr>
<tr>
<td>3MVol</td>
<td>0.362**</td>
<td></td>
</tr>
<tr>
<td>6MVol</td>
<td>0.436**</td>
<td></td>
</tr>
<tr>
<td>1YVol</td>
<td>0.492**</td>
<td></td>
</tr>
<tr>
<td><strong>the Philippines</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1MVol</td>
<td>0.6**</td>
<td></td>
</tr>
<tr>
<td>3MVol</td>
<td>0.697**</td>
<td></td>
</tr>
<tr>
<td>6MVol</td>
<td>0.820**</td>
<td></td>
</tr>
<tr>
<td>1YVol</td>
<td>0.581**</td>
<td></td>
</tr>
<tr>
<td><strong>Thailand</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1MVol</td>
<td>0.511**</td>
<td></td>
</tr>
<tr>
<td>3MVol</td>
<td>0.663**</td>
<td></td>
</tr>
<tr>
<td>6MVol</td>
<td>0.766**</td>
<td></td>
</tr>
<tr>
<td>1YVol</td>
<td>0.427**</td>
<td></td>
</tr>
</tbody>
</table>

* significant at 5% level; ** significant at 1% level

Table 12: Correlation between CDS spread changes and stock index volatilities.
Source: Authors.

positively (but comparatively weaker) linked to respective 1-year volatility of Shanghai SE Composite index according to both correlation measures. In case of Japan we can document an above zero weak correlation of sovereign CDS spreads only with 1-month equity volatility. Overall, for China and Japan across the different size windows we obtain inconsistent results with positive and negative correlation coefficients. To sum up the correlation outcome for all the sampled countries except China and Japan strongly confirms the Merton theory. Here it is interesting to note that among the Asian countries China and Japan are characterized with the highest credit ratings and, hence, lower default risk that could be a reason for the weaker positive correlation (or its lack) between their sovereign CDS spreads and stock index volatilities.

Before testing the hypothesis about a positive relationship between Asian sovereign credit and market risks (Hypothesis 3) we checked our data for skewness and kurtosis. According to the results presented in Table 10, where descriptive statistics of CDS
spread changes and stock index returns are summarized, the first differences of CDS spreads for all the Asian countries exhibit extremely fat tails (kurtosis differs from 0 significantly), whereas logged stock index return series are also leptokurtic. The distribution of CDS spread changes along all the Asian countries is skewed with Japan, Indonesia and Thailand demonstrating a positive skewness and the rest of the sample a negative one. The similar conclusion holds for the distributions of the logged stock index return series that are all skewed to the left. Such an outcome supports the use of GARCH (1,1) model for volatility estimation.

After generating time series of variances with the GARCH model we run both the Pearson and Spearman rank correlation tests to determine a relationship between volatilities of sovereign CDS spreads changes and stock index returns. For all the countries the contemporaneous correlation between respective volatilities is strongly significant and positive. The uncertainty on the Asian stock market seems to be contagious for the sovereign CDS market and vice versa. In other words, an increase in the market risk (sovereign credit risk) is accompanied by a rise in the sovereign credit risk (market risk). With regards to the correlation strength it turns out that the variances of the Chinese markets (with the lowest Pearson and Spearman rank correlation coefficients of 0.243 and 0.137 correspondingly) are the least sensitive to each other, whereas those of Korean stock and sovereign CDS markets (with the highest Pearson and Spearman rank correlation coefficients of 0.753 and 0.509 respectively) tend to be strongly linked. Overall, the speculative grade sovereigns (Indonesia and the Philippines), but also Korea (investment grade sovereign), which are characterized by the highest CDS spreads across the sample, also demonstrate higher correlation between volatilities of CDS and stock index markets. This finding allows us to confirm the second part of Hypothesis 3 about a stronger variance correlation for sovereigns with higher risk premiums. It is also in line with the findings by Coronado et al. (2011) for the Eurozone sovereign entities.

<table>
<thead>
<tr>
<th>Country</th>
<th>correlation between CDS spread and stock index volatilities#</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson</td>
</tr>
<tr>
<td>China</td>
<td>0.243**</td>
</tr>
<tr>
<td>Japan</td>
<td>0.319**</td>
</tr>
<tr>
<td>Korea</td>
<td>0.753**</td>
</tr>
<tr>
<td>Indonesia</td>
<td>0.419**</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.307**</td>
</tr>
<tr>
<td>the Philippines</td>
<td>0.464**</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.391**</td>
</tr>
</tbody>
</table>

#estimated with GARCH(1,1)
**significant at 1% level

Table 13: Correlation between CDS spread and stock index variances.
Source: Authors.

To test our fourth hypothesis about the dominance in the price discovery process, we first create an appropriate VAR model. As was mentioned in the section Empirical Tests we assume the maximal lag order of our vector autoregressive model to be 5, what is also confirmed by both the Akaike and Schwarz Bayesian information criteria tests. Additionally for a proper use of the VAR model we need to check its residuals for a serial correlation. The results of Durbin-Watson statistic and Lagranger-Multiplier test
demonstrate lack of serial correlation at any lag for both VAR models for all the countries in the sample.

