

# An empirical analysis of sovereign CDS - Bond relation before and during financial crisis

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**Aalto University**  
**School of Economics**

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## AN EMPIRICAL ANALYSIS OF SOVEREIGN CDS – BOND RELATION BEFORE AND DURING FINANCIAL CRISIS

### PURPOSE OF THE STUDY

The purpose of the study is to examine the relation of credit default swaps (CDS) and the underlying bonds in both emerging market countries and developed market countries before and during the financial crisis. I will examine whether there is a possible arbitrage opportunities in different markets before and during crisis through the basis method. I will also investigate which factors have a significant impact on the basis and whether they differ depending on country. I will also investigate the long term and short term price discovery process depending on the country.

### DATA

Data set consists of 5 year credit default swap quotes and 5 year generic bond yield quotes obtained daily from Datastream or Bloomberg Terminal with the time span of 2nd of May 2005 to 30th of September 2010. Study includes 21 countries and all in all 29 673 observations of CDS and bond quotes each.

### RESULTS

Findings of the study show potential arbitrage opportunity through constant positive basis in both periods. Basis widens in the time of distress creating even more attractive arbitrage opportunity. Basis changes are mainly caused by one or two factors according to principal component analysis and partly supported by regression results. Regression results show risk appetite to drive the basis changes before crisis. When entering to the time of distress economical and political instability reflected through exchange rates and liquidity of markets appear to drive the basis changes. Clustering analysis of the basis change shows countries to be clustered more according to credit risk of a specific country instead of regional factors.

Lead-lag relationship of derivative markets and bond markets was not stated clearly in either period but indicates bond market to be the price discovery location for most of the countries before crisis but after the crisis started the price discovery location is strongly country depended.

### KEYWORDS

credit default swap, bond, financial crisis, basis

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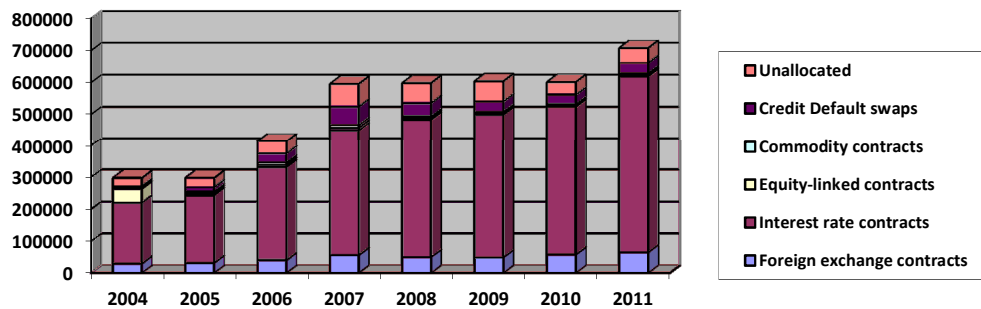
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# 1. Introduction

## 1.1. Background and motivation for the study

Early stages of Credit Default Swaps (CDS) goes back to the beginning of 1990s when Bankers Trust carried out the first trades in 1991. Nevertheless it is JPMorgan which has been credited for creating modern CDS in 1994<sup>1</sup>. Originally CDS market was an inter-bank market to exchange credit risk without selling the underlying bonds but nowadays it is widely used instrument in credit derivative markets (see Figure 1 and 2) and it involves financial institutions ranging from insurance companies to hedge funds and banks.

**Figure 1. Global OTC derivative market.** The figure presents overall market size of OTC derivative market from 2004 to 2011. Figure reports notional amounts outstanding in billions of US dollars. Notional amounts outstanding provide a measure of market size and reference from which contractual payments are determined in derivatives market.



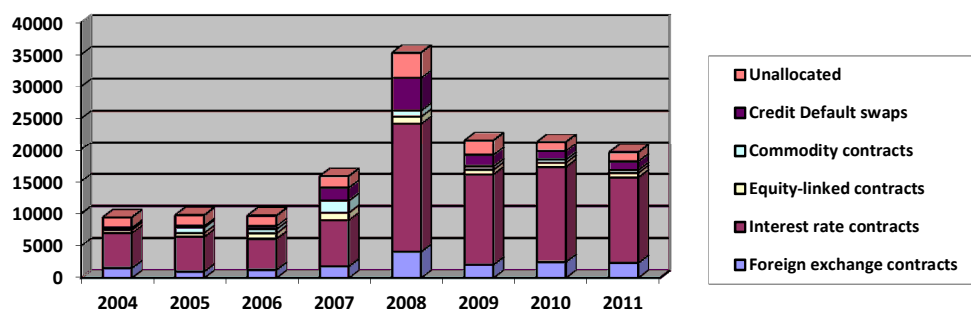
Source: BIS

Over the last decade interest towards CDS market has increased and the trading with CDS along with it. Financial crisis created a short downturn in the growth which was mainly caused by market exits of other players than banks (ECB, 2009). After the low volume years, 2009 and 2010, the interest towards the market has started to grow again. Quickly growing market has captured the interest of researchers and analysts which has led to increased amount of studies on CDS and their relation to the underlying bond market. As the majority of trading on CDS is still conducted on corporate CDS, previous studies have mainly concentrated on

<sup>1</sup> <http://www.thedailybeast.com/newsweek/2008/09/26/the-monster-that-ate-wall-street.html>

investigating the relationship between corporate bond market and corporate CDS market (cf. Hull, Predescu and White, 2004).

**Figure 2. Global OTC derivative market.** The figure presents overall market size of OTC derivative market from 2004 to 2011. Figure reports gross market value in billions of US dollars. Gross market value provides a measure of the scale of financial risk transfer taking place in derivatives markets.



Source: BIS

Investors have not seen sovereign CDS markets attractive until recent years mainly for two reasons. First, the sovereign CDS and bonds spreads have been very low as sovereign bonds have been seen as risk-free. Second the trading activity in this segment has been scarce (Arce et al., 2012). Due to these factors the academic interest towards sovereign CDS market has been low. In the early stages of sovereign CDS trading, trading was mainly done on emerging market CDS as emerging market countries were seen to have higher probability of default than developed countries<sup>2</sup>.

After the collapse of Lehman Brothers in September 2008, investors started to reassess the default risk of developed countries which caused widening of spreads as well as increased trading on the overall CDS market. The increased default risk was due to financial rescue packages and other stabilizing operations in respective countries. This was a necessity as the correlation of risk between financial institutions could lead to a system collapse due to an individual failure (Bernanke, 2009). These actions have created deteriorated fiscal positions leading to increase in the public sector deficit to the levels which have not been seen since World War II in developed countries (Panetta et al., 2009). Due to the history of defaults in

<sup>2</sup> Packer and Suthiphongchai (2003) studied the growth of sovereign CDS market and also compared the average sovereign CDS premia by credit ratings. As their study found, in the early stages more than 90% of the quotes were related to emerging markets.



sovereign debt, previous studies conducted on CDS can be put roughly in two categories: studies investigating emerging markets before crisis (cf. Küçük, 2010; Levy, 2009) and studies investigating developed countries, mainly EU, during crisis (cf. Bai and Collin-Dufresne 2010, Foley-Fisher 2010).

## **1.2. Research gap and contribution**

Most of the studies have been concentrating on few countries within emerging markets or within developed markets. So far only Wang and Moore (2012) and Longstaff et al. (2010) have combined both of the markets in their studies. In this study I will follow more closely Longstaff et al. (2008) who included 26 countries ranging from less developed to developed countries. The study investigated whether diversifying sovereign credit portfolios across countries has benefits by analyzing sovereign credit spreads and excess returns. He conducted a regression analysis with global financial market variables, local economic variables, global risk premia and net inflows into global funds. Study showed that the excess returns on sovereign credit is mostly due to carrying global risk and not country specific risk. Based on this they stated that diversifying sovereign credit portfolios internationally might benefit in small scale but not as much as diversifying equity portfolios. According to them one reason could be the substantially correlated sovereign credit returns compared to correlations of stock index returns. However the study did not either cover western countries nor financial crisis period.

One approach to study CDS market has been analyzing developed countries before and during financial crisis. As one of the example and bases for this study is the study of Fontana and Scheicher (2010). They examined CDS and bond spreads of ten Euro area countries from 2006 to 2010. They divided the time period in two – to time before and after Lehman Brothers collapsed. The study analyzed and confirmed the arbitrage opportunity between CDS premia and bond yield spreads. They also find ratio of debt to influence on the basis. They also examined in which market the price discovery takes place – in CDS market or in bond market. They came to the conclusions that it is equally split in the sample group in short term.

Inspired by these two studies I am including countries from emerging markets and developed markets and using the time period approach introduced by Fontana and Scheicher (2010). I will examine whether there is a possible arbitrage opportunities in different countries before and during crisis through the basis method. I will also examine which factors have a significant impact on the basis and whether they differ depending on country. I will also examine the long term and short term price discovery process depending on the country. The study can be done due to the fact that I was able to receive data from 21 countries (including Europe, Africa, Australia and Asia regions) for the time period of 2005-2010. The behavior of CDS-bond market relation through basis method has not been conducted with this geographical scope over the financial crisis time. As there has been seen big change especially in CDS market behavior during financial crisis, everything is conducted in two periods – before crisis and during crisis. This will also give us an opportunity to examine changes the financial crisis has caused in different parts of the world.

### **1.3. Key terms and definitions**

Here I will present some key terms used in the study as the definition of the term varies among studies.

*CDS premia* - Premia refers to the price paid of a CDS contract in basis points

*CDS spread* - In this study spread is referred to the bid-ask spread, even though commonly CDS spread has been used as premium paid over a CDS contract.

*Basis* - Basis is the difference between a CDS and a bond over a risk free bond.

*Financial crisis* - In this study financial crisis is counted to start from the collapse of Lehman Brothers.

*Credit event* - This refers to events that trigger the payment from the seller to the buyer of the contract, for example default or late payments.

*Bond yield spread* - This refers to the yield of a specific bond over a risk-free bond of the same maturity.

#### **1.4. Limitation of the study**

Limitations are mainly due to the constraints of data. This is caused by fairly young CDS market as the active trading with developed countries' CDS has only started after financial turmoil occurred. Due to this my data is starting from May 2005. Insufficient data from Datastream restrained my sample period to end in September 2010. Fairly recent trading activity resulted in excluding in total of 30 countries from the sample group.

#### **1.5. Structure of the study**

The paper is structured as followed. Second chapter will focus on defining the mechanism of CDS and how the market works. In third chapter I will closely look at the previous literature. In fourth chapter I will form the hypothesis based on the previous studies. Fifth chapter concentrates on describing the methodology more in detail. In chapter six I will describe the data used in the study and in chapter seven I will presents the results. Final section concludes the paper with summary and presents suggestions for further study.

## **2. Credit Default Swap**

In this section I will introduce the credit default swap product and its mechanism. I will also elaborate more about the market and its participants. I will also shortly compare the CDS market and bond market as they have different features although they are expected to trade the same default risk.

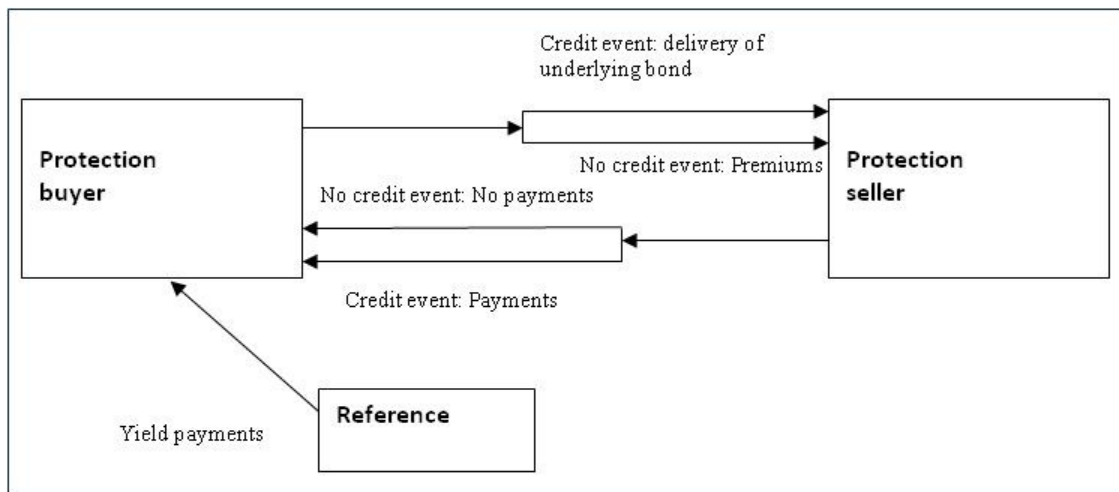
### **2.1. Mechanism of a CDS Agreement**

A CDS contract allows investor to trade or hedge the risk that an underlying entity would default. This can be a corporate, sovereign borrower or financial institution. CDS contract can be used for pure trading purposes but many times it is seen as an insurance policy, where one

side assumes the risk and the other pays a premium. What lowers the threshold to use CDS compared to many other securitization is the fact that there is no prefunding required from the protection seller's side.

The protection buyer pays a yearly premia until pre-defined credit event occurs or until the contract matures. In case of credit event or if reference borrower becomes insolvent, protection seller absorbs the financial losses. Premia that has been agreed upon, generally remains the same until the contract matures. This is also seen as the compensation for carrying the risk of a default. If credit event occurs, the protection seller has the obligation to settle the contract. There is two ways of settlements used, cash settlement or physical settlement, which will be discussed later on in more detail. Mechanism of the CDS trading has been presented in the Figure 3.

**Figure 3. Mechanism of CDS Agreement.** This figure presents how the CDS contract is constructed.



After creation of CDS, sovereign bonds have become assets that can be turned into liquidity if needed and short the risk with a cheaper and quicker way than one could on bond markets. Especially in the current turmoil there is constant news from the markets which indicate a bigger demand of CDS protection buyers and fewer sellers. This can lead to twisted pricing and volatility. When considering the market size (see Figure 4) and the concentration of counterparties, one big deal can misrepresent the whole market for one specific country.

Chan-Lau and Kim (2004) find that during periods of distress the liquidity moves towards the CDS market. This creates a need of working CDS market as the bond market turns expensive and illiquid. Fitch's research<sup>3</sup> find the underlying bond yield level and the level of liquidity on sovereign CDS to be highly correlated. As the liquidity on sovereign CDS is low, bond yields tend to rise and vice-versa.

## **2.2. Typical Agreement**

CDS market has fairly standard agreements with standard maturities however there is demand for such and the issue has been addressed by International Swaps and Derivatives Association (ISDA). Currently one could say a typical CDS contract is written on notional capital of USD 5 million or USD 10 million with a maturity of 5 or 10 years. Most of the CDS contracts are single name contracts where the credit event depends on one bond or a loan, but portfolio name contracts also do exist (e.g. multi-name CDS or Index CDS). As there is no standard agreement, every agreement has to be negotiated separately but they operate under International Swaps and Derivatives Association's Master Agreement frameworks.

## **2.3. Settlement**

The settlement of a CDS contract can be done as a physical settlement or as a cash settlement in a case of a credit event. Typically settlement type has been agreed on up-front. Theoretically the incurred loss should be calculated as the difference between the face value of the underlying bond and the amount that can be recovered from the underlying issuer. In practice it is difficult to predict the post-default recovery value. This has led to the favor of physical settlement to overcome the problem.

According to British Banker's Association Survey (2006), until 2005 physical settlement was most commonly used - up to 73% of the cases. This meant that in case of a credit event protection buyer has to deliver the underlying bond in exchange for compensation. In cash settlement, in case of a credit event protection buyer receives the difference between the bond value at the time of a settlement and the bond's nominal value in cash. Cash Settlement

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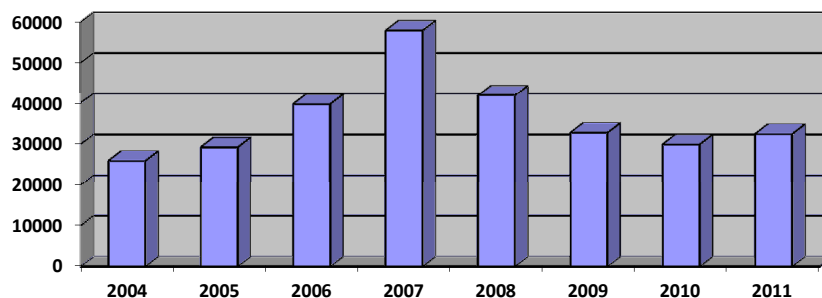
<sup>3</sup> <http://www.fitchratings.com/web/en/dynamic/articles/Greek-Yields-Show-Benefit-of-Liquid-CDS-Market.jsp>

accounted only for 23 % of cases and only 3 % of contracts were settled by fixed amount. Situation after 2005 changed when popularity of cash settlement increased due to the incorporation of auction settlement<sup>4</sup> procedures in standard CDS contracts (Markit, 2009).

## 2.4. Market and its participants

The actual size of CDS market is difficult to estimate. This is due to the over-the-counter (OTC) nature of the product and data providers which use different sampling and collection methods. There are three main parties Bank for International Settlements (BIS), International Swaps and Derivatives Association (ISDA) and Depository Trust & Clearing Corporation (DTCC) which collect and provide trading and settlement activity data. Estimation of the overall size of the market was 32 trillion USD in June 2011 (BIS, 2011). Figure 4 and 5 show the development of the market over time both in notional amounts and in gross market value.

**Figure 4. Total amount CDS contracts outstanding.** The figure presents overall market size of CDS market from 2004 to 2011. Figure reports notional amounts outstanding in billions of US dollars. Notional amounts outstanding provide a measure of market size and reference from which contractual payments are determined in derivatives market.



Source: BIS

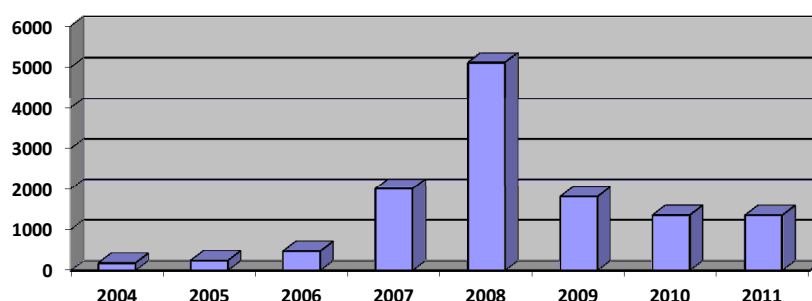
It is important to note that notional amount reflect the cumulative total of past transactions and it can give misleading image of the size of the market. This is due to the large scale offsetting transactions as an attempt to increase or decrease the exposure to CDS risk. This

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<sup>4</sup> In this procedure participants are asked to submit a bid price as well as a price at which they are willing to trade the bond. After this “inside market midpoint” is calculated. Participants are also asked to submit the amount the wish to sell or buy. If bid and ask volumes match inside the market midpoint, this will be the final price otherwise second round is organized (Helwege et al., 2009)

leads to multiple transfer issue which will be addressed later on in more detail. Gross market value on the other hand takes into account offsetting transactions, however net notional amount of CDS contracts can still exceed the notional amount of bonds. This implies to “naked CDS” trading which is more commonly done on corporate CDS. Naked CDS trading has caused lot of discussions during last couple of years as it has been accused to increase the borrowing costs of the sovereigns<sup>5</sup>.

**Figure 5. Total amount CDS contracts outstanding.** The figure presents overall market size of CDS market from 2004 to 2011. Figure represents gross market value and is reported in billions of US dollars. Gross market value provides a measure of the scale of financial risk transfer taking place in derivatives markets.



Source: BIS

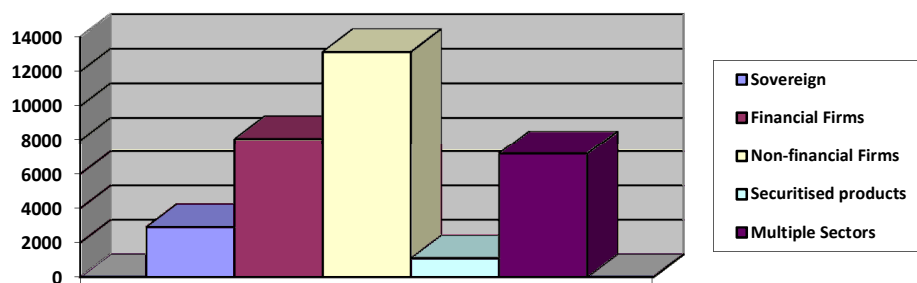
From the overall trading in 2011 the majority of the trading in CDS markets was done with corporate CDS followed by bank’s CDS and sovereign CDS (see Figure 6). As the volume of sovereign CDS market has been low compared to the bond market (approximately 32 trillion USD versus 54 trillion<sup>6</sup> USD in June 2011) and due to the OTC nature of the product, only big players afford to enter the markets<sup>7</sup>, which includes banks and other financial intermediates (see Figure 7). A survey conducted by Fitch (2009) showed that about 88% of the total notional amount bought and sold during the year 2008, were conducted by the 5 largest members out of the 26 major players on the market. Banks use CDSs mainly for managing their own portfolios, but besides banks and security houses, hedge funds are one of the biggest participants in the CDS market.

<sup>5</sup> See for example the study of Portes (2010) or Delatte et al. (2012).

<sup>6</sup> <http://www.viewsoftheworld.net/?p=1766>

<sup>7</sup> Big players have benefited from standardization of contracts in the form of lower transaction costs. This has been highly welcomed as bid/ask spreads have narrowed through increased trading.

**Figure 6. CDS contracts by sector.** Figure represents CDS contracts in notional amount outstanding by different sectors which are described below more in detail. Figure is reported in billions of US dollars.



**Sovereigns:** Governments excluding publicly owned financial or non-financial firms.

**Financial firms:** Financial institutions including building societies, leasing companies, insurance companies and pension funds.

**Non-financial firms:** Other than financial firms and sovereigns.

**Securitized products, i.e. portfolio or structured products:** CDS contracts written on a securitized product or a combination of securitized products, i.e. asset-backed securities (ABS) or mortgage-backed securities (MBS). The reference entity of these types of contracts are the individual securities or loans that were used to construct it. These contracts could be therefore classified as multi-name rather than single-name instruments.

CDS on other securitised products (including collateralised debt obligations)

**Multisectors:** CDS where the reference entities belong to different sectors (such as in the case of basket credit default swaps).

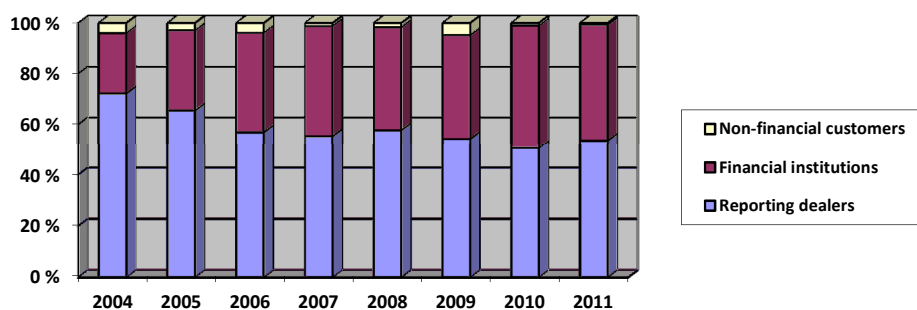
Source: BIS

Most of the trading up to the market crash in 2008 was done on emerging market papers as Western countries were seen as risk-free. Also as ISDA started to provide standardized definitions on terms and conditions of the CDS<sup>8</sup>, it increased the popularity of CDS contracts. At the same time though the data from ECB (2009) shows large scale exits of other's than bank players from CDS markets after the crisis started. This applies to all CDS categories, not just sovereign CDS market.

<sup>8</sup> Last amendments to the Master agreement have been introduced in 2009, when the auction settlement has been defined more in detail ([www.isda.org](http://www.isda.org))



**Figure 7. CDS contracts by counterparty.** Figure represents counterparties share of the overall CDS market in percentages between 2004 and 2011. Categories are defined below.



**Reporting dealers:** Institutions whose head office is located in one of the 13 reporting countries (Australia, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States) and which participate in the semiannual OTC derivatives market statistics. “Reporting dealers” are mainly commercial and investment banks and securities houses, including their branches and subsidiaries and other entities that are active dealers.

**Financial institutions:** Financial institutions which are not reporting dealers, including central counterparties (CCPs), banks, funds and non-bank financial institutions which may be considered as financial end users (eg mutual funds, pension funds, hedge funds, currency funds, money market funds, building societies, leasing companies, insurance companies and central banks).

**Non-financial customer:** Any counterparty other than those described above, in practice mainly corporate firms and governments.

Source: BIS

## 2.5. Credit events

History shows that defaults usually come in waves and concentrates on time of distress such as Great Depression and World War 2 (Moody’s, 2009). History also shows that emerging markets are more likely to default than developed markets (Reinhart and Rogoff, 2008).

In general credit event can be triggered by the crash of an entity, problems of payments (premiar), restructuring of debt, obligation default and obligation acceleration (ISDA, 2002). Full-scale defaults usually do not apply to sovereign CDS which leads the contract documentation to concentrate on debt restructuring, repudiation/moratorium and failure to pay. This means for example late payments can trigger a CDS.

## **2.6. Reasons for a government default**

Looking at the history, governments have usually defaulted due to debt in foreign currency (Hatchondo, Martinez and Sapriza, 2007). This has led to renegotiation of debt exchange and restructuring. According to Hatchondo et al. (2007) this will mean drop in GDP and decrease in growth staying between 0,5 - 2%. This will be followed by a drop in the rating of the country, growing debt expenses, slower pace of trading, stress on banking system and appearance of political changes.

Home currency defaults may occur for couple of reasons. In some countries there is a rule of having to have gold as a guarantee for the printed money and government runs out of gold. Second problem is the shared currency. For example now Greece cannot print more money as it uses euro. Also printing money will devalue the currency and increase inflation exponentially which again shrinks “real economy”. For companies which have used foreign currency debt to acquire assets in home currency, devaluation would be disastrous. Due to this some countries rather default in their own currency than devalue.

## **2.7. CDS market versus Bond market**

Few considerations should be taken into account when comparing the markets and products. As mentioned one of the biggest advantages of CDS is the unfunded nature of the product. The off balance-sheet nature of CDS contracts attract investors who would like to “clear up” their balance-sheet. For them it is more attempting to sell a protection than to buy a bond to receive the exposure to the same credit risk. This leads to the situation of having partly different market participants in bond markets and in CDS markets which also trade for different reason (Blanco et al., 2003). This is actually recommendable as it reduces the counterparty risk which is seen as one of the most notable risks in CDS market<sup>9</sup>. The problem is not eased by multiple transfer of credit risk where protection seller hedges the exposure with another party which again hedges it forward. This problem has been addressed by suggesting trade compression parties as well as central counterparty.

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<sup>9</sup> For example see study by Arce et al. (2011) or Levy (2009)

Besides the suggested central clearing, CDS contracts generally oblige protection seller to post collateral. According to ISDA standards, these collaterals are risk sensitive and the amount of collateral moves as the underlying entity's default risk moves. This has been done to prevent systematic risk due to multiple transfer of credit risk.

CDS is not either linked to a specific bond but to a specific issuer. In case of a credit event combined with a physical settlement option, the protection buyer can choose from a pool of bonds which he can deliver and profit from the cheapest-to-deliver option<sup>10</sup>. The method is described more in detail in section 5.1.

Bond market tends to gather investors with the buy-and-hold strategy such as insurance companies and pension funds. Due to the strategy, it results in poor liquidity in the market whereas CDS market does not hold this problem. The amount of CDS contracts is also not fixed which has the counter effect of multiple transfer of credit risk.

One aspect is also that in case of a credit event according to CDS agreement, seller pays the par minus the recovery rate, while in bond agreement the bond holder may only get market price minus the recovery rate.

Besides the reasons above, according to Fontana and Scheicher (2010) from trader's point of view bonds and CDS are not perfect substitutes. Bond prices are seen to be affected by interest rate risk, default risk, funding risk and market risk. CDS prices on the other hand are only affected by default risk and counterparty risk.

### **3. Literature review**

In this section I will present the previous studies on which I will base my hypothesis and analysis on later on. Corporate CDS market has been the main target of studies and it will be briefly introduced while the main focus will be on studies conducted on sovereign CDS markets and their relation to the underlying bond market.

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<sup>10</sup> This has been studied by Ammer and Cai (2011)

### 3.1. Overall view on CDS market

Growing size of CDS market has created interest towards studying CDS and its relation to bonds and other variables. As the corporate CDS market is still three times bigger than the sovereign CDS market (see Figure 6), studies have concentrated mainly on corporate markets. Studies have approached the topic from many perspectives covering for example, determinants of the corporate bond spread (cf. Chen et al. 2007), the relation of determinants and corporate CDS premias (cf. Longstaff et al., 2005; Ericsson et al., 2009) or corporate CDS price discovery place (cf. Zhu, 2006). Longstaff et al. (2005) find for example liquidity to have an impact on CDS premias while Ericsson et al. (2009) find firm's leverage and volatility to have an impact. Price discovery studies suggests corporate CDS market to reflect the information more accurately and quicker than the bond market before the crisis<sup>11</sup>. Study conducted by Zhu (2006) also showed that even though long-run parity conditions hold, in short-run price discrepancies can exist between corporate CDS and bond market.

The sovereign bond market differs from corporate bond world as they traditionally have very low probability of default<sup>12</sup>. Sovereign bonds have been seen as a "safe-haven" in financial turbulence (Hartmann et al., 2004) and they are among the largest borrowers in the world. Sovereign bonds have also more bonds outstanding, longer maturities and larger issues compared to corporate bonds (Ammer and Cai, 2011). Sovereigns do not have the options of loans as companies nor do they go bankrupt or liquidate their assets in financial distress.

Although sovereigns lack the option of complete bankruptcy, the recent financial turmoil has created some doubts about using sovereign bonds as a risk free rate – which is also the key feature of asset pricing. The doubt cast on the stability of the governments is due to financial aid governments have given to their financial institutions since October 2008 (Ejsing and Lemke, 2010). The doubt is not without a reason according to studies. Dieckmann and Plank (2010) studied the pricing of sovereign CDS with a focus on the private-public risk transfer in 16 European countries from 2003 to 2009. They found sovereign CDS to be significantly linked to the respective country's banking system. They also find EMU countries CDS

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<sup>11</sup> See for example Blanco et al. (2005) or Hilscher et al. (2011)

<sup>12</sup> See for example studies on sovereign bond market liquidity or market integration (cf. Manganelli and Wolswijk, 2009) or bond market developments in euro area during crisis time (cf. Sgherri and Zoli, 2009; Haugh et al., 2009).

premia' to be more sensitive to the stability of the financial institutions than non-EMU countries. This question was also analyzed by Ejsing and Lemke (2010) who also documented a linkage between CDS premia changes of Euro area banks and their governments. They find financial aid packages to lower banks' CDS premia but at the same time increase sovereign CDS premia. Dataset consisted of 10 countries and 25 banks. Time period is from January 2008 to June 2009. An alternative approach has been presented by Pan and Singleton (2008) and Andritzky and Singh (2007) where they consider separately default risk and recovery risk which is one of the key elements when pricing CDS.

Merton (1974) introduced the structural model which is commonly used as the theoretical framework for analyzing corporate credit risk. Gapen et al. (2005) extended the model to cover sovereign credit risk. They argued that the main drivers of the risk are the volatility of the sovereign assets and the country's leverage. Due to this Gapen et al. (2005) see corporate and sovereign credit risk analysis to be comparable.

### **3.2. Possibility for arbitrage and reasons for it**

So called basis method has been widely adopted method to investigate the arbitrage opportunities between CDS and bond markets and to determine theoretical prices. This has been created due to the difficulty of determining repo costs and counterparty risk. In basis method the possibility for arbitrage arises when the difference between CDS premia and bond spreads does not equal to zero.

When markets are rational and investors share the same information, the difference the bond and the CDS premia should equal to zero as they are supposed to be the prices for the same credit risk. However when examining CDS-bond parity Levy (2009) was not able to find zero basis to hold for emerging market countries although when liquidity effects are counted in he is able to confirm the theoretical assumptions of the zero basis. Küçük (2010) studies CDS-bond basis for 21 emerging market countries before financial crisis and comes to the same conclusion. He finds that basis does not equal to zero and it is related to bond liquidity, speculation in CDS market, CDS liquidity, equity market performance and world macroeconomic factors. Ammer and Cai (2011) study shows that "cheapest to deliver" option is one factor affecting CDS premia, driving the basis above zero when studying nine

emerging market countries. They also find that CDS premia and bond spread are linked by a stable linear long-run equilibrium relations. Foley-Fischer (2010) again studied relation of bond and CDS premia of ten EMU countries. He finds that in non-crisis time the basis is consistent with relatively small amount of investors believing that one of the European countries would default and thus create no arbitrage opportunities. However he finds evidence that during the time of distress apparent arbitrage opportunities emerges. Foley-Fischer's data was from the years 2008 and 2009. Palladini and Portes (2011) studied 6 euro countries from 2004 to 2011 and concluded that the basis does not equal to zero giving the opportunity for arbitrage. However they did not differentiate between pre crisis and post crisis time. Arce et al. (2012) was able to include counterparty variable in the study and find counterparty risk indicator to have a negative and significant impact on the basis. They also find costs and low liquidity in the bond market compared to CDS market to have a negative impact on the basis. This finding is in line with the previous studies.

Instead of using basis method, Mayordomo, Pena and Romo (2011a) did an analysis of persistent deviation between CDS and bond market with European corporate bonds to study arbitrage opportunities. Their result show persistent deviation both in pre-crisis and during crisis period.

Fontana and Scheicher (2010) find sovereign basis to be positive before and during crisis. They argue that it might be due to "flight to liquidity" effect (Beber et al., 2009). This phenomenon result in lower bond spreads during the time of distress. They also find basis to be significantly linked to the cost of short-selling bonds and both country specific and global risk factors. Longstaff et al (2010) was able to find evidence that CDS premias are more related to global factors than local factors when studying 26 developed and less-developed countries. The study stated that more than 50% of sovereign CDS premias were explained by three components. All of these components are global variables. They also find that CDS quotes of sample countries were highly correlated. Longstaff et al. (2010) also concluded that from the global variables, variables related to US market changes had the most impact on the CDS premias. Global factors importance for CDS premias was also documented by Pan and Singleton (2007) when they examined sovereign CDS premias against U.S. stock market returns and VIX volatility index. Remolona et al. (2007) found that country specific fundamentals primarily drives sovereign risk while global investors' risk aversion drives time variation in the risk premia when using a dynamic panel data model.

### **3.3. Relationship of CDS and Bond Spreads**

Most of the papers on price discovery between CDS and bond markets are based on either Hasbrouck's (1995) or Gonzalo and Granger's (1995) methodologies. These methods investigate the short-term relationship of the markets. For investigating the long term relationship almost all of the studies rely on Johansen cointegration method (1991).

Studies conducted before crisis show that it is difficult to conclude that one particular market dominates the price discovery process in short-term (cf. Chan-Lau and Kim, 2004) or that price discovery appears to be country depended (cf. Bowe, Klimaviciene and Taylor, 2009). Ammer and Cai (2011) find difficult to determine which market leads in the study of 9 emerging market countries before crisis, but they argue that relatively more liquid market tends to lead. Longstaff et al. (2010) and Arce et al. (2012) in their studies find price discovery process to be state-depended. As Ammer and Cai, Arce et al. argue market liquidity to be a significant factor in determining which market leads price discovery. Delatte et al. (2010) studies 11 European countries from 2008 to 2010 and find that bond market tend to lead the price discovery process during low tension periods, but during high tension periods CDS market leads. This finding goes hand in hand with the study of Fontana and Scheicher (2010) and is supported by study conducted by Delis and Mylonidis (2010). Delis and Mylonidis studied four South European Euro currency country from 2007 to 2010. They examined the dynamic interrelation between bond and CDS premias on the basis based on Granger causality test. Palladini and Portes (2011) study of 6 euro area countries find derivative markets to move ahead of bond markets. Though they did not separate the time period pre and post crisis.

## **4. Hypothesis**

In this section I will build my hypothesis based on the previous studies.

The two main factors of which the basis is constructed from includes bond yield and CDS premia, besides the risk-free bond yield. Those two factors are assumed to price the same risk – default risk of a specific country. This should result in the basis to equal zero in the long run due to theoretical assumption of investors to be rational and share the same information.