While presenting regression outcome for the VAR model we comment on Granger causality results testing the hypothesis of the dominance in the price discovery process (Hypothesis 4). In the table below we summarize the VAR results listing only those regressions and those coefficients that are significant at 5% level. We mark those slopes that demonstrate the expected negative relation between the tested time series. We present both unstandardized and standardized coefficients (in parentheses). This is due to the following argument. The logged stock index returns range from -0.18 to 0.21 (a hundredth part), while CDS spread changes can be as low as -223.81 and as high as 316.80 (an integer part). Thus, where the CDS spread change is a dependent variable we have to deal with too large slopes, while in case of the logged stock index return as a response variable too small slopes are in place. This complicates comparability between slopes within and between regressions and in some cases gains too small values that SPSS interprets as 0 without recognizing a sign (+/-). Coefficient standardization alleviates this problem showing the change in the explained variable measured in standard deviations.

The F-statistic appears to exceed its critical value for each regression and the explanatory power, $R^2$, varies between 0.022 and 0.143 across the sample with the mean value of 0.076. The 2-dimensional VAR results for the period 2007 - 2011 confirm the negative relation between sovereign CDS and stock markets across all the Asian countries, when standardized coefficients are considered. For China, Indonesia and Thailand this relation is one-sided with an increase (decrease) in CDS premiums causing a fall (rise) in corresponding stock indices. For Japan, Korea, Malaysia and the Philippines sovereign CDS and stock markets are interrelated in a bidirectional way. Comparing our results for the recent period with those of in Chan et al. (2008) it is interesting to mention that the sovereign CDS in China and Thailand have maintained their role as a leading market and the Philippines kept bidirectional causality between both markets over the time. However, in case of Indonesia the CDS market has taken the lead (in Chan et al. (2008) bi-directional relationship) and for Malaysia FTSE Bursa Malaysia KLCI started to provide useful information on sovereign risk (in Chan et al. (2008) dominance of sovereign CDS market). Whereas Chan et al. (2008) find no causation for Japan during 2001 – beginning of 2007, we report controversial results for the consequent 5-year period. An explanation for this can be that the risk profile of the country (the perception of higher sovereign risk among investors) has changed over time\(^{17}\) (Osamu, 2010) making the Japanese CDS and stock markets responsive to each other.

For all the countries except Japan our regression outcome confirms inefficiency of Asian sovereign CDS markets: the 1st difference of sovereign CDS spreads exhibit positive autocorrelation at the 1st lag across the whole sample and additionally at the 2nd lag for China, Korea, Indonesia and the Philippines. Thus, the Asian sovereign CDS market promises profit opportunities to investors, who skillfully exploit its inefficiency. Meanwhile, logged stock index returns demonstrate a positive serial correlation only for 2 countries: Malaysia (at lag 1 and lag 3) and the Philippines (at lag 1).

\(^{17}\) S&P cut the sovereign rating for Japan from “AA” in April, 2007 to “AA-u” in February, 2011.
To test our two last hypotheses further we will apply the above described 2-dimensional VAR model and Granger causality test to shorter nonintersecting periods. On the one hand, dividing our whole time horizon into spans will serve as a robustness check. On the other, we’ll explore the shorter periods of time series separately not only with a mere purpose of statistics, but more importantly searching for an economic interpretation of intertemporal relation between the Asian sovereign CDS spreads and stock indices during different market states. We decided to test the following subperiods:

1\textsuperscript{st} period (pre-crisis): 01.01.2007 – 31.08.2008,

2\textsuperscript{nd} period (crisis\textsuperscript{18}): 01.09.2008 – 31.08.2009,


We should mention that our post-Lehman period incorporates the Eurozone debt crisis starting at the end of 2009. However, it seems to have a marginal influence on the Asian markets until late summer, 2011 that allows us to classify this time as post-crisis. Since August 2011 the Asian markets have demonstrated increased volatility due to the Eurozone debt woes. Unfortunately for the time of thesis writing this subperiod (01.08.2011 – 31.12.2011) is not yet long enough for a separate robust statistical

\textsuperscript{18} Here under “crisis” we imply the global credit crunch triggered by Lehman Brothers’ bankruptcy on 15.09.2008