However as there are different participants in the CDS market and bond market due to the difference in the nature of the products, they also trade for different reasons (Blanco et al., 2003). Different motives of trading could also lead into following and gathering different information. This might cause the bond yield and CDS premia to move independently resulting in basis being either positive or negative which is widely documented phenomenon by previous studies. Due to this and based on the results of the previous study (cf. Levy, 2009; Palladini et al., 2011) I construct my first hypothesis.

*Hypothesis 1 (H1): Overtime basis does not always equal to zero, therefore there is a possibility for arbitrage.*

There is a general assumption of CDS premias to be higher in emerging market<sup>13</sup> countries than in developed market countries. This is based on the assumption of emerging market countries to have higher default risk than developed countries (Reinhart and Rogoff, 2008). The differences rise from economical, political, social and demographical issues which differ between these groups. Due to the close nature of CDS premia and basis I will extend this assumption to effect the basis as well and construct my second hypothesis.

*Hypothesis 2 (H2): The basis is higher in emerging markets than in the developed markets over time.*

The difference between the CDS premia of emerging market countries and developed market countries has been generally recognized but the geographical co-movement of the CDS premia has been studied less. Due to this I will next examine whether the basis move in geographically clustered groups or whether it tends to create groups based to the prevailed default risk resulting in economically clustered groups. In Longstaff et al. study, in the Working Paper version published in April 2008, they had included cluster analysis which showed CDS premias' co-movement to be clustered according to geographical areas such as Middle East countries as one cluster and Asian countries in another cluster. It would refer the basis to move according to other factors than credit spread levels. Based on this I will construct my third hypothesis.

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<sup>13</sup> In this study emerging market is defined to include countries of the MSCI Emerging Markets Index: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, South Africa, Taiwan, Thailand, and Turkey.



*Hypothesis 3 (H3): The basis move in clusters according to geographical regions, Europe, Asia, Africa and Australia.*

Next I will examine the determinants which possibly cause the basis to change and might also explain the geographical co-movement differences. Previous studies have mainly focused on examining variables' impact on CDS premia instead of the basis, however I will use these studies as comparable due to close nature of CDS premia and the basis. Previous studies (cf. Longstaff et al., 2010; Pan and Singleton, 2007) have concluded global variables to have significance impact on the premia. Most of these variables have been US related. This has been documented for example by Longstaff et al. (2010), who find CDS premia to be 74% correlated with US Stock Market returns through principal component analyses. Also Wang and Moore (2012) find particularly developed countries to be linked tighter to the US and US interest rate since the Lehman Brothers collapsed. Wang and Moore studied the sovereign CDS spreads of 38 emerging and developed economies from January 2007 to December 2009.

As important as US economic changes have been on CDS premia, market liquidity has been documented to be one of the key driver for premia changes as well (cf. Küçük, 2010). Liquidity's impact has not been widely studied yet, but studies which have included the variable, have shown it to have significant impact. Liquidity of a market is argued by many studies to determine where the price discovery takes place also therefore an interesting variable to study. Based on this I will test and construct my fourth and fifth hypothesis.

*Hypothesis 4 (H4): US Stock return and US Treasury yield have a significant impact on the basis in majority of the countries.*

*Hypothesis 5 (H5): Liquidity variable has a significant impact on the basis in majority of the countries.*

My last hypothesis will examine where the price discovery will take place – within the bond market or CDS market. Previously conducted cluster analysis and regression results might also help to explain the price discovery behavior. According to Fontana and Scheicher, 2010, price discovery is taken place in markets where informed investors trade the most. Before the financial crisis started, sovereign bonds were seen as safe haven which lead to low volume of

trading on the developed market CDS. Based on Fontana and Scheicher's statement and supported by other studies (cf. Delis and Mylodinis, 2010) it can be expected that the price discovery should have taken place in the bond markets before the crisis. When financial turmoil started, investors' views changed. Investors saw a growing possibility of sovereign default as governments started to provide rescue packages for their banks to overcome the related problems which Lehman Brothers' collapse created (cf. Dieckmann and Plank, 2010). As the probability of default grew, investors started to look for an option to hedge their risk and turned to CDS market. The shift from bond market to derivative market has been also documented by Delatte et al. (2010) among others. Based on these findings I will construct my sixth and seventh hypothesis.

*Hypothesis 6 (H6): Price discovery takes place in the bond market before the financial crisis.*

*Hypothesis 7 (H7): Price discovery takes place in the CDS market during the financial crisis.*

## **5. Methodology**

In this section I will introduce the methodology used in the thesis and rationalize the choice of the methodology. Main focus is to analyze the basis which will be introduced more closely in the section followed. I will also use different methodologies to study both long term and short term relationship between CDS and bond market – whether there is a cointegration and whether one market leads the other in the short term.

### **5.1. Arbitrage opportunity and the Basis**

Sovereign CDS and government bonds are assumed to offer investors exposure to the same risk or return of the sovereign debt. This means CDS premia and bond yield spreads should be equal and react the same way and at the same time to the market events or otherwise there is an opportunity for arbitrage. However this is not always the case. According to Duffie (1999) and elaborated by Hull and White (2003), there exists a perfect arbitrage opportunity. This is created between a risky bond at par, a riskless par bond and a CDS contract of the

same maturity. They base their view on the assumptions that the price of a CDS contract can always be deducted from an asset swap spread of a bond. However this requires frictionless repo markets and that the recovery rate of a defaulted bond to be zero. This also requires an estimate of risk-neutral probability that the underlying bond defaults at different future times and that there exists a recovery rate.

If following Duffie's and Hull and White's logic, without taking into account costs associated with shorting a risky asset, annual yield of risk-free bond must equal to the difference between annual yield of the risky bond and the cost of credit protection expressed as a percentage of the risky bond nominal value.

Let's assume  $CDS_{premia}$  represents the annual premia paid at CDS market for the credit protection. The annual yield of risk free bond is represented by  $BY_{rf}$  and annual yield of risky bond by  $BY$ , then:

$$BY_{rf} = BY - CDS_{premia} \quad (1)$$

This will mean every time  $BY_{rf} > BY - CDS_{premia}$  investors make profit buying the risk-free bond, shorting risky bond and selling protection. On the other hand when  $BY_{rf} < BY - CDS_{premia}$  then buying the risky bond, buying protection to it and shorting the risk-free bond would be profitable.

The same can be presented in terms of the basis. The basis is the difference between CDS premia and the bond yield of the same underlying entity minus risk-free bond yield of the same maturity.

For no arbitrage to appear, basis should equal to zero:

$$"Basis" = CDS_{premia} - (BY - BY_{rf}) = 0 \quad (2)$$

For this theoretical arbitrage relation to hold, each feature of the two bonds must be identical. We must also disregard the counterparty risk, i.e., the possibility that the protection seller might be unable to make payment in case of a credit event.

In case basis does not equal to zero we face a situation more commonly known as positive basis or negative basis. When CDS premia is greater than bonds spread we have positive basis situation. This means investor can sell the CDS , buy a risk-free bond and short sell the reference entity bond to gain arbitrage profit. When the CDS premia is smaller than bond spread we have so called negative basis. In this case investor should buy CDS contract, reference entity bond and short sell the risk free bond.

<b>CDS spread &gt; Bond Spread</b>	<b>CDS spread &lt; Bond Spread</b>
"positive basis"	"negative basis"
<ol style="list-style-type: none"> <li>1. Sell CDS</li> <li>2. Buy risk-free bond</li> <li>3. Short sell the reference entity bond</li> </ol>	<ol style="list-style-type: none"> <li>1. Buy CDS</li> <li>2. Buy the reference entity bond</li> <li>3. Short sell risk-free bond</li> </ol>

As found in literature review in practice basis does not equal to zero and can be negative or positive. Andritzky and Singh (2007) and Merrill Lynch (2006) among others provide a sample of the factors that can cause the phenomenon:

***Structural factors***

1. Cheapest-to-deliver option can drive CDS premia wider. After credit event protection buyer has to deliver qualifying loan or a bond to the risk seller as for payment (in case of physical settlement). Buyer has the incentive to deliver the least valuable instrument that is eligible. As market simultaneously looks for cheapest-to-deliver option this might cause a "squeeze" on these bonds and drive prices up elsewhere.
2. As CDS are unfunded it attends to pull CDS spreads tighter. When investors which are funded above LIBOR sell a protection and at the same time has the CDS premia locked at LIBOR rates, this creates an attractive opportunity for investor. This again drives CDS basis tighter.

3. Counterparty risk tends to tighten the basis as well. Whether the payment is received in case of default depends on the counterparty, not the underlying entity. The risk depends on the degree of correlation of default risk between underlying entity and the counterparty. The higher the correlation, the greater the risk for the protection buyer. This factor will be also tested in this study.
4. Some bonds have a feature of coupon step-up language. If rating of the issuer is downgraded the coupon increases and vice versa. However CDS premia does not follow the rule. As an example when rating trend is negative it will have a widening impact on basis.
5. Trading below or above par can also effect on the basis. As an example, if the bond is traded below par, the buyer carries only the risk of the cash price of the bond, while the protection seller carries the risk of the par value. This leads to protection seller to demand higher premium and drive the basis wider.
6. Haas (2003) also suggest that a technical default<sup>14</sup> can cause widening of CDS spreads. In this case all the characteristics of credit event exist but no official credit event has been confirmed. Protection seller can require higher CDS premiums as a compensation for the scenario.

### ***Market factors***

1. Illiquidity of underlying debt can have an impact on the basis. The effect is uncertain as there might be two options for the illiquidity. In one case protection can be more liquid than the underlying bond and as many want to cover their exposure it tightens the CDS spread. The other option can be that debt itself is popular and is traded very tight causing CDS premia to widen.
2. Issuance of large synthetic CDOs tend to pull the overall CDS market tighter. This is due to originating banks which have to build up long credit positions in wide range of names before or after the transactions.

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<sup>14</sup> Technical default is defined as violation against bond covenant requirements by the issuer. These defaults do not refer to failure to pay interest and do not necessarily result in losses to the bondholder (Haas, 2003).

3. Investors view on credit market can drive the basis wider. This is due to the fact that investor can take either long credit position or a short credit position. When the market is viewed negatively investors tend to buy protections as it is seen easier than borrowing bonds for short selling. This leads to investors possibly paying more for protection than what the bid side is on assets swaps.
4. Investor also holds repo market option which can lead to higher CDS premiums. This is due to the option of the protection buyer to refinance in the cash market with a repo agreement under the risk free rate.

Besides the market and structure risks mentioned above there can be other factors influencing on arbitrage opportunities. One can be the must have opportunity to borrow or sell risk-free and another can be tax issues. Arbitrage theory also assumes that you can sell the bond with face value plus accrued interest even though in reality the bonds are sold only as face value (Zhu, 2004).

I will be using the basis method to study my first hypothesis and support second hypothesis with it:

*Hypothesis 1 (H1): Overtime basis does not always equal to zero, therefore there is possibility for arbitrage.*

*Hypothesis 2 (H2): The basis is higher in emerging markets than in the developed markets over time.*

## **5.2. Principal component analysis**

With principal component analysis I am trying to isolate a small number of common factors that would explain the correlation pattern. This is done for CDS premiums, bond yield spreads and for the basis.

This method has been used by Longstaff et al. (2010) and Pan and Singleton (2006) among others in their studies. Both of the studies find first principal component to have strong explanatory power of the movements. I will use principal component analysis to examine if there is as strong co-movement in my sample. This would refer to few factors having big influence on the spread changes over the whole sample group. Later on I will attempt to capture these components through regression method.

Principal component analysis is also conducted on 14 banks' CDS premias for the period from May 2005 to September 2010. This is done to obtain the first component which will be later on used in regression to describe the default probability of the counterparties.

### **5.3. Clustering analysis**

Principal component analysis supports the cluster analysis. As principal component analysis looks for common factors, cluster analysis helps to identify the structure of it through searching structure in correlation matrix – which countries move alike.

Cluster analysis is used to classify a set of items into two or more mutually exclusive unknown groups based on combination of interval variables. In other words, algorithm tries to form groups of data so that the average correlation between countries of the same group is maximized while the average correlation between countries of different groups is minimized. As Longstaff et al, (2008) I will use Ward's method in which clusters are formed so as to minimize the increase in the within-cluster sum of squares. The distance between two clusters is the increase in these sums of squares if the two clusters were merged. Cluster analysis stopping rules are used to determine the number of clusters in the data.

Cluster analysis will be conducted on the basis spread to examine which countries tend to move together. This helps me to study the hypothesis number two and three.

*Hypothesis 3 (H3): The basis move in clusters according to geographical regions, Europe, Asia, Africa and Australia.*

## 5.4. Multiple regression

As principal component analysis looked for the commonalities and cluster analysis the structures of the commonalities, multiple regression will try to analyze the nature of them. I will try to catch the reason for the commonalities through hypothesis based on previous studies. I will use multiple regression method to test my fourth and fifth hypothesis.

*Hypothesis 4 (H4): US Stock return and US Treasury yield have a significant impact on the basis in majority of the countries.*

*Hypothesis 5 (H5): Liquidity variable has a significant impact on the basis in majority of the countries.*

Multiple regression method minimizes the sum of squared vertical distances between the observed responses in the dataset and the responses predicted by the linear. By using multiple regression method I am trying to assess which factors have an impact on the changes of the basis. To do this I have chosen a set of variables which has been found significant in the previous studies (cf. Arce et al., 2012; Fontana and Scheicher, 2010). The distinction between global, local and risk premium variables was introduced by Longstaff et al. (2010) and it is partly reproduced in this paper.

My empirical model is constructed as followed.

$$\Delta Basis_{it} = c + \beta_1 \Delta (Debt\ to\ GDP)_t + \beta_2 \Delta (Exchange\ rate)_t + \beta_3 \Delta (US\ Treasury\ Yield)_t + \beta_4 \Delta (US\ Stock\ Market)_t + \beta_5 \Delta (European\ Stock\ Market)_t + \beta_6 \Delta (iTraxx)_t + \beta_7 \Delta (VIX)_t + \beta_8 \Delta (Counterparty)_t + \beta_9 \Delta (Bid-Ask\ Spread)_t + \varepsilon_{it} \quad (3)$$

Where  $Basis_{it}$  represents the difference between CDS premia and corresponding bond yield over risk-free rate of a country  $i$  at the time  $t$ .  $\beta$  represents the change of the specific variable and  $\varepsilon$  is the error term.



I will also use Newey-West correction to overcome the autocorrelation and heteroskedasticity in the error terms in the model. This is often used to correct the effect of correlation in the error terms regression applied to time series.

#### **5.4.1 Variables used in regression**

In this section I will present more closely variables used in regression. Variables are mainly chosen based on previous studies where these variables have shown to be significant. I will also introduce few a new variables or an alternative variable for the previous studies.

##### **5.4.1.1 Local variables**

This group of variables is designed to measure the impact of the local economy on the basis. Local variables are assumed to have an effect on the basis to show the country itself can effect on their own probability of default.

###### **5.4.1.1.1 Proxy for a country's debt**

Following Fontana and Scheicher's study (2010), first local variable is the proxy of country's total outstanding bonds relative to its GDP. In the structural models of sovereign credit risk (Gapen et al., 2005) higher debt relative to assets is a major risk factor. Following this assumption I am expecting to see high debt increasing the volatility of the CDS premia and this way also higher CDS premias. Large bond market generally lower transaction costs through high liquidity of the market. However if demand is lower than the amount pushed to market, it might have adverse impact on bond market liquidity.

###### **5.4.1.1.2 Exchange rate**

The exchange rate measures the strength of the local economy relative to its international counterparties. Volatility in currency can be caused by economic and political instability which worsens the credit quality and leads to depreciation of the currency. I am using exchange rate as a proxy for capturing the effects of capital flows of goods and the effects of local political and economic events on the credit qualities of sovereign issuers (Pan and

Singleton, 2006). The exchange rate is expressed as the amount of local currency that can be bought for one US dollar.

#### **5.4.1.2 Global variables**

As US is not included in the sample we are mainly using US related variables to measure global factors impact on the basis. This approach is in line with the study of Longstaff et al. (2010) who finds US Federal Reserve decisions and US economic situation to have a big impact on global scope.

##### **5.4.1.2.1 US Treasury yield**

US Treasury yield reflects the risk free asset as well as potential changes in US economic growth. This variable has been used for example in Longstaff et al. (2010) study.

##### **5.4.1.2.2 US stock market return**

This variable is used to capture the effects of the US business cycle. We have used MSCI US Broad Market index as it represents 99,5% of the capitalization in the US equity market.

##### **5.4.1.2.3 European stock market return**

I will present this variable, MSCI Europe, to capture the business cycle in Europe. This is done to capture the financial crisis implications in Europe. MSCI Europe consists of 16 developed market country indices: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

### 5.4.1.3 Risk Premium variables

These variables are designed to measure the impact of the investors risk appetite as well as systematic risk through counterparty variable. All variables measure different kind of risk.

#### 5.4.1.3.1 VIX

The index of implied volatility of S&P 500 index and it is widely used measure of risk. Variable shows market's expectation of future volatility. Additionally it provides information on the amounts the investors are willing to pay to protect their positions from price volatility. Following the study of Longstaff et al. (2010), which find variable to have high correlation with CDS premia changes, I am including this variable.

#### 5.4.1.3.2 Corporate CDS premium (iTraxx Europe)

This index is added to catch the investors overall appetite for credit risk. iTraxx Europe consists equally weighted, 125 most liquid corporate CDS names of the Europe.

#### 5.4.1.3.3 Counterparty risk

As mentioned before counterparty risk plays a big role in highly concentrated CDS market. Due to the nature of the CDS market I cannot identify the exact counterparties for each CDS contract. This would be difficult even though I would know the original counterparty information as the process of 'netting' in the credit market makes it extremely hard. This is due to for example multiple credit risk transfer. Therefore I am implementing method used by Arce et al. (2012) in their study. I will use the first principal component obtained from the CDS premiums of the main 14 banks which act as dealers on the market<sup>15</sup>. The first principal component series should reflect the common default probability and there for work as

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<sup>15</sup> Main dealers are: Bank of America, Barclays, BNP Paribas, Citigroup, Credit Suisse, Deutsche Bank, Goldman Sachs, HSBC, JP Morgan, Morgan Stanley, Royal Bank of Scotland, Societe Generale, UBS and Wells Fargo (ISDA Research notes, 2010)

measure of counterparty risk<sup>16</sup>. The first principal component of the banks' CDS premia manages to explain 98% of the total variance of the observed variables in the first period. In the second period the first principal component explains 63% of the total variance of the observed variables.

#### **5.4.1.4 Liquidity Variables**

##### **5.4.1.4.1 Bid-ask spread**

As noted many studies find liquidity to have a big impact on spreads (cf. Levy, 2009). To test for the relative liquidity effects I will count the difference of bid and ask prices of CDS in each country. Bigger the CDS spread, less liquid is the market.

Unfortunately due to data availability problems I was able to gather only CDS data which causes the variable to tell only liquidity situation on CDS markets.

For countries Czech Republic, Denmark, Hungary, Ireland, Norway, Poland, Sweden and Turkey, I was not able to obtain the bid and/or ask prices. Thus, I constructed a general bid and ask spread based on all available bid-ask data.

#### **5.4.2. Excluded variables**

I have not included sovereign ratings as to explain variations in CDS premia as Cossin and Hricko (2001) and as Cossin and Jung (2005). Since rating has an impact on bond prices, one can intuitively expect that higher rating would lead to lower CDS premia and vice-versa. This approach is more long-term oriented since the ratings are not adjusted fast enough after the arrival of the information to the market. There for I have excluded this variable.

Remolona et al. (2007) used other macroeconomic variables such as inflation rate, industrial production, CDP growth consensus forecast and foreign exchange reserve. Their results show

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<sup>16</sup> Arora et al. (2009) used dealers' CDS spreads as a proxy for counterparty risk in their study. They study the existence of counterparty risk in the corporate CDS market.

some of the factors to be significant but they have been excluded from the study based on insufficient data.

## 5.5. Price discovery analysis

An efficient price discovery process is result of quick adjustment of the prices to the new information according to Yan and Zivot (2007). Previous studies have looked at the CDS and bond relation from long term and short term perspective. For the long-term relation most of the studies have relayed on Johansen's cointegration method (1995) which is also the foundation for short-term testing with Vector Error Correction Model (VECM). With these methods I will test my fourth and fifth hypothesis of

*Hypothesis 6 (H6): Price discovery takes place in the bond market before the financial crisis.*

*Hypothesis 7 (H7): Price discovery takes place in the CDS market during the financial crisis.*

### 5.5.1. Unit-root and cointegration

For being able to use VECM model, CDS and bond yield spreads have to be tested for non-stationary and cointegration. To test non-stationary feature, I will perform the standard Augmented Dickey-Fuller unit-root test (Dickey and Fuller, 1979) on both CDS and bond yield spreads. The model is constructed as followed.

$$\Delta y_t = \alpha + \beta y_{t-1} + \delta t + \zeta_1 \Delta y_{t-1} + \zeta_2 \Delta y_{t-2} + \dots + \zeta_k \Delta y_{t-k} + \epsilon_t \quad (4)$$

where  $\alpha$  is a constant,  $\beta$  the coefficient on a time trend and k the lag order of the autoregressive process.

For testing long term relationship through cointegration I will perform Johansen's Test for cointegration. As I have only two variables, result can show at most rank one cointegration relationship. Johansen's model is contracted as followed.

$$\Delta Y_t = \alpha\beta'y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + \epsilon_t \quad (5)$$

If two price series are cointegrated, coefficient matrix  $\alpha\beta'$  has reduced rank equal to 1 and there exists 2x1 vectors  $\alpha$  and  $\beta$ , where the vector  $\beta'$  is cointegration vector.

It is important to note though that both of these tests might suffer from structural break interference which might effect on the end result.

### 5.5.2. Vector Error Correlation Model

To investigate the short term relationship between the two markets – previous studies have mainly used two different approaches. One approach is called Granger-causality test which has been employed by for example Delis and Mylonidis (2010) among others. This method requires credit spreads to be integrated of order one and for this reason can be applied to a larger number of days than the more basic Gonzalo and Granger (1995) test. This is due to the absence of the cointegration requirements in the Gonzalo and Granger method.

Another commonly used method is Vertical Error Correlation Model (VECM). It is a linear representation of the stochastic data generation process. Each of the variables in the model is considered endogenous, comprising from two components. First, it is a linear function of the past realized variables in the system and second, an unpredictable innovation component. Following the study of Fontana and Scheicher (2010) among others, I will use the method to the study the short-term relationship.

The VECM is constructed as followed:

$$\Delta CDS_t = c_1 + \lambda_1 (CDS_{t-1} - \alpha - \beta BY S_{t-1}) + \sum_{i=0}^n \gamma_1 \Delta CDS_{t-1} + \sum_{i=0}^n \delta_1 \Delta BY S_{t-1} + \epsilon_{1t} \quad (6)$$

$$\Delta BY S_t = c_2 + \lambda_2 (CDS_{t-1} - \alpha - \beta BY S_{t-1}) + \sum_{i=0}^n \gamma_2 \Delta CDS_{t-1} + \sum_{i=0}^n \delta_2 \Delta BY S_{t-1} + \epsilon_{2t} \quad (7)$$

where  $CDS_t$  refers to CDS premium at a time  $t$  and  $BY S_t$  refers to bonds' yield spread at a time.  $\varepsilon_{1t}$  and  $\varepsilon_{2t}$  refers to i.i.d shocks. Correction terms  $\alpha$  and  $\beta$  refer to cointegration.

If  $\lambda_1$  is negative and significant, it means that the CDS market adjusts to remove the pricing errors. This means price discovery is taken in bond market. If  $\lambda_2$  is significant and positive, it means that cash market adjusts and price discovery is taken in CDS market. If both coefficients are significant and with proper sign, the relative magnitude of the adjustment coefficients determines the relative importance of each market in price discovery.

## 6. Data

In this section I will describe the data used in the study and also rationalize the choice of it in case there exist more than one option for the data which has been commonly used in the studies.

### 6.1.CDS data

The credit default swap data was obtained from Datastream. Datastream gathers the data from Thompson Reuters and Credit Market Analysis (CMA). Original plan was to gather data from 2001 to 2011 but the time scope had to be re-adjusted due to lack of data in Datastream and the young nature of the product. In order to maximize the number of observations and in an effort to attain significant results, I limited the study to countries which had quotes available May 2<sup>nd</sup> 2005 onwards till September 20<sup>th</sup> 2010. This resulted to including 21 countries<sup>17</sup> in the study and excluding 51 countries. The 21 countries included represent Asia, Europe, Africa and Australia. There was neither a country default in my sample during the time period.

The data consist of daily mid quotes of sovereign CDS contracts. I concentrated the study on 5 year maturity and US dollar denominated quotes since they are standard and most traded. All in all I obtained 29 673 observations for the CDS premias in total.

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<sup>17</sup> Countries included in the study: Austria, Australia, Belgium, Czech Republic, Denmark, Germany, Greece, Hong Kong, Indonesia, Ireland, Italy, Japan, Norway, Pakistan, Philippines, Poland, Portugal, Sweden, South Africa, South Korea and Turkey.

## 6.2. Bond data

Bond data is obtained from Bloomberg Terminal. I use 5 year Generic Yield for the respective 21 countries. Market for sovereign bond is mostly illiquid which makes reliable data hard to obtain. Many of the previous studies have conducted interpolation to gather the needed data. This was used for example in the study of Hull et al. (2004). The problem of the method is the difficulty of carrying it out for a long period of time due to the need of bonds with maturity left before and after the required point. In case of this study it would mean data of a bond with maturity left less than five years and a bond with maturity left over five years. In reality the number of bonds outstanding is limited with mixed maturities hence creates the problem of reliability.

Chen- Lau and Kim (2004) used JPMorgan Chase Emerging Market Bond Index Plus as their bond yield reference to overcome the problem. However most commonly used alternative method for linear interpolation has been bond yield curve data provided by trading data collecting parties. This has been done for example by Palladini and Porter (2011) in their study. They used Datastream Market Curve Analysis which was available for nine countries.

For the empirical testing matching maturity of the bond and CDS contracts is important, as the default probability changes as the maturity changes. Due to this I decided to use Bloomberg Terminal's 5 year Generic Yield as bond reference data as it provides more reliable and smoother approximations. Bonds underlying are both in local currencies and in US dollar. This is important to remember as it might impact in the yield through exchange rate risk. Even though the risk, CDS contracts are most commonly written in different currencies than the underlying bond. As an example when credit event occurs in eurozone we might expect euro to depreciate against US dollar. For an investor holding a euro bond and USD nominated protection this will result in windfall profit for euro based hedger. However CDS premias usually adjust to prevent the exploitation of the possible currency depreciations.



### **6.3. Regression's variable data**

#### **6.3.1. Debt to GDP**

Debt to GDP refers to bonds outstanding versus GDP. Data was collected from International Monetary Fund database which reports Debt to GDP ratio on yearly basis.

#### **6.3.2. Exchange rate**

Exchange rate refers to local currency over US dollar. I gathered daily data and it was collected from Datastream.

#### **6.3.3. US Treasury Yield**

US Treasury Yield data was collected from webpage of Board of Governors of Federal Reserve System. Data is collected on daily basis with 5 year maturity.

US Treasury Yield is also used as the risk free rate in this study. This is done as the sample group contains countries all over the world and not just Europe region when German bund rate would have been more appropriate. US Treasury Yield is also seen to have greater liquidity than any other bond (cf. Feldhutter and Land, 2008; Longstaff, 2004), which can be then interpreted as less risky. However it has been argued that the T-bill rate is lower than what the funding costs are for the investor and therefore not appropriate risk-free benchmark. Due to this some studies (cf. Fontana and Scheicher, 2010) use swap rate as a proxy for risk-free. Swap rate is not a frictionless solution either. It has argued to include systematic risk which arises from the financial institutions.

#### **6.3.4 US Stock Market data and European Stock Market data**

To investigate US Stock Market I am using MSCI US which has been collected on daily basis from Datastream.

To catch the effect of European business cycle, I am using European Stock Market data is MSCI Europe which has also been collected on daily basis from Datastream.

#### **6.3.4 VIX and iTraxx**

Data for the both variables have been collected from Datastream on daily basis.

#### **6.3.5 Counterparty**

Data used for counterparty variable is main dealers' CDS mid price data. Data is collected from Bloomberg on daily basis, however, data for all the banks were not available for both periods. For the first period only six banks, Bank of America, Citigroup, Goldman Sachs, JPMorgan Chase, Morgan Stanley and Wells Fargo, were included in the sample. For the second period all of the banks were included in the sample.

#### **6.3.6 Bid-Ask spread**

Data is bid and ask CDS quotes from the sample countries when available<sup>18</sup>. Data is collected from Datastream on daily basis.

### **7. Results and analysis**

In this section I will test and present the results of my hypothesis which are summarized in Table 1 below. I will also further analyze the results and their implications.

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<sup>18</sup> These countries include: Austria, Australia, Belgium, Germany, Greece, Hong Kong, Indonesia, Italy, Japan, Pakistan, Portugal, South Africa and South Korea.

**Table 1. Hypothesis**

<b>Hypothesis</b>	<b>Method used</b>
<i>Hypothesis 1 (H1): Overtime basis does not always equal to zero, therefore there is possibility for arbitrage.</i>	the Basis
<i>Hypothesis 2 (H2): The basis is higher in emerging markets then in the developed markets over time.</i>	the Basis
<i>Hypothesis 3 (H3): The basis move in clusters according to geographical regions, Europe, Asia, Africa and Australia.</i>	Clustering analysis
<i>Hypothesis 4 (H4): US Stock return and US Treasury yield have a significant impact on the basis in majority of the countries.</i>	Multiple regression
<i>Hypothesis 5 (H5): Liquidity variable has a significant impact on the basis in majority of the countries.</i>	Multiple regression
<i>Hypothesis 6 (H6): Price discovery takes place in the bond market before the financial crisis.</i>	Johansen's cointegration and VECM
<i>Hypothesis 7 (H7): Price discovery takes place in the CDS market during the financial crisis.</i>	Johansen's cointegration and VECM

## **7.1. Descriptive analysis**

### **7.1.1 Descriptive statistics of CDS**

Table 2 and 3 show the descriptive statistics of CDS dataset. During the whole maturity CDS premia varied between 3,43 and 1602,56 basis points.

**Table 2. Descriptive Statistics for Sovereign Credit Default Swap Premias.** This table reports summary statistics for daily premias for five-year sovereign CDS contracts from the 2<sup>nd</sup> of May 2005 to the 11<sup>th</sup> of September 2008 period. CDS premias are measured in basis points.

Country	Mean	Standard Deviation	Minimum	Median	Maximum	N
Austria	3,895	3,294	0,5	2,1	13,5	880
Australia	15,698	12,774	2,4	13,8	78,3	880
Belgium	6,429	7,672	1,0	2,5	33,6	880
Czech Republic	13,618	12,698	4,3	7,4	66,2	880
Denmark	10,748	17,977	1,6	5,2	200,6	880
Germany	3,430	2,371	0,6	2,4	13,8	880
Greece	18,503	15,689	4,4	13,3	69,8	880
Hong Kong	15,863	15,135	1,4	10,0	70,0	880
Hungary	48,316	40,415	15,0	31,4	210,7	880
Indonesia	191,398	56,952	91,4	191,4	320,0	880
Ireland	10,262	10,640	1,5	5,2	66,2	880
Italy	15,663	11,550	5,3	10,5	50,1	880
Japan	8,703	6,869	2,0	5,7	56,7	880
Norway	6,738	4,752	1,0	6,0	22,9	880
Pakistan	312,031	175,893	146,2	235,0	1000,0	880
Poland	23,798	17,200	6,8	17,0	97,8	880
Portugal	12,771	11,851	3,4	7,6	49,7	880
Sweden	17,678	20,973	1,0	9,0	160,8	880
South Africa	73,533	51,711	23,8	53,0	230,4	880
South Korea	39,694	28,479	14,0	26,4	139,5	880
Turkey	206,683	52,460	116,9	194,1	351,0	880

Table 2 represent the statistics of the first period. There Pakistan had the biggest average CDS premia with 312,03 basis points. Smallest average premia was at Germany with 3,43 basis points. These countries also had the biggest and smallest standard deviations, Pakistan with 175,89 basis points and Germany with 2,37 basis points. By looking at the average CDS premiums within EU countries, the biggest premium was at Hungary with 48,31 basis points.

On average developed countries have lower average basis premias. European Union countries seem to have lower CDS premias on average compared to other developed countries with the exception of Hungary, Poland and Greece. Within EU region Eastern European countries Poland, Hungary and Czech Republic and South Europe countries Greece and Italy has higher average CDS premias then rest of the Europe excluding Sweden which is almost at the same level as Greece.

**Table 3. Descriptive Statistics for Sovereign Credit Default Swap Premias.** This table reports summary statistics for daily premias for five-year sovereign CDS contracts from the 12<sup>th</sup> of September 2008 to the 30<sup>th</sup> of September 2010. CDS premias are measured in basis points.

Country	Mean	Standard Deviation	Minimum	Median	Maximum	N
Austria	93,786	44,234	12,5	83,9	273,0	534
Australia	63,467	35,476	20,5	50,7	189,4	534
Belgium	74,824	34,847	21,5	63,5	157,8	534
Czech Republic	119,977	60,488	49,0	95,0	350,0	534
Denmark	54,078	32,264	13,5	40,2	147,8	534
Germany	37,226	14,957	8,5	36,2	91,9	534
Greece	331,574	264,658	51,9	235,6	1125,8	534
Hong Kong	71,442	29,315	36,8	58,6	162,1	534
Hungary	317,319	109,658	140,7	314,4	638,4	534
Indonesia	334,576	222,296	140,5	206,9	1256,7	534
Ireland	198,264	80,507	31,2	179,9	489,8	534
Italy	125,969	46,750	41,6	116,4	244,7	534
Japan	62,185	20,543	16,5	64,3	120,7	534
Norway	26,134	11,168	7,5	23,3	65,3	534
Pakistan	1602,560	892,027	473,3	1863,7	5105,7	534
Poland	168,798	71,655	57,3	139,3	417,6	534
Portugal	139,932	98,401	40,5	95,8	461,3	534
Sweden	60,528	31,935	12,0	49,5	160,8	534
South Africa	230,539	119,375	114,2	169,5	683,3	534
South Korea	186,542	117,765	73,3	131,4	700,0	534
Turkey	268,412	123,836	153,8	202,3	849,2	534

In the second period biggest average CDS premia and biggest standard deviation was at Pakistan with 1602,56 basis points and with 892,03 basis points. Smallest average premia was at Norway with 26,1 basis points as well as the smallest standard deviation of 11,16 basis points. Within EU region the biggest average CDS premia was obtained from Greece with 331,57 basis points. This was the third biggest average CDS premium among the sample group.

In the second period developed countries on average had lower average CDS premias and standard deviation. The biggest growth in premias however was seen in Europe where CDS premiums grew on average 103 basis points (excluding Greece) compared to rest of the world where the growth was 95 basis points (excluding Pakistan). Average CDS premias changed the least between first and second periods in Norway, Denmark, Sweden and Germany.

### 7.1.2 Descriptive statistics of Bond Yield Spread

Table 4 and 5 show the descriptive statistics of bond yield over a risk free rate of US Treasury bill. During the whole maturity bond yield spread varied between -3,09 and 10,83 basis points.

**Table 4. Descriptive Statistics for Sovereign Bond Yield Spreads.** This table reports summary statistics for daily spreads for five-year sovereign bond yields over five year US T-bill yields from the 2<sup>nd</sup> of May 2005 to the 11<sup>th</sup> of September 2008 period. Bond yield spreads are measured in basis points.