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Japan</th>
<th>Korea</th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>the Philippines</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rt</td>
<td>ΔCDSt</td>
<td>Rt</td>
<td>ΔCDSt</td>
<td>Rt</td>
<td>ΔCDSt</td>
<td>Rt</td>
</tr>
<tr>
<td>Rt-1</td>
<td>21,227 (0,077)</td>
<td>-21,212 (0,212)</td>
<td>-23,375 (-1,154)</td>
<td></td>
<td>0,081 (0,081)</td>
<td>0,086 (0,085)</td>
<td>56,275 (0,072)</td>
</tr>
<tr>
<td>Rt-2</td>
<td>-14,477 (-0,95)</td>
<td></td>
<td>-0,095 (-0,096)</td>
<td>87,152 (0,083)</td>
<td>0,084 (0,086)</td>
<td>-0,085 (-0,082)</td>
<td></td>
</tr>
<tr>
<td>Rt-3</td>
<td>38,271 (0,081)</td>
<td></td>
<td>-56,055 (-0,092)</td>
<td></td>
<td>-75,866 (-0,095)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rt-4</td>
<td>0,131 (0,130)</td>
<td>-0,001 (-0,163)</td>
<td>0,182 (0,181)</td>
<td>0,141 (0,141)</td>
<td>0,328 (0,328)</td>
<td>0,296 (0,296)</td>
<td>0,229 (0,226)</td>
</tr>
<tr>
<td>Rt-5</td>
<td>0,223 (0,222)</td>
<td>0,104 (0,104)</td>
<td>0,149 (0,152)</td>
<td>0,139 (0,139)</td>
<td>-0,122 (-0,091)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔCDSt</td>
<td>-0,163 (-0,163)</td>
<td>-0,185 (-0,193)</td>
<td>-0,89 (-0,90)</td>
<td>0,082</td>
<td>-0,112 (-0,112)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0,022</td>
<td>0,092</td>
<td>0,056</td>
<td>0,083</td>
<td>0,029</td>
<td>0,097</td>
<td>0,099</td>
</tr>
<tr>
<td>R Square</td>
<td>0,21</td>
<td>0,497</td>
<td>6,904</td>
<td>2,931</td>
<td>9,57</td>
<td>3,484</td>
<td>15,34</td>
</tr>
</tbody>
</table>

Table 14: 2D VAR for the whole period.
Source: Authors.
analysis. For the future research on the topic, however, we would recommend to study the relationship of Asian CDS and stock markets during this particular subperiod when sufficient time series can be generated.

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Japan</th>
<th>Korea</th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>the Philippines</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rt-1</td>
<td>Rt</td>
<td>ΔCDSt</td>
<td>Rt</td>
<td>ΔCDSt</td>
<td>Rt</td>
<td>ΔCDSt</td>
<td>Rt</td>
</tr>
<tr>
<td>ΔCDSt-1</td>
<td></td>
<td>-0,358 (-0,366)</td>
<td></td>
<td>-58,463 (-0,241)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔCDSt-2</td>
<td></td>
<td>-0,166 (-0,169)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔCDSt-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔCDSt-4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔCDSt-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td>0,057</td>
<td>0,147</td>
<td>0,125</td>
<td>0,118</td>
<td>0,082</td>
<td>0,063</td>
</tr>
<tr>
<td>F-statistic</td>
<td></td>
<td>2,092</td>
<td>4,929</td>
<td>4,098</td>
<td>4,157</td>
<td>2,794</td>
<td>2,042</td>
</tr>
</tbody>
</table>

Table 15: 2D VAR for the 1st period.
Source: Authors

According to Table 15, where co-movement of Asian sovereign CDS and equity markets during 2007 – August, 2008 is depicted statistically, we can report the negative relation between the corresponding markets only for Korea and the Philippines with the leading role of respective stock indices. Changes in stock index returns explain 11,8% of changes in CDS spreads for Korea and only 6,3% for the Philippines. It is interesting to note that the logged stock index return as a response variable cannot be explained with our lead-lag model for the period in focus.

During the crisis period the explanatory power of our 2 dimensional VAR increases across the sample comparing to the previous one. Thus, R Square ranges from 0,139 to 0,282 with the average value of 0,193. Contrary to the VAR outcome in the pre-crisis period the regression with the logged stock index return as a dependent variable becomes statistically significant for Indonesia, Malaysia and the Philippines and exhibits a negative link (standardized coefficients) between the corresponding sovereign
CDS and stock markets. For the Philippines sovereign CDS starts to compete with PSEi for the market dominance comparing to the previous period. For Indonesia the sovereign CDS market takes a lead of the stock market. For Malaysia the negative relation between both markets similar to the Philippines is bidirectional. In the course of the financial turmoil Nikkei 225 demonstrates dependency with the Japanese sovereign risk: a fall (an increase) in the Japanese stock index causes widening (tightening) of the Japanese sovereign CDS spread.

With regards to autocorrelation in sovereign CDS spread changes 5 out of 7 Asian countries (China, Korea, Malaysia, the Philippines and Thailand) signalize market inefficiency mainly at the 1st lag.

In the post-Lehman period the explanatory power of our model decreases with R square lying within the interval of 0.042 and 0.157 and averaging 0.079. It is interesting to note that whereas during this time frame the sovereign CDS market loses its leading positions for Indonesia and Malaysia, it becomes dominant for the Thai stock market and serves as an explanatory, but simultaneously as explained variable for Japan. The KOSPI Index regains its leading role it played in the pre-crisis period for the Korean sovereign CDS market. In case of China for the 3rd period we obtain somehow a controversial conclusion in comparison to the whole period. A widening (tightening) in the Chinese sovereign CDS premiums are caused by a drop (rise) in logged stock
returns at lag 3. However, one should also mention the VAR with CDS spread change as a response for China demonstrates the lowest F-statistic across the Asian countries during the post-crisis period questioning its outcome.

According to the results for the 3rd period the Asian sovereign CDS and stock markets respectively show no positive autocorrelation with the only exception of the Philippines, where PSEi is serially correlated at lag 4.

As we have mentioned before, due to sharpening of the Eurozone debt crisis since late summer 2011 the Asian market have become turbulent again. Therefore, it is interesting to test our 2-dimensional VAR for the last period omitting the time span of increased volatility. The results, which are summarized in the table below show quite a different picture from that one above. Thus, without inclusion of the period of August 2011 – December 2011, we can document the negative relation between the sovereign CDS and stock markets with the leading role of the former only for 2 countries: Japan and the Philippines. This provides some evidence that the relationship of Asian sovereign CDS and stock index returns differs depending on the market state. Thus, without including the period of increased volatility caused by the Eurozone debt crisis the intensity of the relationship (measured by the number of statistically significant links) between both markets seem to resemble that one in the pre-crisis period.

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Japan</th>
<th>Korea</th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>the Philippines</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rt</td>
<td>ΔCDS</td>
<td>Rt</td>
<td>ΔCDS</td>
<td>Rt</td>
<td>ΔCDS</td>
<td>Rt</td>
</tr>
<tr>
<td>Rt-1</td>
<td>-0.161</td>
<td>(-0.161)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rt-2</td>
<td>-0.143</td>
<td>(-0.144)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rt-3</td>
<td>-31,416</td>
<td>(-0.136)</td>
<td>-40,532</td>
<td>(-0.144)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rt-4</td>
<td>-36,750</td>
<td>(-0.164)</td>
<td></td>
<td></td>
<td>0.124</td>
<td>(0.121)</td>
<td></td>
</tr>
<tr>
<td>Rt-5</td>
<td></td>
<td></td>
<td>107,963</td>
<td>(-0.211)</td>
<td>0</td>
<td>(-0.147)</td>
<td></td>
</tr>
<tr>
<td>ΔCDS-1</td>
<td>-0.001</td>
<td>(-0.181)</td>
<td>-0.148</td>
<td>(-0.142)</td>
<td>-0.001</td>
<td>(-0.283)</td>
<td>-0.001</td>
</tr>
<tr>
<td>ΔCDS-2</td>
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<td>-0.249</td>
<td>(-0.239)</td>
<td></td>
<td></td>
<td>0</td>
</tr>
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<td>ΔCDS-3</td>
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<td>(-0.136)</td>
<td></td>
<td>0</td>
<td>-0.172</td>
<td>(-0.165)</td>
<td>0</td>
</tr>
<tr>
<td>ΔCDS-4</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0.157</td>
<td>(0.146)</td>
<td></td>
</tr>
<tr>
<td>ΔCDS-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Square</td>
<td>0.042</td>
<td>0.092</td>
<td>0.082</td>
<td>0.057</td>
<td>0.053</td>
<td>0.08</td>
<td>0.157</td>
</tr>
<tr>
<td>F statistic</td>
<td>1,964</td>
<td>3,047</td>
<td>2,69</td>
<td>2,758</td>
<td>2,125</td>
<td>3,505</td>
<td>7.29</td>
</tr>
</tbody>
</table>

Table 17: 2D VAR for the 3rd period.
Source: Authors.
We summarize the outcome for Hypothesis 5 about varying intensity of the relationship between the Asian CDS spread and stock index markets over the time in the table below. The interdependency of both markets appears to increase significantly in the crisis and post-Lehman periods. However, adjusting the post-Lehman period for the

<table>
<thead>
<tr>
<th>Sovereign</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pre-crisis</td>
</tr>
<tr>
<td>China</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>1</td>
</tr>
<tr>
<td>Korea</td>
<td>1</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1</td>
</tr>
<tr>
<td>Malaysia</td>
<td>3</td>
</tr>
<tr>
<td>the Philippines</td>
<td>1</td>
</tr>
<tr>
<td>Thailand</td>
<td></td>
</tr>
</tbody>
</table>

**Table 19: Relationship between both markets during different subperiods (no. of significant negative slopes).**
Source: Authors.
time of heightened turbulence due to the Eurozone debt crisis we find out the relationship to be the most intensive only during the crisis period. Thus, we can confirm that the link between the Asian sovereign credit risk and stock index markets is state-dependent. It enhances with the market volatility.

To get a better insight of the price discovery process during the whole period as well as its evolution over the time (Hypothesis 6) we summarize the Granger causality test outcome for the respective periods in the following table.