Country	Mean	Standard Deviation	Minimum	Median	Maximum	N
Austria	-0,467	0,945	-1,59	-0,75	1,52	880
Australia	1,714	0,965	0,48	1,34	4,06	880
Belgium	-0,432	0,960	-1,55	-0,78	1,61	880
Czech Republic	-0,565	1,137	-1,73	-1,13	2,14	880
Denmark	-0,377	1,070	-1,65	-0,79	2,10	880
Germany	-0,497	0,875	-1,52	-0,77	1,37	880
Greece	-0,303	1,000	-1,46	-0,64	1,85	880
Hong Kong	-0,405	0,242	-1,00	-0,40	0,21	880
Hungary	3,126	1,265	1,44	2,71	6,98	880
Indonesia	6,794	1,912	3,42	6,77	11,82	880
Ireland	-0,329	0,980	-1,46	-0,68	1,79	880
Italy	-0,329	0,980	-1,46	-0,68	1,79	880
Japan	-3,094	0,633	-3,89	-3,41	-1,48	880
Norway	-0,022	1,024	-1,26	-0,37	2,26	880
Pakistan	5,846	1,712	4,22	5,14	11,16	880
Poland	1,225	1,176	-0,30	0,65	4,07	880
Portugal	-0,379	0,952	-1,52	-0,71	1,64	880
Sweden	-0,500	0,990	-1,72	-0,84	1,54	880
South Africa	3,936	0,942	2,18	3,74	6,20	880
South Korea	0,957	0,946	-0,22	0,53	3,13	880
Turkey	2,048	0,631	1,09	1,87	3,86	880

In the first period the biggest average bond yield spread was at Indonesia with 6,79 basis points. They also had the biggest standard deviation of 1,91 basis points. Lowest average bond yield spread was at Japan with -3,09 basis points. Lowest standard deviation was at Hong Kong with 0,242 basis points.

On average European bond yield over US Treasury bill are negative which can reflect as bigger trust on European countries with the exceptions of Poland and Hungary. Outside Europe Japan has the only negative yield spread.

**Table 5. Descriptive Statistics for Sovereign Bond Yield Spreads.** This table reports summary statistics for daily spreads for five-year sovereign bond yields over five year US T-bill yields from the 12<sup>th</sup> of September 2008 to the 30<sup>th</sup> of September 2010. Bond yield spreads are measured in basis points.

Country	Mean	Standard Deviation	Minimum	Median	Maximum	N
Austria	0,635	0,562	-0,29	0,39	2,15	534
Australia	2,611	0,459	1,50	2,73	3,69	534
Belgium	0,847	0,564	-0,08	0,70	2,35	534
Czech Republic	1,398	0,623	-0,08	1,30	3,03	534
Denmark	0,803	0,524	-0,09	0,68	2,32	534
Germany	0,123	0,435	-0,63	0,02	1,30	534
Greece	3,732	2,877	0,71	2,95	12,41	534
Hong Kong	-0,446	0,209	-0,96	-0,47	0,18	534
Hungary	6,337	1,808	3,21	5,67	11,17	534
Indonesia	7,874	2,360	5,45	6,84	17,31	534
Ireland	0,992	0,607	-0,08	0,92	2,67	534
Italy	0,992	0,607	-0,08	0,92	2,67	534
Japan	-1,523	0,398	-2,22	-1,63	-0,41	534
Norway	0,862	0,421	0,01	0,83	2,12	534
Pakistan	10,834	1,376	8,83	10,30	14,85	534
Poland	3,471	0,437	2,30	3,43	5,04	534
Portugal	1,375	0,846	0,17	1,28	4,26	534
Sweden	0,284	0,292	-0,29	0,28	1,24	534
South Africa	6,059	0,423	5,10	5,98	7,17	534
South Korea	2,453	0,318	1,71	2,46	3,35	534
Turkey	3,445	1,814	1,42	2,61	11,12	534

In the second period the biggest average bond yield spread was at Pakistan with 10,834 basis points and the lowest at Japan with -1,523 basis points. Biggest standard deviation is at Greece with 2,877 basis points when the smallest standard deviation is at Sweden with 0,292 basis points.

On average the bond yield spread grew compared to US T-bill yield which can be interpret as a shift in the trust or flight to liquidity from mainly Europe to US. Biggest change in spread is at Pakistan and Hungary, but when excluding these the average spread is in EU countries with 1,60 basis points on average compared to rest of the world with 1,15 basis points. Smallest change was at Hong Kong which was the only country which remained with negative spread in the second period.

### 7.1.3 Descriptive statistics of Basis

Tables 6 and 7 show the descriptive statistics of the basis. During the whole maturity the basis varied between 3, 92 to 1591,72 basis points.

**Table 6. Descriptive Statistics for Sovereign Basis.** This table reports summary statistics for daily spreads for five-year CDS premia minus corresponding bond yield over US T-bill of each country from the 2<sup>nd</sup> of May 2005 to the 11<sup>th</sup> of September 2008. Basis is measured in basis points.

Country	Mean	Standard Deviation	Minimum	Median	Maximum	N
Austria	4,362	2,506	1,01	3,32	12,40	880
Australia	13,985	12,450	1,38	11,14	75,18	880
Belgium	6,860	6,850	1,84	3,53	32,46	880
Czech Republic	14,183	11,697	5,40	8,54	64,38	880
Denmark	11,125	18,139	2,35	6,34	201,73	880
Germany	3,927	1,729	0,97	3,42	12,99	880
Greece	18,806	14,929	4,66	14,46	68,15	880
Hong Kong	16,268	15,106	1,81	10,21	70,46	880
Hungary	45,190	39,244	13,07	29,00	203,89	880
Indonesia	184,604	55,310	87,85	184,56	308,74	880
Ireland	10,591	10,005	2,00	6,51	67,64	880
Italy	15,992	10,767	5,65	11,36	48,54	880
Japan	11,797	6,505	5,27	9,05	59,98	880
Norway	6,761	4,432	1,12	6,02	21,16	880
Pakistan	306,185	174,328	141,13	230,04	988,88	880
Poland	22,573	16,236	6,50	16,56	93,73	880
Portugal	13,150	11,053	3,82	8,61	48,35	880
Sweden	18,179	21,013	1,77	8,28	161,33	880
South Africa	69,597	50,937	20,46	49,42	224,20	880
South Korea	38,736	27,674	13,56	25,88	136,60	880
Turkey	204,635	51,921	115,75	192,25	348,01	880

In the first period the biggest average basis was at Pakistan with 306,18 basis points. Pakistan also had the biggest standard deviation of 171, 32 basis points. Lowest average basis was at Germany with 3,92 basis points with the sample group's lowest standard deviation of 1,72 basis points. On average EU countries had lower basis compared to non-EU countries.



**Table 7. Descriptive Statistics for Sovereign Basis.** This table reports summary statistics for daily spreads for five-year CDS premia minus corresponding bond yield over US T-bill of each country from the 12<sup>th</sup> of September 2008 to the 30<sup>th</sup> of September 2010. Basis is measured in basis points.

Country	Mean	Standard Deviation	Minimum	Median	Maximum	N
Austria	93,150	43,910	11,04	83,50	271,71	534
Australia	60,855	35,816	17,56	48,18	187,61	534
Belgium	73,978	34,676	20,04	62,56	156,40	534
Czech Republic	118,579	60,062	48,11	93,95	347,67	534
Denmark	53,275	31,973	11,90	39,51	146,81	534
Germany	37,104	14,926	7,40	36,13	91,61	534
Greece	327,842	261,878	50,09	231,89	1116,92	534
Hong Kong	71,888	29,228	37,45	59,18	162,37	534
Hungary	310,981	108,055	135,46	308,32	627,40	534
Indonesia	326,702	220,075	134,52	200,77	1242,88	534
Ireland	197,273	80,294	29,75	178,24	488,30	534
Italy	124,977	46,467	40,09	115,63	243,50	534
Japan	63,708	20,501	17,98	65,97	121,63	534
Norway	25,273	11,046	5,82	22,43	64,21	534
Pakistan	1591,726	891,367	462,31	1853,43	5094,29	534
Poland	165,326	71,393	54,33	135,85	413,64	534
Portugal	138,557	97,747	38,99	93,99	457,57	534
Sweden	60,245	31,902	11,16	49,42	160,77	534
South Africa	224,480	119,129	107,97	163,67	677,51	534
South Korea	184,089	117,665	71,37	128,88	698,05	534
Turkey	264,968	122,081	151,83	199,78	838,61	534

In the second period the biggest average basis was at Pakistan with 1591,72 basis points with also the biggest standard deviation of 891,36 basis points. Lowest average was at Norway with 25,27 basis points with a standard deviation of 11,04 basis points. This was also the lowest standard deviation of the sample group.

Biggest change between the periods was at Pakistan (1285,54 basis points) and smallest at Norway (18,51 basis points). On average non-EU countries had bigger change (growth of 242, 82 basis points on average) compared to EU countries (growth of 118,07 basis points on average). This reflects basis changes to be more closely related to CDS changes than to bond yield spread changes.

## 7.2. Basis method analysis

Tables 6 and 7 and supported by Figure 8 in appendix show clear deviation from zero in both periods. Finding is in line with previous studies (cf. Levy, 2009; Ammer and Cai, 2011) and

gives us possibility to state a potential arbitrage opportunity in all of the countries in both periods.

Arbitrage opportunity is created through positive basis in both periods in all of the countries. Even though there exists a potential opportunity, it is not automatically used. This is due to high costs of short selling the bond as the repo market is often illiquid for risky bonds (Blanco et al., 2003). On the other hand Adler and Song (2010) find in their study short selling costs to be partly responsible for the constant positive basis which is also seen in this study.

Results also show increase in the basis for all of the respective 21 countries from one period to another one. This can be seen as investors growing belief in default probability. Persistent positive basis is a combination of different factors of which to mention few:

1. According to Ammer and Cai (2011) one of the reasons can be the cheapest to deliver option which gives the protection buyer a chance to deliver the least valuable instrument that is eligible. This often means protection seller ends up with least favorable alternative with least favorable yield. To compensate the risk, protection seller requires higher premia.
2. Aunon-Nerin et al (2002) find that changes in ratings have a significant impact on sovereign CDS premia. Due to this the possible negative rating changes after the financial crisis started, might have increased the basis. Ismailescu and Kazemi (2010) also find evidence of the CDS of investment grade countries to respond mainly to negative credit rating announcements while the spreads of speculative grade countries respond largely to positive announcements. They studied the sovereign CDS spreads of 22 emerging economies from January 2<sup>nd</sup> 2001 to April 22<sup>nd</sup> 2009.
3. Restructuring of debt is a common measure in time of distress and can also increase CDS premia and this way influence on the basis (De Witt, 2006).
4. Investors' view has also influence on the basis. After the financial turmoil started, investors have had negative view of market which might have caused investors to buy more protections as it is seen easier than borrowing a bond for a short sale. Demand

narrows the spreads but the premia is higher as the investors see increased probability of default.

Based on the results:

Hypothesis	Result
<i>Hypothesis 1 (H1): Overtime basis does not always equal to zero, therefore there is possibility for arbitrage.</i>	Accepted for both periods

Table 8 presents the average basis spreads for both emerging market and for developed market. This finding is in line with general assumptions and Gapen et al. (2005) theory of debt volatility influencing pricing.

**Table 8. Average basis per market.** Table presents the average basis spreads in basis points of emerging markets and developed markets in both periods, from 2<sup>nd</sup> of May 2005 to 11<sup>th</sup> of September 2008 and from 12<sup>th</sup> of September 2008 to 30<sup>th</sup> of September 2010. Emerging markets include: Czech Republic, Hungary, Indonesia, Korea, Pakistan, Poland, South Africa, and Turkey. Developed markets include: Austria, Australia, Belgium, Denmark, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Norway, Portugal and Sweden.

Market	1st period	2nd period
Emerging Market	92,82	238,29
Developed Market	12,45	106,67

Based on the results shown in the Table 8.

Hypothesis	Result
<i>Hypothesis 2 (H2): The basis is higher in emerging markets then in the developed markets over time.</i>	Accepted for both periods

### 7.3. Principal component analysis

Table 9 and 10 illustrate the results of principal component analysis where I attempt to isolate a small number of common factors that would explain the correlation patterns. Principal component analysis is conducted on CDS, bond yield spread and on basis data for both periods.

**Table 9. Principal Components Analysis Results.** This table reports summary statistics for the principal components analysis of the correlation matrix of daily sovereign bond, CDS premia and basis changes of each country from the 2<sup>nd</sup> of May 2005 to the 11<sup>th</sup> of September 2008. All observations denotes results based on the correlation matrix computed using all available overlapping observations for each pair-wise correlation.

Principal component	Eigenvalue	Difference	Percentage Explained	Cum, Percentage Explains
CDS - First	12,938	11,022	64,692	64,692
CDS - Second	1,916	0,607	9,581	74,273
CDS - Third	1,309	0,334	6,545	80,818
CDS - Fourth	0,975	0,224	4,874	85,692
Bond Yield Spread - First	16,127	14,538	76,797	76,797
Bond Yield Spread - Second	1,589	0,429	7,566	84,362
Bond Yield Spread - Third	1,160	0,746	5,523	89,885
Bond Yield Spread - Fourth	0,414	0,089	1,973	91,859
Basis - First	13,490	11,606	64,239	64,239
Basis - Second	1,884	0,578	8,971	73,210
Basis - Third	1,306	0,324	6,220	79,430
Basis - Fourth	0,982	0,198	4,678	84,108

The results indicate stronger commonalities in bond yield spreads compared to CDS or basis in the first period. First two components capture over 89% of the variation in the correlation of bond yield spread matrix while in CDS and basis matrix 80% and 79% of variation was captured by first two components.

**Table 10. Principal Components Analysis Results.** This table reports summary statistics for the principal components analysis of the correlation matrix of daily sovereign bond, CDS premia and basis changes of each country from the 12<sup>th</sup> of September 2008 to the 30<sup>th</sup> of September 2010. All observations denotes results based on the correlation matrix computed using all available overlapping observations for each pair-wise correlation.

Principal component	Eigenvalue	Difference	Percentage Explained	Cum, Percentage Explains
CDS - First	13,059	7,747	62,185	62,185
CDS - Second	5,312	4,279	25,295	87,480
CDS - Third	1,033	0,505	4,917	92,397
CDS - Fourth	0,528	0,201	2,513	94,910
Bond Yield Spread - First	10,880	7,777	51,811	51,811
Bond Yield Spread - Second	3,103	1,900	14,775	66,586
Bond Yield Spread - Third	1,203	0,186	5,727	72,313
Bond Yield Spread - Fourth	1,017	0,133	4,845	77,158
Basis - First	12,980	7,622	61,811	61,811
Basis - Second	5,358	4,313	25,516	87,326
Basis - Third	1,045	0,511	4,978	92,305
Basis - Fourth	0,534	0,204	2,543	94,418

When moving from period one to period two, situation changes. In period two CDS and basis correlation matrix capture over 87 % of the variation in the correlation with the first two components while in bond yield spread two components capture only 66 % of the changes in variations. Similar findings of principal component changes was done by Fontana and Scheicher (2010) in their study, when they conducted a study on Euro area relation.

Overall it can be said that over 50% of the variations of the spreads can be explained by one component. Regarding the basis, second component causes over 25% of the variations during the time of distress. This is mainly caused by CDS spread which has also 25% of variations explained by the second component. In time of distress it seems investors to concentrate on following few certain elements instead of just one or in contrary – react to all news.

## 7.4. Clustering analysis

Table 11 reports the results of clustering analysis. In both periods Pakistan is in its own cluster. As a robustness check I tried also with fewer clusters as well as more and the result stayed the same. This means Pakistan's basis to have unique correlation compared to others as the algorithm tries to form groups so that the correlation between the countries in the same group is maximized.

**Table 11. Sovereign Credit Clusters.** This table reports the clusters formed on the basis of the correlation matrix of daily changes in sovereign basis spreads. The pair wise correlations in the correlation matrix are computed using all available overlapping observations for the two sovereigns. Ave. Basis Spread is the average basis value taken over all daily observations for all sovereigns within a cluster and reported in basis points. Ave. Corr. Internal denotes the average correlation among sovereigns within each cluster.

**Period 1 May 2005 - September 2008**

Country	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Countries in Cluster	Austria Australia Belgium Czech Republic Denmark Germany Greece Hong Kong Ireland Italy Japan Norway Poland Portugal Sweden	Hungary South Korea South Africa	Turkey Indonesia	Pakistan
Ave. Basis Spread	12,571	51,175	194,619	306,184
Ave. Corr. Internal	0,505	0,971	0,734	N/A

**Period 2 September 2008 - September 2010**

Country	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Countries in Cluster	Austria Australia Belgium Czech Republic Denmark Germany Hong Kong Ireland Italy Japan Norway Poland Portugal Sweden	Hungary Indonesia South Africa South Korea Turkey	Greece	Pakistan
Ave. Basis Spread	91,728	262,244	327,842	1591,726
Ave. Corr. Internal	0,645	0,941	N/A	N/A

In the first period Indonesia and Turkey had high internal average correlation of 0,734. However, even higher was the average internal correlation in cluster two where Hungary, South Korea and South Africa are located. They had internal average correlation of 0,971. In the second period all of the five countries were located in the same cluster with extremely high internal correlation of 0,941 and also the highest individual average premias of the whole sample group excluding Pakistan. This can be interpreted to mean that the countries are seen to have equally good or bad situation and the news from the market affects them the same way. This leads to the basis to move highly correlated.

In first period cluster one with the most of the countries has an average internal correlation of 0,505. Countries included in the cluster seem to be stable developed countries with low average basis before crisis. In the second period Greece is detached from the group to form a separate cluster. This can be seen as the result of the crisis Greece is facing at the moment and the sensitivity of its basis to variable changes compared to other countries. Although Ireland faced banking crisis, it has not had as big impact on CDS and bond prices as Greece and it has been able to stay in the so called stable group.

In contrary to Longstaff et al. (2008) findings, clusters were not formed according to geographical regions. My sample group's basis seem to be affected more by the credit risk than geographical factors. This assumption can be supported by the move of Greece to its own cluster in the second period.

Based on this:

Hypothesis	Result
<i>Hypothesis 3 (H3): The basis move in clusters according to geographical regions, Europe, Asia, Africa and Australia.</i>	Rejected in both periods

## 7.5. Regression analysis

To examine the factors causing the basis to change I ran multiple regression for each country using nine explanatory variables, with Newey-West standard errors and three lags. I used Newey-West to correct autocorrelation and heteroskedasticity from the residuals. This way OLS estimates are still unbiased but autocorrelation and heteroskedasticity is no longer efficient.

Tables 12 and 13 report the Newey-West *t-statistics* of the corresponding regression variables and the number of observations for each country of the sample group. Significance of one-, five- and ten-percent level is denoted by \*\*\*, \*\* and \*, respectively.