<table>
<thead>
<tr>
<th></th>
<th>whole period</th>
<th>1st period</th>
<th>2nd period</th>
<th>3rd period</th>
<th>Adjusted 3rd period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ΔCDS causes R</td>
<td>R causes ΔCDS</td>
<td>ΔCDS causes R</td>
<td>R causes ΔCDS</td>
<td>ΔCDS causes R</td>
</tr>
<tr>
<td>China</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Japan</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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</tr>
<tr>
<td>Korea</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>the Philippines</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Thailand</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 20: Granger causality test for the whole period and subperiods.
Source: Authors.

Overall, the Asian CDS market led the stock index market for the whole period 2007 - 2011. However, in 4 (Japan, Korea, Malaysia, the Philippines) out of 7 cases the Asian stock market demonstrates a feedback process. Considering the relationship between the Asian sovereign CDS and stock markets during the shorter periods characterized by different market states we get somehow ambiguous results. Thus, for the pre-crisis period we document the leading role of the Asian stock markets that took place, however, only in approx. 30% of cases (Korea and the Philippines). During the 2nd period the causality becomes bidirectional (3 vs. 3 cases; bidirectional relationship for Malaysia and the Philippines, dominance of stock index market for Japan vs. dominance of CDS market for Indonesia). In the aftermath of the Lehman crisis the Asian stock market took the lead over the sovereign credit risk one (4 vs. 3 cases; leading role of stock index markets for China, Korea, Malaysia vs. dominance of CDS markets for the Philippines and Thailand, bidirectional causality for Japan). When the adjusted period is considered the sovereign CDS market appears to dominate the price discovery process, however, only in approx. 30% of cases (Japan and the Philippines). In general we can confirm our last hypothesis that the price discovery process in both markets is subject to change over time. However, it is difficult to detect a clear pattern of change in dominance of either market during different periods, since the results are statistically significant for different countries (only for the Philippines, where PSEi gives in its leadership to the sovereign CDS market in the aftermath of Lehman turmoil, it is possible). Additionally the outcome for China during the 3rd period contradicts that one during the whole period. However, since the explanatory powers of both VAR models for the whole and post-Lehman periods are extremely low, we decide to deem the results as hardly reliable.
4.5 Robustness check

Finally, to control for an omitted variable and to check for robustness we extend our 2 dimensional VAR model including implied volatility as an explanatory variable. This measure has been already accounted for in the previous analysis by Norden and Weber (2009) and Coronado et al. (2011). Unfortunately, we have to restrain from applying Asian volatility indices, since they are still in the germ phase and don’t possess sufficient liquidity either to hedge the Asian risk or trade it (Vaghela, 2012). Alternatively as a proxy for volatility in our thesis we use CBOE\(^{19}\) VIX Index, a commonly used measure of the implied volatility of S&P 500 index options, that is also known as a “fear index”. It estimates the market expectation of stock market volatility over the following 30 days. VIX is a weighted mix of prices for a number of options on the S&P 500 index. To calculate this implied volatility measure the current market prices for all out-of-the-money puts and calls options normally in the first and second SPX contract months are used. (CBOE, 2009). Including VIX into our regression analysis of Asian financial markets in focus is, however, not without possible flaws. Thus, especially in the short-run changes of the risk-appetite on the Asian financial markets may not necessarily correlate with the broader “fear index”. This points out at existence of so called basis risk. For example, a spike in the Japanese volatility as a consequence of the earthquake had no relation to the investor sentiment in the U.S.

Firstly, to take a quick snapshot of the relation between VIX, the Asian sovereign CDS and stock index markets we demonstrate it visually. According to the graphs in Appendix 4 one can document a negative linkage between the S&P500 index implied volatility and Asian stock markets, whereas the “fear index” and Asian sovereign CDS appear to be positively related.

To test the graphical relationship statistically we augment our 2 dimensional VAR model with the first difference of contemporaneous and lagged implied volatility:

\[
R_t = a_t + \Sigma b_{rp}R_{t-p} + \Sigma c_{rp}\Delta CDS_{t-p} + \Sigma d_t\Delta Vol_t + \Sigma e_t\Delta Vol_{t-1} + \varepsilon_{rt},
\]

\[
\Delta CDS_t = a_{cds} + \Sigma b_{cdsp}R_{t-p} + \Sigma c_{cdsp}\Delta CDS_{t-p} + \Sigma d_{cds}\Delta Vol_t + \Sigma e_{cds}\Delta Vol_{t-1} + \varepsilon_{cdst}.
\]

According to the adjusted R Square (see Appendix 6) the explanatory power of the augmented regression model has considerably increased across the whole sample. Thus, the 2 dimensional VAR with implied volatility explains on average 25% of Asian stock markets except China with R Square of only 0.035. With regards to sovereign credit risk the new model accounts for 24% of CDS spread changes on average across the whole sample.

The complete regression output is presented in the table below. Both contemporaneous and lagged VIX appear to be significant in our new 2-dimensional VAR model across all the Asian countries in focus. As it was expected the implied volatility exhibits a negative relation with the Asian stock markets, whereas the “fear index” is positively correlated with the sovereign credit risk measure. Such results point out at an integra-

\(^{19}\)Chicago Board Options Exchange
<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>Japan</th>
<th>Korea</th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>the Philippines</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rt</td>
<td>ΔCDSt</td>
<td>Rt</td>
<td>ΔCDSt</td>
<td>Rt</td>
<td>ΔCDSt</td>
<td>Rt</td>
</tr>
<tr>
<td>Rt-1</td>
<td>23,651 (0.085)</td>
<td>-0.215 (-0.214)</td>
<td>-23,602 (0.154)</td>
<td>-0.147 (-0.145)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rt-2</td>
<td></td>
<td>0.093 (0.095)</td>
<td></td>
<td>-47,984 (-0.078)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rt-3</td>
<td></td>
<td></td>
<td>36,673 (0.076)</td>
<td></td>
<td>-54,399 (-0.088)</td>
<td></td>
<td>-70,580 (-0.085)</td>
</tr>
<tr>
<td>Rt-4</td>
<td>-15,975 (-0.059)</td>
<td>-12,179 (-0.079)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rt-5</td>
<td></td>
<td>-51,831 (-0.108)</td>
<td></td>
<td></td>
<td>-96,291 (-0.156)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔCDSt-1</td>
<td>��-71 (0.071)</td>
<td>-0.001 (-0.128)</td>
<td></td>
<td>0.087 (0.087)</td>
<td>0.076 (0.077)</td>
<td>0.249 (0.249)</td>
<td>0.167 (0.167)</td>
</tr>
<tr>
<td>ΔCDSt-2</td>
<td>0.255 (0.259)</td>
<td>-0.080 (-0.079)</td>
<td></td>
<td>0.126 (0.126)</td>
<td>0.092 (0.094)</td>
<td>0.00 (0.108)</td>
<td>0.134 (0.134)</td>
</tr>
<tr>
<td>ΔCDSt-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>ΔCDSt-4</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>AVolt</td>
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<td>0.258</td>
<td>0.182</td>
<td>0.276</td>
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</table>

Table 21: Augmented VAR for the whole period (incl. implied volatility).
Source: Authors.

The results appear to be similar to the original ones based on absolute CDS changes. The sovereign credit risk market leads the stock one for all the considered countries, while except for Indonesia and Thailand this relationship is bidirectional. Thus, with the exception of China (where the explanatory power of the regression model appears to be the least one), the outcome of the original 2 dimensional VAR is confirmed for robustness.

As an additional check of robustness we also tested logged CDS spread changes. The results appear to be similar to the original ones based on absolute CDS changes.
5. CONCLUSION

This concluding chapter of the thesis summarizes our findings consistent to the research question and research purposes highlighted at the very beginning. Additionally, we discuss the contribution of our research to already existing literature on the topic and evaluate it according to quality criteria. Finally, we suggest some relevant areas to be of possible interest for further research.

5.1 Concluding discussion

The main concern of our thesis was to find out what relationship exists between Asian sovereign CDS and stock markets. To answer this question we firstly considered the relevant theoretical framework describing a linkage between both asset classes. The relationship between sovereign CDS and stock indexes (stock index volatilities) can be captured by the structural credit risk model (Chan-Lau & Kim, 2004).

Secondly, we provided an overview of previous studies that explore the relationship in practice. As a reference study for our thesis we used Chan et al. (2008), who address the dynamic relationship between sovereign CDS and stock indexes for 7 Asian countries during 2001 – February, 2007. Additionally as a guidance for our research we selected studies by Bystroem (2005) and Coronado et al. (2011).

Finally, we put forward an extensive set of hypotheses to examine the relationship between Asian sovereign CDS and stock markets comprehensively. In this respect, we tried to capture its state and evolution during a calm/turbulent market, detect a link between relevant volatility measures, and determine the dominance of either market in the price discovery process. The summary of the main results of our research sorted out by a corresponding hypothesis is presented below.

<table>
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<th>Hypothesis #</th>
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<th>Rejected</th>
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<tbody>
<tr>
<td>Hypothesis 1</td>
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<td>Hypothesis 5</td>
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<td>Hypothesis 6</td>
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</table>

*However, feedback process for 4 out of 7 countries

Table 22: Summary of main findings.
Source: Authors.

Hypothesis 1: *Asian sovereign CDS and stock markets are interrelated and move in the opposite directions both at levels and changes.*

Our correlation results confirm that the absolute values of CDS spreads and stock index prices across the Asian countries in focus are (strongly) negatively linked. According to the correlation output for CDS changes and stock index returns they also exhibit a negative relationship that is additionally backed by the VAR outcome. Our findings are in line with the Merton theory and additionally supported by our reference study on Asian sovereign CDS and stock markets by Chan et al. (2008) as well as the studies by
Bystroem (2005) and Coronado et al. (2011) on the relationship of European corporate (sectoral iTraxx CDS indexes) and sovereign CDS with respective stock markets.