### 7.5.1. Analysis of the first period

In the first period variable VIX is the most significant variable. VIX is significant for 14 countries out of 21. For other variables significance is detected in less than half of the sample group. This finding is in line with the results of principal component analysis which implied one common factor to capture over 60% of the changes.

Deviations of the basis line are big according to  $R^2$  value. On average  $R^2$  is small, below 10 %, besides Hong Kong, Indonesia, South Africa, South Korea and Turkey.



**Table 12. Results of the Regression of the Change of Daily Basis Spreads on the Local Variables, Global Variables, Risk Variables and Liquidity Variable.** This table reports the Newey-West t-statistics of the corresponding regression variables, as well as the R<sup>2</sup> and the number of observations for each country from the 2<sup>nd</sup> of May 2005 to the 11<sup>th</sup> of September 2008. Significance at the one-, five and ten percent level is denoted by \*\*\*, \*\* and \* respectively.

Variable	Local Variables		Global Variables			Risk Variables			Liquidity Variable	R <sup>2</sup>	# obs
	Debt to GDP	Exchange rate	US Treasury Yield	US Stock Market	Europe Stock Market	iTraxx Europe	VIX	Counterparty	Bid-Ask Spread		
Austria	-1,75*	0,44	0,05	-1,12	-2,60***	-1,30	1,38	0,41	2,16**	0,018	879
Australia	-0,62	0,09	-0,10	-1,63*	-1,02	-0,04	-1,92**	-0,09	1,40	0,019	879
Belgium	-0,69	1,97**	2,01**	-0,56	0,94	0,66	2,91***	-0,00	0,79	0,027	879
Czech Republic	-0,48	0,20	-0,07	0,98	-0,61	0,44	2,31**	2,83*	1,02	0,017	879
Denmark	0,24	1,03	1,00	-0,20	1,63*	0,95	-0,48	-0,21	0,42	0,004	879
Germany	-0,39	1,18	0,72	-0,29	-1,88*	-1,10	1,45	0,92	2,50**	0,023	879
Greece	-3,04***	0,38	0,52	-3,39***	-0,58	1,82*	2,04**	1,16	-0,38	0,014	879
Hong Kong	-0,15	0,71	0,07	0,78	0,60	0,58	1,99**	0,28	2,57***	0,328	879
Hungary	0,30	3,08***	-0,44	3,37***	0,11	1,55	2,95***	-1,56	0,96	0,099	879
Indonesia	0,93	5,06***	-5,56***	0,99	1,48	0,39	6,14***	1,40	0,24	0,198	879
Ireland	-2,19**	0,25	1,27	-4,36***	0,96	1,09	0,98	-0,67	-1,08	0,003	879
Italy	0,39	-0,52	1,88*	2,09**	1,79*	2,27**	4,46***	3,59*	-0,44	0,067	879
Japan	-1,89*	0,31	0,90	-2,82***	-0,76	-1,01	1,51	0,80	-0,11	0,010	879
Norway	-0,78	1,47	2,81***	1,20	1,66*	0,40	2,42**	-0,57	-1,47	0,005	879
Pakistan	0,70	1,21	-1,50	1,38	-1,20	0,18	4,30***	0,93	1,70*	0,091	879
Poland	-2,39**	2,36**	-0,04	0,66	0,65	1,62*	2,62	-0,10	0,96	0,088	879
Portugal	0,34	0,63	1,52	1,00	1,90*	2,98***	5,25***	0,99	2,35**	0,085	879
Sweden	-3,31***	-0,66	-0,02	-3,11***	1,74*	1,15	0,29	-1,51	2,18**	0,013	879
South Africa	1,68*	4,70***	-4,12***	3,12***	-1,14	0,07	7,16***	1,31	0,70	0,178	879
South Korea	-0,29	5,36***	-3,55***	0,46	-0,77	0,84	7,65***	1,13	1,63*	0,171	879
Turkey	1,73*	14,39***	-1,62*	0,96	-0,85	-0,53	7,90***	1,48	1,25	0,459	879

The relationship between Debt to GDP and the basis tends to be negative and is significant for eight countries. This is in line with the study of Fontana and Scheicher (2011). However finding is surprising as it means basis grows as the debt decreases. One explanation could be flight to quality phenomenon (Beber et al., 2009). If debt decreases, it means default probability decreases. During non-crisis time flight to quality causes yields to go down on well rated bonds. If CDS premia stays unchanged due to other factors, basis would grow.

Exchange rates tend to have a positive relationship with basis and it is significant for seven countries. Higher basis refers to local currency depreciation. This in line with the results of Longstaff et al. (2010) and Carr and Wu (2006) who studied the relationship between CDS

premia and exchange rates. Currency depreciation is seemed to be linked in credit quality worsening and thus creates higher CDS premia. What is notable is that variable is significant only for non-euro countries referring to stable and strong euro and stable political and economical situation before crisis.

US Treasury yield has both negative and positive relationship with the basis depending on the country and it is significant for seven countries. However countries whose basis is significantly influenced by US Treasury Yield tend to have negative basis. This could be explained by flight to liquidity as US Treasury is seen safer or more liquid than respective countries' bonds. Cossin and Hricko (2001) find in their study lower corporate CDS premia be linked to higher borrowing costs and hence lower credit quality. In sovereigns, positive basis on the other hand, could be explained by higher inflation expectations which could possibly lead to tightening of Federal Reserve's monetary policy. This again would lead to slower economic growth in US and this way also influences other countries.

US Stock Market has also both negative and positive relationship with the basis depending on the country and it is significant for eight countries. Countries whose basis is significantly influenced by US Stock Market tend to have negative relationship. This is in line with the findings of Longstaff et al. (2010). Decreased returns can be seen as a sign of slower economic growth and reflect the uncertainty of the future. Investors may react to this by increasing the CDS premia.

Relationship between the basis and European Stock Market is fairly equally split between positive and negative values and it is significant for seven countries. However as in US Stock Market, countries which are significantly influence by the variable tend to have negative relationship. Variable is significant only to European countries referring investors to assume local impact.

iTraxx has a clear positive relationship with the basis. This means corporate derivative markets and sovereign derivative markets tend to follow each other. Variable is significant only to Portugal, Italy, Greece and Poland.

VIX has a positive relationship with the basis and is significant for 14 countries. This finding is in line with the study of Arce et al. (2012). This tells us that as the fear or uncertainty of the

future grows, the more are the investors willing to pay for credit risk protection. Growing CDS premias and illiquid bond market creates opportunity for growing basis.

Counterparty risk has both positive and negative relationship with the basis. Only two have statistically significant results which are both with positive sign. This is surprising as it means that basis increases as the default risk increases. Probability of default is linked to the counterparties' CDS premias. This means that dealer would still be able to charge the same or even higher premia from sold CDS contract even though the counterparty's own default risk increases. This could refer market to overlook the counterparty risk posed before the crisis.

Bid-Ask Spread of CDS market has a positive relationship with the basis and is significant in seven countries. Higher bid-ask spread implies a less liquid CDS market and this way can drive basis up. This is in line with the study of Levy (2009) who finds strong support of illiquidity of CDS contracts to the rising CDS premias in the emerging markets.

When reflecting the regression results to cluster analysis results, there can be see one trend. Countries in cluster two and three are significantly influenced by variables VIX and exchanger rate. This might refer to investors views of seeing these countries risky which is already shown in high basis. Exchange risk might be reflecting the instability of political and economical factors. For cluster four, Pakistan, liquidity and VIX are significantly influenced.

### **7.5.2. Analysis of the second period**

In the second period most significant variable is Exchange rate followed by US Treasury Yield, Europe Stock Market and Bid-Ask Spread. Exchange rate is significant for 18 countries out of 21, followed by US Treasury Yield to be significant for 17 countries out of 21. Principal component analysis results showed two components to explain over 87 % of the variation.

In second period  $R^2$  value grows throughout the sample group. However the value is not very high as it remains between 9% and 53%.

**Table 13. Results of the Regression of the Change of Daily Basis Spreads on the Local Variables, Global Variables, Risk Variables and Liquidity Variable.** This table reports the Newey-West t-statistics of the corresponding regression variables, as well as the R<sup>2</sup> and the number of observations for each country from the 12<sup>th</sup> of September 2008 to the 30<sup>th</sup> of September 2010. Significance at the one-, five and ten percent level is denoted by \*\*\*, \*\* and \* respectively.

Variable	Local Variables		Global Variables			Risk Variables			Liquidity Variable	R <sup>2</sup>	# obs
	Debt to GDP	Exchange rate	US Treasury Yield	US Stock Market	Europe Stock Market	iTraxx Europe	VIX	Counterparty	Bid-Ask Spread		
Austria	-0,51	5,02***	-4,45***	-1,36	-4,33***	1,02	-2,80***	- 0,68	3,47***	0,270	534
Australia	-1,05	2,30**	-0,34	0,15	-1,82*	2,64***	-0,20	- 0,95	1,59	0,187	534
Belgium	-0,75	4,62***	-4,76***	-1,88	-2,20**	0,39	-1,16	- 0,07	1,50	0,183	534
Czech Republic	-0,34	5,56***	-3,83***	-1,24	-2,10**	0,63	-3,13***	-0,08	2,74***	0,259	534
Denmark	-1,06	4,34***	-2,89***	-2,15	-2,57**	-0,09	-1,44	- 0,45	4,29***	0,218	534
Germany	0,91	3,65***	-1,80*	-4,22***	-2,49**	-0,79	-0,67	0,52	2,99***	0,193	534
Greece	-0,58	4,78***	-3,75***	-2,07**	-2,63***	-0,83	-0,78	- 0,64	3,00***	0,134	534
Hong Kong	0,26	0,80	-1,33	-1,59*	-0,67	1,33	1,87*	- 0,89	-0,66	0,118	534
Hungary	3,02***	6,55***	-4,81***	-2,40**	-1,02	-0,36	-1,37	1,78	1,30	0,390	534
Indonesia	-1,11	2,85***	-5,49***	-1,68*	-1,08	0,62	-2,69***	- 0,26	3,99***	0,434	534
Ireland	-0,91	3,43***	-1,61*	-2,40**	-3,48***	0,31	-2,28**	- 0,74	0,31	0,172	534
Italy	0,29	5,86***	-4,10***	-1,81*	-3,23***	0,21	-1,87*	- 0,99	3,43***	0,226	534
Japan	-1,28	-1,04	-0,73	-0,58	-3,23***	0,55	0,13	0,26	2,19**	0,209	534
Norway	-0,80	2,57***	-1,46	-1,00	-1,87*	0,30	-1,23	0,50	1,30	0,082	534
Pakistan	-0,96	1,04	-2,68***	-0,67	0,10	0,19	1,71**	- 0,16	1,24	0,094	534
Poland	-0,95	8,78***	-4,83***	-1,04	-3,02***	-0,55	-2,11**	- 0,09	2,14**	0,368	534
Portugal	-0,28	5,03***	-3,71***	-1,91**	-3,48***	-0,47	-1,53	- 0,01	4,75***	0,176	534
Sweden	-0,87	4,56***	-3,40***	-1,26	-3,58***	1,91*	-1,98**	0,44	2,66***	0,220	534
South Africa	1,49	7,59***	-5,23***	-2,49**	-1,83*	0,27	-2,10**	-0,82	3,48***	0,398	534
South Korea	1,41	7,15***	-5,14***	-1,07	-0,62	1,07	-1,30	- 0,32	4,71***	0,383	534
Turkey	2,27**	11,43***	-5,01***	-2,00**	-1,35	0,63	-2,70***	1,03	2,59***	0,534	534

Debt to GDP has negative relationship with the basis in the second period as well. However the variable is significant only in two countries, in Hungary and Turkey which both have positive relationship with the basis. This means as the debt increases, the basis increases as well reflecting default probability to be priced in the premias.

Exchange rate has again positive relationship with the basis. Variable is significant in 18 countries out of 21 and includes all European countries. This could refer to the arising concerns over economical stability in the respective countries. Only Hong Kong, Japan and Pakistan did not have exchange rate as significant variable.

US Treasury Yield has clear negative relationship with the basis in the second period. Variable is also significant in 17 countries which could refer liquidity to move to US bonds from other bonds as US is seen to be one of the most liquid bonds and thus driving the yield down of the US Treasury Yield. This can also create problems in repo markets and grow the costs of short selling. This could limit the possible arbitrage opportunities even though the positive basis has increased since the first period.

US Stock market has a negative relationship with the basis. However variable is only significant to 10 countries which is less than what Longstaff et al. (2010) study finds. They concluded US Markets to have big influence on CDS premias changes in most of the countries in the sample group. This could be interpreted as slow economic growth after crisis has an influence on the basis.

European Stock Market has a negative relationship with the basis in the second period. Variable is also significant for 15 out of 21 countries which is a clear change from the first period. This can indicate investors worry over Europe's economy and its influence on the global scope.

iTraxx has positive relationship with the basis in the second period as well, but significant only for Australia and Sweden.

In the second period VIX variable surprisingly changes from having positive relationship to having a negative relationship with the basis. Change of the sign of the basis when entering the period of the distress was also the finding of Arce et al. (2012). This would refer the volatility in the stock market to decrease while default probability of sovereigns grow. This could be caused by two opposite views – future is seen negatively and hopes of growth stay low keeping volatility low or governments are seen to help through financial packages while it deteriorates governments' budgets. The significance of the variable also decreased to 11 countries in the second period.

In the second period counterparty risk has a negative relationship with basis which is in line with the findings of Arce et al. (2012) and Arora et al. (2010), however surprisingly the variable is not significant in any country. This could reflect investors to recognize the counterparty risk but not as much to have a significant impact. Question relays also on how

much financial rescue packages to financial institutions during the crisis have impacted on banks' CDS premiums by lowering them and thus keeping counterparty risk under control. Negative relationship refers dealer's default probability to increase, while the CDS premiums' charged by the dealer are reduced. This then reflects on basis through narrowing it as the default probability grows.

Bid-Ask Spread variable has positive relationship with the basis also in the second period. However there is a clear change in significance. Variable is now significant in 15 countries out of 21. This is in line with Levy (2009) study among others. This could indicate investors to follow more closely to the liquidity of the markets and also this way effect on price discovery place.

By looking at the cluster analysis, the cluster separation cannot be explained through regression. All of the clusters have the same most significant variables.

Out of nine variables, US related variables represent two of them. In the first period the most significant variable was risk variable VIX and in the second period most significant variable is exchange rate. Both of the US variables were not significant for most of the countries in the sample group in the first period but US Treasury Yield variable was second significant variable in the second period with 17 countries out of 21. However US Stock Market was significant only for 10 countries also in the second period. Based on these results I can reject my fourth hypothesis of US Treasury Yield or US Stock Market having significant impact on the basis in majority of the countries in the first period, but cannot completely reject or accept in the second period.

Liquidity variable was significant only for seven countries in the first period. Significance grew for the second period and it was significant for 14 countries. Based on this I will reject my fifth hypothesis in the first period but accept in the second period.

<b>Hypothesis</b>	<b>Result</b>
<i>Hypothesis 4 (H4): US Stock return and US Treasury yield have a significant impact on the basis in majority of the countries.</i>	Rejected in the first period but undetermined in the second.
<i>Hypothesis 5 (H5): Liquidity variable has a significant impact on the basis in majority of the countries.</i>	Rejected in the first period, but accepted in the second period.

## **7.6. Price discovery analysis**

### **7.6.1. Analysis of Unit root and Cointegration**

Price discovery process testing is done in three steps. First I conducted Augmented Dickey-Fuller Unit Root Test for both CDS premias as well as bond yield spreads. As results show in the Table 14, I cannot reject the null hypothesis of a unit root at 5% level. This means time series of both variables in all countries show clear signs of stationary and are all statistically significant.

Next I conduct Johansen's Test for cointegration to examine the long term relationship of CDS premias and bond yield spreads. Results are shown in the Table 13. Results show clear cointegration rank of one in all of the countries for both periods. This contradicts the results of Fontana and Scheicher (2010) who find cointegration during crisis but not in the period before. Our results indicate that even though they can deviate from the equilibrium for short period of time, they will return back in to it in the long run.

**Table 14. Results of Augmented Dickey-Fuller test and Johansen's Test for Cointegration for CDS and bond yield spread relationship.** Dickey-Fuller columns presents the result of Augmented Dickey-Fuller test, where null hypothesis of stationary time series at 5% level is indicated by \*. Trace test presents the results of Johansen's Test for Cointegration. Rejection of null hypothesis of Zero Cointegration Vectors is indicated by \*.

**Period 1 May 2005 - September 2008**

Country	Dickey-Fuller CDS	Dickey-Fuller Bond	Trace Test
Austria	-21,24*	-16,68*	834,2*
Australia	-19,80*	-16,95*	840,16*
Belgium	-22,01*	-16,68*	893,16*
Czech Republic	-19,49*	-14,75*	732,14*
Denmark	-17,45*	-16,31*	704,11*
Germany	-20,98*	-16,54*	874,51*
Greece	-18,43*	-16,73*	728,20*
Hong Kong	-17,93*	-15,26*	713,55*
Hungary	-15,45*	-15,65*	680,45*
Indonesia	-15,90*	-16,20*	644,12*
Ireland	-18,06*	-17,05*	739,53*
Italy	-19,28*	-17,05*	743,94*
Japan	-20,99*	-17,07*	856,05*
Norway	-17,60*	-17,85*	727,90*
Pakistan	-17,27*	-15,35*	795,51*
Poland	-16,36*	-16,87*	668,81*
Portugal	-20,27*	-16,83*	774,72*
Sweden	-16,32*	-16,38*	712,07*
South Africa	-14,97*	-17,39*	711,58*
South Korea	-14,90*	-17,19*	712,23*
Turkey	-16,52*	-14,62*	634,91*

**Period 2 September 2008 - September 2010**

Country	Dickey-Fuller CDS	Dickey-Fuller Bond	Trace Test
Austria	-11,53*	-14,28*	413,17*
Australia	-13,10*	-13,50*	414,80*
Belgium	-12,40*	-12,98*	385,07*
Czech Republic	-12,24*	-13,57*	448,23*
Denmark	-11,69*	-13,34*	428,78*
Germany	-11,63*	-14,26*	414, 62*
Greece	-12,76*	-13,49*	393,67*
Hong Kong	-13,02*	-12,92*	435,77*
Hungary	-11,72*	-12,16*	343,59*
Indonesia	-12,25*	-12,66*	486,29*
Ireland	-12,45*	-15,15*	422,83*
Italy	-12,94*	-15,15*	434,66*
Japan	-12,09*	-13,38*	420,16*
Norway	-13,98*	-14,14*	433,27*
Pakistan	-14,57*	-9,99*	360,26*
Poland	-12,08*	-11,93*	390,34*
Portugal	-12,21*	-14,52*	413,73*
Sweden	-10,84*	-12,99*	380,92*
South Africa	-12,41*	-12,94*	395,18*
South Korea	-12,06*	-12,34*	432,73*
Turkey	-12,58*	-11,57*	497,90*



### 7.6.2. Analysis of Lead-lag relationship

Stationary and cointegrated results gives me the possibility of running VECM for both periods for all of the countries. VECM gives me more information about the short term relationship between the CDS market and the bond market. Results can be seen in the table 15 and 16.

**Table 15. Results of VECM test for CDS and bond yield spread relationship.** Lambda 1 ( $\lambda_1$ ) and Lambda 2 ( $\lambda_2$ ) refers to coefficients of the results for each country from the 2<sup>nd</sup> of May 2005 to the 11<sup>th</sup> of September 2008. Significance at the five percent level is denoted by \* respectively. If  $\lambda_1$  is negative and significant, it means that the CDS market adjusts to remove the pricing errors. This means price discovery is taken in bond market. If  $\lambda_2$  is significant and positive, it means that cash market adjusts and price discovery is taken in CDS market. If both coefficients are significant and with proper sign, the relative magnitude of the adjustment coefficients determines the relative importance of each market in price discovery.

Country	Lamda 1	Lamda 2	Price discovery market
Austria	-1,443*	0,002	<b>Bond</b>
Australia	-1,313*	0,002	<b>Bond</b>
Belgium	-1,595*	-0,017	<b>Bond</b>
Czech Republic	-1,281*	0,002	<b>Bond</b>
Denmark	-0,942*	0,001*	<b>Both</b>
Germany	-1,527*	0,004	<b>Bond</b>
Greece	-1,115*	-0,072*	<b>Bond</b>
Hong Kong	-1,082*	0,021	<b>Bond</b>
Hungary	-0,498*	0,099*	<b>Both</b>
Indonesia	-0,330*	0,194*	<b>Both</b>
Ireland	-1,026*	0,002*	<b>Both</b>
Italy	-1,178*	-0,214	<b>Bond</b>
Japan	-1,386*	0,031*	<b>Both</b>
Norway	-0,005	0,007*	<b>CDS</b>
Pakistan	-1,025*	-0,008	<b>Bond</b>
Poland	0,001	0,008*	<b>CDS</b>
Portugal	-1,296*	-0,057*	<b>Bond</b>
Sweden	-0,123*	-0,001*	<b>Bond</b>
South Africa	-0,008	0,024*	<b>CDS</b>
South Korea	-0,067*	0,065*	<b>Bond</b>
Turkey	-0,904*	0,071*	<b>Both</b>

In the first period in only three of the countries price discovery takes place in the derivative markets. These were Norway, Poland and South Africa. According to Fontana and Scheicher's (2010) idea of price discovery taking place in the market where investors trade the most refers bond market to be illiquid compared to CDS market in these three countries, although this cannot be confirmed by regression results. Bond market result is not significant either referring to CDS market to receive information first and move first while bond market adjust afterwards.

In six of the countries lead-lag relationship cannot be able to determine. Both of the markets have statistically significant coefficients referring to receiving information and absorbing it in both markets. What is common to these six countries according to regression results was the significance of liquidity variable. This could refer that both markets receive the information at the same time but the price discovery place changes depending on where the liquidity is greater for the time being. This would be in line with the study of Levy (2009).

In twelve countries, which is majority of my sample group, price discovery takes place in the bond market. When looking at the regression results of liquidity variable, all of the countries with bond market as price discovery location, have strong positive relationship with the basis and 7 of them are significant. This could refer the CDS markets to be illiquid and therefore move the price discovery to the bond market.

Clusters do not define or explain in which market the price discovery takes place. For example cluster 2 includes Hungary which has price discovery in CDS market, South Africa where bond market leads and South Korea where price discovery is undetermined. This confirms previous studies which state price discovery to be country depended.

**Table 16. Results of VECM test for CDS and bond yield spread relationship.** Lambda 1 ( $\lambda_1$ ) and Lambda 2 ( $\lambda_2$ ) refers to coefficients of the results for each country from the 12<sup>th</sup> of September 2008 to the 30<sup>th</sup> of September 2010. Significance at the five percent level is denoted by \* respectively. If  $\lambda_1$  is negative and significant, it means that the CDS market adjusts to remove the pricing errors. This means price discovery is taken in bond market. If  $\lambda_2$  is significant and positive, it means that cash market adjusts and price discovery is taken in CDS market. If both coefficients are significant and with proper sign, the relative magnitude of the adjustment coefficients determines the relative importance of each market in price discovery.

Country	Lamda 1	Lamda 2	Price discovery market
Austria	-0,087*	-0,074*	<b>Bond</b>
Australia	-0,453*	-0,143*	<b>Bond</b>
Belgium	-0,772*	-1,090*	<b>Bond</b>
Czech Republic	-0,053	0,094*	<b>CDS</b>
Denmark	-0,240*	0,027*	<b>Both</b>
Germany	0,018	-0,041*	<b>CDS</b>
Greece	-0,158*	-0,117*	<b>Bond</b>
Hong Kong	-0,674*	0,320*	<b>Both</b>
Hungary	-0,125	0,176*	<b>CDS</b>
Indonesia	-0,306*	0,289*	<b>Both</b>
Ireland	-0,126*	-0,063*	<b>Bond</b>
Italy	-0,122*	-0,064*	<b>Bond</b>
Japan	-1,157*	0,058	<b>Bond</b>
Norway	-0,396*	-0,160*	<b>Bond</b>
Pakistan	-1,102*	0,008	<b>Bond</b>
Poland	-0,559*	0,069*	<b>Both</b>
Portugal	0,027*	0,024*	<b>CDS</b>
Sweden	-0,028	-0,153*	<b>CDS</b>
South Africa	-0,196*	-0,037*	<b>Bond</b>
South Korea	-0,384*	0,106*	<b>Both</b>
Turkey	-0,776*	0,508*	<b>Both</b>

In the second period five of the countries in my sample group have CDS market as price discovery location. All of the five countries are different then in the first period, meaning price discovery place has changed during the time of distress. In the first period, these five countries had bond market as price discovery place. By looking at the regression results, most of these five countries changed from not having significant impact on the basis from exchange rate, US Treasury Yield, US Stock market and Bid-Ask liquidity to having a significant impact. All of the five countries are also located in Europe. Exchange rate can be referring to instability in the countries which might drive the price discovery to the CDS market. At the same time liquidity is moving to US from respective countries, which also favors CDS market, even though the CDS market liquidity variable showed CDS market to be illiquid.

In the second period, in six countries the place for price discovery is undetermined and have statistically significant coefficients in both markets. From these countries Turkey, Indonesia

and Denmark remains with the same status from period 1 to period 2. South Korea and Hong Kong changed from price discovery place of bond market to undetermined and Poland from CDS market to undetermined. According to the regression results liquidity variable has a significant impact on the basis in five of the countries with undetermined price discovery place.

This leaves me with 10 countries out of 21 to have price discovery in the bond market. Difference between the periods with bond market as primary price discovery place, is the significance of the coefficients. In the second period, even though price discovery takes place in the bond market, CDS market also is significant.

In second period cluster 2 includes high basis countries which have bond or undetermined market as price discovery place. All of these countries have also positive and sig. liquidity factor in reg.

Based on the empirical findings.

<b>Hypothesis</b>	<b>Result</b>
<i>Hypothesis 4 (H4): Price discovery takes place in the bond market before the financial crisis.</i>	Accepted
<i>Hypothesis 5 (H5): Price discovery takes place in the CDS market during the financial crisis.</i>	Rejected

As final note, market might not have the same participants as the nature of the product is different and it is traded for different reason. This also gives the assumption that the market does not share the same information which the non-zero basis might indicate. This could be also the reason for the short-term pricing differences.

## **8. Conclusion**

Collapse of Lehman Brothers created a domino effect, where financial institutions have had to turn to their governments for help. Too big to fail has been the mantra of the day. Governments have issued financial rescue packages with the cost of the public economy.

Earlier safe-haven statuses have been questioned by investors and not without a reason. Greece, Portugal and lately Spain have had to turn to International Monetary Fund and European Union for help to overcome the economic problems. As sovereign CDS contracts are mainly triggered by restructuring or late payments the protections bought might come in use nowadays.

Studies on sovereign CDS market has grown substantially after the crisis began. Most of the studies have concentrated on specific market – emerging or developed, while trying to resolve the driving force of the CDS changes. All of the studies have also studied the basis, so called arbitrage opportunity measure, but have focused then more on the CDS premia itself. In this study I concentrated on studying the fundamentals of the basis and determinants of the basis changes geographically and time wise. This was done to see what changes and where they happened after the crisis began and could the reason for it be founded as well. To conclude the study I also tried to look for evidence of the price discovery place in each country.

The basis measure showed a potential opportunity for arbitrage through constant positive basis although seldom used. What causes the constant positive basis was undetermined though. Adler and Song (2010) argued it to be due to short selling costs. Principal component analysis showed basis changes to be mainly due to one or two factors, which was partly supported by regression results. By looking at the regression results before crisis, risk appetite seemed to be the factor driving the basis changes and when entering time of distress economical and political instability and liquidity of markets seemed to have the biggest impact on the basis changes. Also Europe's distress in second period could be seen through European Stock Market variable which becomes significant for most of the countries. Findings of liquidity and global variables to have an impact on basis is in line with previous studies.

As the last part I studied the price discovery location. Before the crisis lead-lag relationship was clearer by stating bond market to be the market where price discovery takes place. This is also in line with Fontana and Scheicher's (2010) argument of price discovery taking place in the market with the highest liquidity. Before the crises volumes of CDS trading on developed market countries was low which could explain the finding. After the Lehman Brothers collapsed, the price discovery becomes country depended and weakly could be tied to the liquidity situation of the markets.

When examining the basis geographically wise, cluster analysis show basis to follow theoretical models. In the model CDS premias are argued to be influenced mostly by debt and the volatility of it which can be seen through the basis levels. This resulted in clusters based on basis levels and economical uncertainty. Even though it follows theoretical framework it contradicts earlier findings of regional clustering (Longstaff et al., 2008).

Even though the subject is studied widely after the crisis, there is still lot of questions unanswered. Further studies are still needed to examine for example the reasons for widely documented constant positive basis and what are the driving forces for price discovery locations. However the difficulty of the research arises from for example the OTC nature of the product and illiquidity of sovereign bond market which limits also the possibility of obtaining reliable data.

## **References**

### **Literature**

Adler, M. and Song, J. (2010). The behavior of emerging market sovereigns' credit default swap premiums and bond yield spreads, *International Journal of Finance & Economics* 15(1,) p.31-58.

Ammer, J. and Cai, F. (2011) Sovereign CDS and Bond Pricing Dynamics in Emerging Markets: Does the Cheapest-to-Deliver Option Matter?, *Journal of International Financial Markets, Institutions and Money*, vol. 21, no. 3, pp. 369-387

Andritzky, J. and Singh, M. (2007) The Pricing of Credit Default Swaps during distress, *Journal of Investment Management* 5(4), p. 1-17.

Arce, O., Mayordomo, S. and Pena, J. I. (2012). Credit-Risk Valuation in the Sovereign CDS and Bonds Markets: Evidence from the Euro Area Crisis, Working Paper . Retrieved March 31, 2011 from [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1896297](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1896297)

- Arora, N., Gandhi, P. and Longsta, F. A. (2012). Counterparty credit risk and the credit default swap market, *Journal of Financial Economics* 103(2): 280- 293.
- Aunon-Nerin, D., Cossin, D., Hricko, T., and Z. Huang (2002) Exploring for the Determinants of Credit Risk in Credit Default Swap Transaction Data: Is Fixed Income Markets' Information Sufficient to Evaluate Credit Risk?, *FAME Research Paper No 65*, Retrieved June 11, 2012 from [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=375563](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=375563)
- Bai, J. and P. Collin-Dufresne, (2010). The Determinants of the CDS-Bond Basis During the Financial Crisis of 2007-2009, Working Paper, Retrieved March 31, 2011 from [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2024531](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2024531)
- Beber, A., Brandt M.W. and Kavavejc K. A. (2009) Flight-to-Quality or Flight-to-Liquidity? Evidence from the Euro-Area Bond Market. *Review of Financial Studies* 22, 925 - 957.
- Bernanke, B.S., 2009. Testimony before the Committee on Financial Services, *American International Group*, U.S. House of Representatives, Washington, D.C., 24 March 2009-08-28.
- Blanco, R., Brennan, S., Marsh, I. W., (2005) An Empirical Analysis of the Dynamic Relationship between Investment Grade Bonds and Credit Default Swaps, *Journal of Finance* 60, 2255-2281.
- Bowe, M., Klimaviciene, A., and Taylor, A. P. (2009) Information Transmission and Price Discovery in Emerging Sovereign Credit Risk Markets, Working Paper. Retrieved March 30, 2011 from <https://www.escholar.manchester.ac.uk/uk-ac-man-scw:2b449>
- Calice, G., Chen, J. and Williams, J. M. (2011). Liquidity spillovers in sovereign bond and cds markets: An analysis of the eurozone sovereign debt crisis, Working Paper, Retrieved May 20, 2012 from [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1898596](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1898596)
- Carr, P. and Wu, L. (2006) Theory and Evidence on the Dynamic Interaction Between Sovereign Credit Default Swaps and Currency Options, *Journal of Banking and Finance*, 2007, 31(8), 2383-2403.

Chan-Lau, J.A. and Kim, Y.S. (2004) Equity Prices, Credit Default Swaps and Bond Spreads in Emerging Markets, *IMF Working Paper No. WP/04/27*, International Monetary Fund.

Chen, L., Lesmond D., and Wei, J. (2007). Corporate yield spreads and bond liquidity. *The Journal of Finance* 62 (1), 119-149.

Cossin, D. and Hricko, T. (2001) Exploring for the determinants of credit risk in credit default swap transaction data, Working Paper. Retrieved March 31, 2011 from [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=273454](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=273454)

Cossin, D. and Jung, G. (2005). Do major financial crises provide information on sovereign risk to the rest of the world? A look at credit default swap markets, *FAME Research Paper No.134*.

De Wit, J. (2006), Exploring the CDS-Bond Basis, *Working paper research n° 104 November 2006*, National Bank of Belgium.

Delatte, A. L., Gex, M., and Lopez-Villavicencio, A. (2010) Has the CDS Market Amplified the European Sovereign Crises? A Non-Linear Approach, Working Paper. Retrieved April 15, 2011 from [http://www.southwesternfinance.org/conf-2011/swfa2011\\_submission\\_137.pdf](http://www.southwesternfinance.org/conf-2011/swfa2011_submission_137.pdf)

Delatte, A.L., Gex, M. and Lopez-Villavicencio, A. (2012) Has the CDS market influenced the borrowing cost of European countries during the sovereign crisis?, *Journal of International Money and Finance*, Vol. 31, Issue 3, p. 481-497.

Delis, M. D. and Mylonidis, N. (2010). The Chicken or the Egg? A Note on the Dynamic Interrelation between Government Bond Spreads and Credit Default Swaps, *Finance Research Letters*, 8, pp. 163-170.

Dickey, D.A. and W.A. Fuller (1979), Distribution of the Estimators for Autoregressive Time Series with a Unit Root, *Journal of the American Statistical Association*, 74, p. 427-431



- Dieckmann, S. and Plank, T. (2011). Default risk of advanced economies: An empirical analysis of credit default swaps during the financial crisis, *Review of Finance*, Oxford Journals
- Duffie, D. (1999) Credit Swap Valuation, *Financial Analysts Journal* 55, 73-87.
- Ejsing, J. and Lemke, W. (2010) The Janus-Headed Salvation: Sovereign and Bank Credit Risk Premia during 2008-2009, *Economics Letters*, 110(1), 28-31.
- Ericsson, J., Jacobs, K., Oviedo, R. (2009). The determinants of credit default swap premia. *Journal of Financial and Quantitative Analysis*, vol. 44, no. 1, pp. 109-132.
- Feldhutter, P. and Lando, D. (2008). Decomposing Swap Spreads, *Journal of Financial Economics*, 88, p. 375-405.
- Foley-Fisher, N. (2010), Explaining sovereign bond-CDS arbitrage violations during the financial crisis 2008-09, Working Paper No 26, London School of Economics. Retrieved March 31, 2011 from [http://www.webmeets.com/files/papers/SAEE/2010/482/JMP\\_Nathan\\_Foley\\_Fisher.pdf](http://www.webmeets.com/files/papers/SAEE/2010/482/JMP_Nathan_Foley_Fisher.pdf)
- Fontana, A. and Scheicher M. (2010) An Analysis of Euro Area Sovereign CDS and their Relation with Government Bonds, *European Central Bank*, Working Paper.
- Gapen, M T, D F Gray, C H Lim and Y B Xiao (2005) Measuring and analyzing sovereign risk with contingent claims, *IMF Working Paper 155*, International Monetary Fund.
- Gonzalo, J., and C. Granger (1995) Estimation of common long-memory components in cointegrated systems, *Journal of Business and Economic Statistics* 13, 27–35.
- Haas, P. (2003), CDS Preiseinflussfaktoren, *Bank-Forum*, June 2003, No 31
- Hartmann, P., Straetmans, S. and Vries, C.G. (2004) Asset Market Linkages in Crisis Periods. *Review of Economics and Statistics*, 86(l) :313-326.