**Hypothesis 2:** *Volatility in the stock market is positively correlated to credit risk prices.* Similarly to findings by Bystroem (2005) about a positive correlation between European sectoral iTraxx CDS and stock indexes sovereign CDS spreads increase (decrease) with a rise (fall) in the historical volatility of stock markets and vice versa. For the majority of the Asian countries (with exception of China and Japan) the correlation appears to be strongly positive. The higher credit ratings of China and Japan as a proxy of lower default risk could be a reason for the weaker positive correlation (or its lack) between their sovereign CDS spreads and stock index volatilities.

**Hypothesis 3:** *The relation between CDS and stock index variances is positive and more profound for sovereigns with a higher risk premium.* Estimated GARCH volatilities for Asian sovereign CDS and stock markets demonstrate a strong positive bidirectional correlation. Thus, the uncertainty on the Asian stock market may be contagious for the relevant sovereign credit risk market and vice versa. Moreover, sovereigns with higher CDS spreads such Indonesia, the Philippines and Korea show a stronger correlation between their market and credit risks. The similar findings, but for the Eurozone sovereign markets were made by Coronado et al. (2011).

**Hypothesis 4:** *The sovereign CDS market dominates the price discovery process.* Overall, the Asian sovereign CDS market leads the stock index market. However, in 4 out of 7 countries (Japan, Korea, Malaysia, and the Philippines) the stock index market demonstrates a feedback process. The lead-lag relationship detected by Chan et al. (2008) for the majority of the countries for the preceding period of 2001 – February, 2007 persisted over time. However, in case of Indonesia sovereign CDS market took over the lead from the corresponding stock market and a bidirectional relationship established in Japan (before: no relationship) and Malaysia (before: CDS dominance only). While the Indonesian sovereign CDS market as well as Malaysian stock index market have advanced to react at information changes prompter, the Japanese sovereign CDS spreads and stock index have become responsive to each other on the background of increased sovereign risk. While in Europe the stock market leads the sovereign CDS one (Coronado et al., 2011), in Asia this lead-lag relationship is reverse, what could be explained by less developed Asian stock markets comparing to their European peers.

**Hypothesis 5:** *The intensity of the linkage between the sovereign CDS and stock index markets is state-dependent: it enhances during periods of increased turbulence.* We found that the casual relationship between both Asian markets is subject to change depending on the market state. It becomes more profound when the volatility increases. During the crisis period started with the Lehman bankruptcy the lead-lag relationship is significant for 4 Asian countries (9 VAR negative CDS-stock slopes) comparing to only 2 (2 VAR negative CDS-stock slopes) in the pre-crisis and adjusted (excluding the period of Euro zone debt crisis) post-Lehman periods.

**Hypothesis 6:** *The price discovery process in both markets is subject to change over time.* We detect a dynamic lead-lag relationship between the Asian sovereign CDS and stock markets during 2007 - 2011. Whereas in the pre-crisis period the stock market of 2 countries (Korea and the Philippines) lead the credit risk one, during the consequent 2
periods the causality is bidirectional (3 vs. 3 cases). However, during the adjusted post-Lehman period (excluding the time span of August – December, 2011) it is the Japanese and Philippine sovereign CDS markets only, which take over the lead. Thus, although similar to Coronado et al. (2011) we can confirm a varying price discovery process depending on a market state, we are unable to reveal a clear pattern of change in dominance of either market during different periods because the VAR significance for the same country (with exception of the Philippines) is inconsistent over time.

Additionally in the frames of a robustness check we found a clear dependency of the sovereign Asian CDS and stock markets on the implied volatility index VIX. Whereas the Asian CDS spreads tend to increase, when the “fear index” soars, returns on the Asian equity indices fall. These findings indicate an integration of both Asian sovereign CDS and stock markets with the global one.

To sum up, the answer to our research question is as follows. The relationship covered by the structural model adjusted to sovereigns is empirically justified for the Asian sovereign CDS and stock markets. In whole during 2007 – 2011 the sovereign CDS markets have retained their leadership in the price discovery process as compared to the preceding period studied by Chan et al. (2008). However, spanning the Asian markets for arbitrage opportunities one should also take into consideration their global integration and dependency on broader international indices.

5.2 Contribution to the previous knowledge

With our thesis we contribute to the literature on the empirical evidence of the Merton theory for sovereigns. We strive to raise interest in a region focused research on sovereign CDS markets. To our knowledge, there has been so far only one paper by Chan et al. (2008) covering the relationship of sovereign credit risk and stock markets in Asia. Although in our thesis we focus on the same sample, we are the first to test it in the latest period (2007 – 2011) applying a different methodology. Additionally, we consider the interdependency of the Asian sovereign CDS and stock markets dividing the time span into sub periods to capture various market states. This allows us providing an insight on its evolution over time. Furthermore, to our best knowledge within the related academic literature in English we were the first to study the relationship of the Asian sovereign credit and market risks measured with GARCH(1,1) model. Finally, we shed some light on the Asian markets from the point of their integration with the global market testing their link to the implied volatility VIX index that could be of value for an investor attempting to profit from possible arbitrage opportunities.