- Hasbrouck, J. (1995) One security, many markets: Determining the contributions to price discovery, *Journal of Finance* 50, 1175-1199.
- Hatchondo, J. C., Martinez, L. and Saprizo, H. (2007) The Economics of Sovereign Defaults, *Federal Reserve Bank of Richmond Economic Quarterly*, vol. 93, no. 2, pp. 163-187.
- Haugh D., Ollivaud, P. and Turner, D. (2009) What Drives Sovereign Risk Premiums?: An Analysis of Recent Evidence from the Euro Area. *OECD Working Paper 718*.
- Helwege, J., Maurer, S., Sarkar, A., and Wang, Y., (2009) Credit Default Swap Auctions, *Federal Reserve Bank of New York Staff Reports 372*, May 2009.
- Hilscher, J., Pollet, J., and Wilson, M.m (2011) Uninformed and Inattentive Traders in Credit Default Swap Markets, Working Paper, Oxford University. Retrieved June 11, 2012 from
- Hull, J., Predescu, M., and White, A. (2004) The Relationship Between Credit Default Swap Spreads, Bond Yields and Credit Rating Announcements, *Journal of Banking and Finance*, 28, 2789-2811
- Ismailescu, I. and Kazemi, H. (2010). The reaction of emerging market credit default swap spreads to sovereign credit rating changes, *Journal of Banking and Finance* 34(12): 2861-2873.
- Johansen, S. (1991) Estimation and hypothesis testing of co-integration vectors in Gaussian vector autoregressive models, *Econometrica* 59, 1551-1580.
- Küçük, U. N. (2010) Non-Default Component of Sovereign Emerging Market Yield Spreads and its Determinants: Evidence from Credit Default Swap Market, *Journal of Fixed Income* 19, 44-66.
- Levy, A. (2009) The CDS-Bond Basis Spread in Emerging Markets: Liquidity and Counterparty Risk, Working Paper. Retrieved March 31, 2011 from [http://econ.haifa.ac.il/~todd/seminars/papers08-09/CDS%20Paper%20\(draft\).pdf](http://econ.haifa.ac.il/~todd/seminars/papers08-09/CDS%20Paper%20(draft).pdf)

Longstaff, F. A., Mithal, S. and Neis, E. (2005) Corporate Yield Spreads: Default Risk and Liquidity? New Evidence from the Credit Default Swap Market, *Journal of Finance* 60, 2213-2253.

Longstaff, F. A., Pan, J., Pedersen, L. H. and Singleton, K. J. (2007). How sovereign is sovereign credit risk?, NBER Working Paper No. 13658, Issued in December 2007. Retrieved March 31, 2011 from <http://www.nber.org/papers/w13658>

Longsta, F. A., Pan, J., Pedersen, L. H. and Singleton, K. J. (2010). How sovereign is sovereign credit risk?, *American Economic Journal: Macroeconomics* (13658)

Manganelli, S. and G. Wolswijk (2009) What drives spreads in the euro area government bond market? *Economic Policy* 24, April 2009, 191–240.

Mayordomo, S., Pena, J. I. and Romo, J. (2011) A New Test of Statistical Arbitrage with Applications to Credit Derivatives Market, Working Paper. Retrieved March 30, 2011 from [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1796791](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1796791)

Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates, *The Journal of Finance* 29 (2), Papers and Proceedings of the Thirty-Second Annual Meeting of the American Finance Association, New York, December 28-30, (1973): 449-470.

Packer, F. and Suthiphongchai, C. (2003) Sovereign Credit Default Swaps, *BIS Quarterly Review* December, 79-88.

Palladini, G. and Portes, R. (2011). Sovereign CDS and bond pricing dynamics in the euro-area, Working Paper, London Business School. Retrieved April 15, 2012 from [http://www.cmavision.com/images/uploads/docs/Sovereign\\_CDS\\_And\\_Bond\\_Pricing\\_Dynamics\\_In\\_The\\_Euro-Area.pdf](http://www.cmavision.com/images/uploads/docs/Sovereign_CDS_And_Bond_Pricing_Dynamics_In_The_Euro-Area.pdf)

Pan, J. and Singleton, K.J. (2008) Default and Recovery Implicit in the Term Structure of Sovereign CDS Spreads, *Journal of Finance* 63 (5), 2345 – 2384.

Panetta, F., Angelini, P., Albertazzi, U., Columba, F., Cornacchia, W., Di Cesare, A., Pilati, A., Salleo, C. and Santini, G. (2009), Financial sector pro-cyclicality: Lessons from the crisis, Occasional paper no. 44, Bank of Italy.

Portes, R. (2010) Ban naked CDS, *Euro Intelligence*. Retrieved June 30, 2012 from <http://www.euointelligence.com/euointelligence-news/archive/single-view/article/ban-naked-cds.html>

Reinhart, C. and Rogoff, K. (2008) From Financial Crash to Debt Crisis, *American Economic Review* 101 (August 2011), 1676-1706

Remolona, E., Scatigna, M. and Wu, E. (2008). The dynamic pricing of sovereign risk in emerging markets: Fundamentals and risk aversion, *Journal of Fixed Income* 17(4): 57- 71

Sgherri, S. and Zoli, E. (2009). Euro area sovereign risk during the crisis, *IMF Working Papers* 09/222, International Monetary Fund.

Wang, P. and Moore, T. (2012). The integration of the credit default swap markets during the us subprime crisis: Dynamic correlation analysis, *Journal of International Financial Markets, Institutions and Money* 22(1): 1-15.

Yan, B. and Zivot, E. (2007), The dynamics of Price Discovery, Univeristy of Washington Working Paper Series. Retrieved June 30 2012 from [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=617161](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=617161)

Zhu, H. (2006) An Empirical Comparison of Credit Spreads between the Bond Market and the Credit Default Swap Market, *Journal of Financial Services Research* 29, 211-235.

## **Surveys and reports**

ISDA Master Agreement, 2002. Retrieved June 30, 2012 from [http://www.rensource.com/files/docs/2002\\_ISDA\\_MASTER\\_AGREEMENT.pdf](http://www.rensource.com/files/docs/2002_ISDA_MASTER_AGREEMENT.pdf)

ISDA Research Notes Issue 4 (2010) Concentration of OTC Derivatives among Major Dealers. Retrieved June 30, 2012 from [http://www.isda.org/researchnotes/pdf/ConcentrationRN\\_4-10.pdf](http://www.isda.org/researchnotes/pdf/ConcentrationRN_4-10.pdf)

Bank of International Settlements, OTC derivatives market activity in the first half of 2011, 2011. Retrieved March 15, 2012 from [http://www.bis.org/publ/otc\\_hy1111.pdf](http://www.bis.org/publ/otc_hy1111.pdf)

British Banker Association Survey (2006), BBA Credit Derivatives Report 2006. Retrieved March 15, 2012 from <http://www.bba.org.uk/publications/entry/bba-credit-derivatives-report-2006/books-reports-subscriptions/>

European Central Bank (2009), Credit Default Swaps and Counterparty Risk, August 2009. Retrieved March 15, 2012 from <http://www.ecb.int/pub/pdf/other/creditdefaultswapsandcounterpartyrisk2009en.pdf>

Fitch Survey (2009), Global Credit Derivatives Survey: Surprises, Challenges and the Future, 20 August 2009. Retrieved March 15, 2012 from [http://www.esaf.fazenda.gov.br/esafsite/CCB/program\\_2010/BT-01/RECOMENDADAS/L-11-3\\_Global\\_Credit\\_Derivatives\\_Survey\\_FitchRatings.pdf](http://www.esaf.fazenda.gov.br/esafsite/CCB/program_2010/BT-01/RECOMENDADAS/L-11-3_Global_Credit_Derivatives_Survey_FitchRatings.pdf)

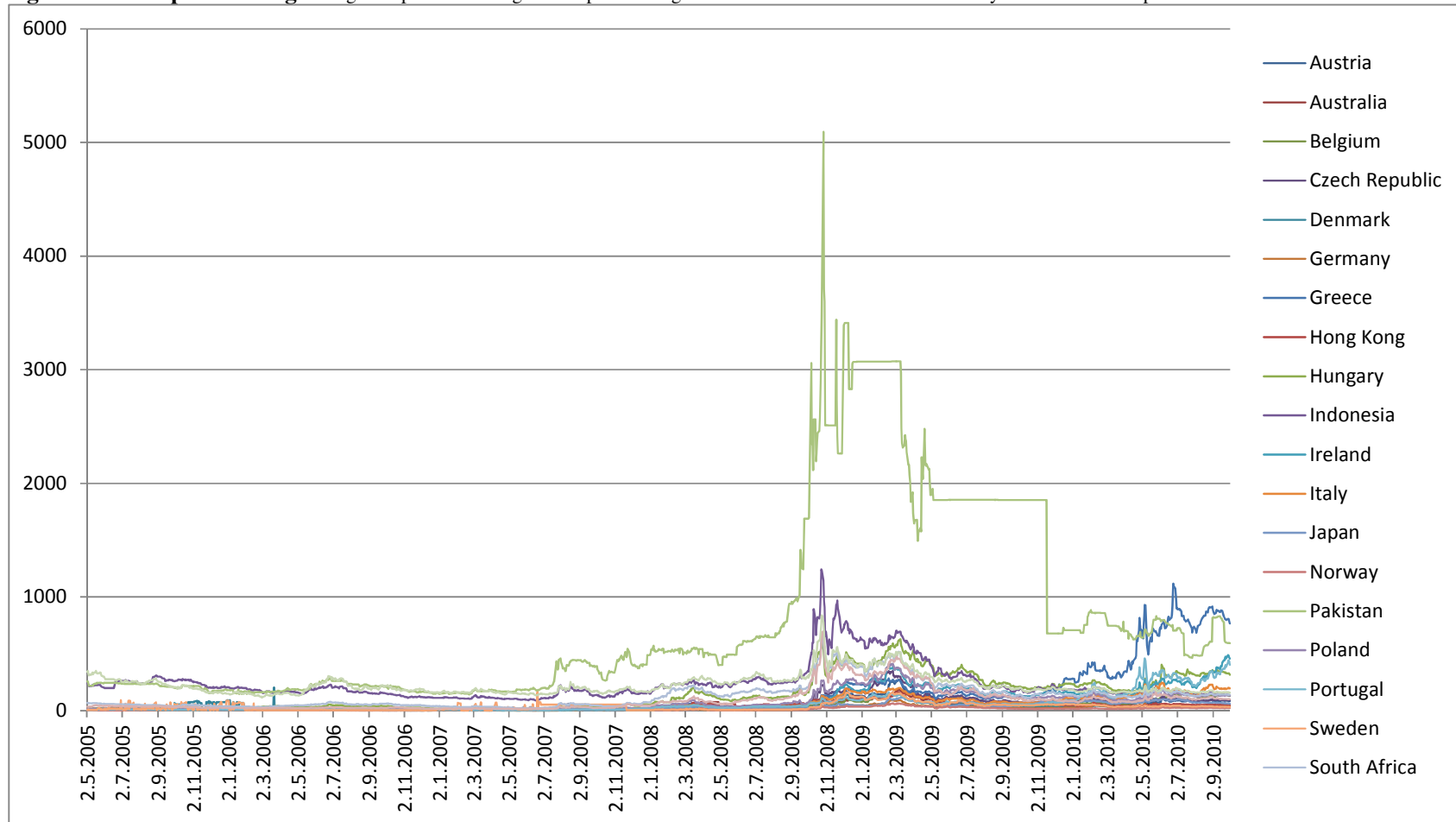
Markit Research Report (2009), The CDS Big Bang: Understanding the Changes to the Global CDS Contract and North American Conventions, March 13 2009. Retrieved March 15, 2012 from [http://www.markit.com/cds/announcements/resource/cds\\_big\\_bang.pdf](http://www.markit.com/cds/announcements/resource/cds_big_bang.pdf)

Merrill Lynch (2006), Credit derivatives Handbook 2006 – Vol. 1. A guide to Single-Name and Index CDS Products, London.

Moody's Investors Service, 2009. Corporate default and recovery rates, 1920–2008. Moody's Global Credit Policy Special Comment, Annual update. Retrieved June 30, 2012 from <http://www.gramercy.com/portals/0/pdfs2/2009%20February%20-%20Moody's%20Annual%20Corporate%20Default%20Report%20-%20Moody's.pdf>

## Appendix

**Figure 8. Basis spread changes.** Figure represents average basis spread changes in all of the countries from 2<sup>nd</sup> of May 2008 to 30<sup>th</sup> of September 2010.



**Table 17. Correlation Matrix of Sovereign Basis Spreads.** This table reports the pair-wise correlation coefficients for monthly excess sovereign credit returns for the indicated countries. Each pair-wise correlation is computed using all available overlapping observations for the two sovereigns.

**Period 1 May 2005 - September 2008**

Country	Austria	Australia	Belgium	Czech Republic	Denmark	Germany	Greece	Hong Kong	Hungary	Indonesia	Ireland	Italy	Japan	Norway	Pakistan	Poland	Portugal	Sweden	South Africa	South Korea	Turkey
Austria	1,000																				
Australia	0,378	1,000																			
Belgium	0,895	0,384	1,000																		
Czech Republic	0,910	0,421	0,962	1,000																	
Denmark	-0,067	0,037	-0,079	-0,097	1,000																
Germany	0,843	0,364	0,832	0,816	-0,045	1,000															
Greece	0,898	0,391	0,965	0,948	-0,041	0,806	1,000														
Hong Kong	0,800	0,505	0,808	0,837	-0,086	0,580	0,820	1,000													
Hungary	0,891	0,389	0,940	0,966	-0,107	0,757	0,939	0,864	1,000												
Indonesia	0,541	0,415	0,503	0,472	0,131	0,483	0,620	0,521	0,475	1,000											
Ireland	0,682	0,307	0,703	0,694	-0,095	0,594	0,678	0,606	0,648	0,439	1,000										
Italy	0,908	0,342	0,970	0,951	-0,084	0,815	0,988	0,793	0,935	0,585	0,680	1,000									
Japan	0,632	0,330	0,585	0,621	-0,056	0,524	0,540	0,477	0,573	0,157	0,445	0,540	1,000								
Norway	0,053	0,150	-0,004	0,018	0,094	0,060	-0,127	-0,031	-0,011	-0,271	0,048	-0,116	0,310	1,000							
Pakistan	0,859	0,242	0,832	0,849	-0,151	0,678	0,805	0,783	0,841	0,488	0,622	0,837	0,500	0,133	1,000						
Poland	0,883	0,315	0,933	0,959	-0,083	0,821	0,955	0,766	0,952	0,535	0,641	0,960	0,535	-0,094	0,813	1,000					
Portugal	0,922	0,367	0,982	0,966	-0,077	0,812	0,985	0,833	0,957	0,548	0,692	0,990	0,566	-0,044	0,863	0,955	1,000				
Sweden	-0,188	0,066	-0,234	-0,240	0,194	-0,164	-0,271	-0,199	-0,266	-0,052	-0,047	-0,282	0,045	0,513	-0,070	-0,295	-0,247	1,000			
South Africa	0,895	0,336	0,952	0,949	-0,118	0,759	0,965	0,837	0,959	0,579	0,683	0,969	0,561	-0,101	0,861	0,943	0,970	-0,268	1,000		
South Korea	0,915	0,343	0,921	0,925	-0,099	0,755	0,940	0,848	0,917	0,637	0,696	0,946	0,534	-0,075	0,911	0,918	0,951	-0,214	0,955	1,000	
Turkey	0,543	0,311	0,509	0,529	-0,190	0,449	0,590	0,589	0,539	0,733	0,408	0,591	0,277	-0,288	0,545	0,562	0,546	-0,188	0,659	0,670	1,000

**Table 18. Correlation Matrix of Sovereign Basis Spreads.** This table reports the pair-wise correlation coefficients for monthly excess sovereign credit returns for the indicated countries. Each pair-wise correlation is computed using all available overlapping observations for the two sovereigns.

**Period 2 September 2008 - September 2010**

Country	Austria	Australia	Belgium	Czech Republic	Denmark	Germany	Greece	Hong Kong	Hungary	Indonesia	Ireland	Italy	Japan	Norway	Pakistan	Poland	Portugal	Sweden	South Africa	South Korea	Turkey
Austria	1,000																				
Australia	0,910	1,000																			
Belgium	0,605	0,521	1,000																		
Czech Republic	0,882	0,908	0,520	1,000																	
Denmark	0,871	0,917	0,465	0,895	1,000																
Germany	0,875	0,809	0,812	0,794	0,745	1,000															
Greece	-0,037	-0,140	0,720	-0,165	-0,173	0,304	1,000														
Hong Kong	0,803	0,923	0,303	0,866	0,865	0,619	-0,366	1,000													
Hungary	0,836	0,869	0,580	0,882	0,823	0,726	-0,024	0,856	1,000												
Indonesia	0,547	0,723	0,134	0,778	0,781	0,389	-0,410	0,838	0,778	1,000											
Ireland	0,633	0,467	0,873	0,459	0,401	0,711	0,581	0,286	0,550	0,027	1,000										
Italy	0,537	0,476	0,934	0,448	0,475	0,756	0,739	0,244	0,512	0,141	0,795	1,000									
Japan	0,435	0,293	0,638	0,251	0,147	0,615	0,549	0,086	0,235	-0,161	0,527	0,600	1,000								
Norway	0,952	0,943	0,578	0,907	0,873	0,846	-0,088	0,868	0,889	0,631	0,588	0,491	0,329	1,000							
Pakistan	0,522	0,664	-0,033	0,712	0,737	0,286	-0,594	0,787	0,631	0,841	-0,015	-0,049	-0,361	0,615	1,000						
Poland	0,917	0,940	0,522	0,979	0,928	0,798	-0,162	0,896	0,917	0,777	0,490	0,468	0,253	0,937	0,721	1,000					
Portugal	0,015	-0,077	0,744	-0,087	-0,112	0,379	0,961	-0,299	0,020	-0,338	0,629	0,783	0,557	-0,034	-0,531	-0,092	1,000				
Sweden	0,891	0,877	0,346	0,863	0,961	0,677	-0,298	0,844	0,776	0,722	0,350	0,347	0,144	0,860	0,733	0,906	-0,253	1,000			
South Africa	0,671	0,814	0,278	0,881	0,854	0,535	-0,332	0,877	0,849	0,974	0,174	0,261	-0,051	0,742	0,837	0,874	-0,253	0,791	1,000		
South Korea	0,670	0,815	0,266	0,858	0,829	0,526	-0,334	0,897	0,859	0,970	0,175	0,245	-0,027	0,749	0,838	0,857	-0,256	0,770	0,979	1,000	
Turkey	0,545	0,709	0,135	0,796	0,746	0,395	-0,417	0,828	0,779	0,984	0,031	0,119	-0,165	0,630	0,841	0,778	-0,338	0,688	0,975	0,971	1,000