5.3 Quality criteria

Finalizing our paper we would like to provide a brief assessment of its quality. Since in our thesis we deal with solely a quantitative research, we seek to look at it through the prism of validity and reliability criteria.

5.3.1 Validity
Validity estimates the extent to which the data, design or test reflect, produce or measure what is intended to be reflected, produced or measured (Jha, 2008, p. 101). In quantitative research King, Keohane, and Verba (1994) distinguish between two kinds of validity: “descriptive inference” (or measurement validity) and “causal inference”, which Cook and Campbell (1979) further classify into internal and external validity. As an additional type Bryman and Bell (2007, pp. 41-42) define ecological validity.

*Measurement validity* estimates the extent to which operationalization and the scoring of cases adequately reflect the concept to be measured (Adcock and Collier, 2001, p. 529). In our thesis we measure a lead-lag relationship of Asian sovereign CDS and stock markets depending on the output generated from the relevant time series processed through the vector autoregressive model in the statistical software SPSS. Vector autoregression appears to be appropriate for analyzing intertemporal relationship of time series, which possess a property of stationarity starting from the first order.

*Internal validity* implies the extent to which any causal difference in the explained variable can be addressed to the explanatory variable. In our thesis this relationship is backed by the one described by the structural credit risk model. Internal validity appears to be of a particular importance, since in our research we seek to detect which market leads in the price discovery process. To find out the causality inference relation we apply Granger test. With some limitations we believe that this methodology is an appropriate one to measure the causality relationship between the time series in focus.

*External validity* evaluates a possibility to generalize the research inference to other groups or settings. Since the Asian countries in our sample are among the most liquid reference entities on the sovereign CDS market and CDS contracts for very few other sovereigns in the Asian region exist, the inference from our research could be generalized on the regional level. However, even the generalization of the results within the narrow regional context should be interpreted with caution, since there can be other than geographical factors (political, economical, etc.) that could affect the outcome. Since our time series include periods of market turmoil, we would recommend to pay due attention when generalizing the results over the time lines.

*Ecological validity* assesses whether inferences generated from research could be used in the frames of real world environment. With this regard the conclusions on the relationship between sovereign CDS and stock indexes for the Asian region reached in our thesis could be applied in working out trading strategies by investors focusing on the relevant Asian markets.

### 5.3.2 Reliability

Reliability is the other key quality measure of quantitative research. This criterion evaluates how consistent are the methods in providing an unbiased outcome for further research replication (Denscombe, p. 106). In our thesis we apply the statistical methods of correlation and vector autoregression enhanced by a number of robustness tests in order to test the intertemporal relationship between the Asian sovereign CDS and stock markets. The methodology we follow has been employed in the previous research on the relevant matter and given a thorough description in our paper can be easily repeated in the future by other researchers.
5.4 Suggestions for further research

As soon as sufficient time series for statistically robust inferences are available to cover the period of the Eurozone crisis escalation we would recommend studying the relationship of the sovereign CDS and stock markets in Asia during this time. In this respect it would be interesting to discover whether the respective Asian markets demonstrate a similar pattern in comparison with the Lehman crisis period.

The evolution of existing and introduction of new Asian volatility indexes could provide food for further implications with regards to our research subject. Thus with the Asian volatility indexes becoming more liquid it would be interesting to test their link with the corresponding sovereign credit and equity markets. This would help to avoid the basis risk (possible absence of correlation to the credit risk on the local markets especially in the short term) that arises when using global volatility indexes instead.

For the following research on the topic we would suggest testing possible new implications within our vector autoregressive model adding new variables. It would be advisable to explore a lead-lag relationship of the Asian sovereign CDS and stock markets including local bond and currency markets as well as to test the influence of global factors.

Furthermore, it would be advisable to test our sample with the methodology applied in Chan et al. (2008), e.g. Johansen’s cointegration rank test to check long run price equilibrium and vector error correction models of market prices (for cointegrated reference entities) to disclose the price discovery process. This would allow comparing the evolution of the findings by Chan et al. (2008) over the time more precisely.

Finally, with regards to the research on the relationship of sovereign CDS and stock markets for emerging countries that often differ in economic and political environment it would be of interest to study this relationship separately for particular geographical regions or credit rating clusters.
REFERENCES


APPENDIX

Appendix 1: Development of Asian sovereign CDS spreads and stock indexes

China

Japan
Thailand

![Graph showing Thailand CDS spread and stock index over time.](image)
Appendix 2: Simplified stationarity test (constant mean) for CDS spread changes

China

Japan

Korea
Appendix 3: Simplified stationarity test (constant mean) for logged stock index returns

China

Japan

Korea
Appendix 4: VIX and Asian sovereign CDS and stock markets

China

Japan
Thailand
Appendix 5: Simplified stationarity test (constant mean) for VIX
Appendix 6: Comparison of adjusted R Squares between 2D VAR and 2D VAR with implied volatility

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