Government Bailout Policy and Sovereign Risk [TBC][*]

Preliminary and Incomplete

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Abstract

We study the impact of implicit and explicit bailout guarantees in the Euro area during the period 2006-2014. We consider both financial sector and government bailout guarantees, and construct measures of systemic risk based on the difference between crash insurance schemes based on sovereign and corporate CDSs. By comparing sovereign and sector-wide CDS indices with suitably matched portfolios of constituents' CDSs, we identify a tradeable basis that increases in periods of financial crisis, is positively associated with announcements of government and monetary interventions by a variety of sources, and cannot be explained by traditional liquidity risk factors. We use our bailout risk measures to explore spillover effects between the financial sector and sovereign risk.

Keywords: CDS, Credit Indices, Liquidity Risk, Government Bailout

JEL Classification: F14; F31; F32; F34; G12; G15.

1 Introduction

We study the price difference between two crash insurance schemes, a portfolio of Credit Default Swap (CDS) contracts on single banks and a CDS index on the financial sector. A portoflio of single-name CDS contract provides protection to the CDS buyers against the default of the underlying firms. A CDS Index contract is a portfolio of CDS contracts and protect the buyer from defaults of each CDS index's constituents. We term the difference as the basket-index spread. As applied by the No-Arbitrage theory, the two schemes of insurance provide exactly the same protection to investors. If the market is efficient, the price difference should be zero. Therefore, during normal market condition, we would expect the difference in insurance costs approximate around zero or positive. The reason to observe a positive difference is due to higher trading cost and liquidity cost involved with establishing the basket position. During the financial crisis, investors concern about future economic condition and worries about extreme downside losses. To protect themselves, investors purchase crash insurances.The intensive demand for crash insurance during the financial crisis push up the price of the index and would put our basket-index spread into negative. The potential systemic credit risk premium that increases during the financial crisis would decrease the basket-index spread when the systemic risk peaks.

Meanwhile, the past financial crisis and Eurozone sovereign debt crisis witnessed series of government intervention originated from various authorities, including federal/regional governments, central banks and IMF. Effective and Successful government bailout therefore should shift the truncate extreme downside losses by private investors and hence reduce the systemic credit risk premium, and push up our basket-index spread. But what if the government is not capable to bailout the economy at all, such as the Irish government? Would high sovereign risk reduce the embedded government put protection in dire economic conditions? Motivated by this, we explore a panel study on CDS indices across the US and EU markets across different sectors. We find cross sectional decrease in the basket-index spread for the US market during the US financial crisis, as well as EU non-financial and non-sovereign sectors, which suggests increasing systemic risk during the crisis period. We find the basket-index spread for the EU senior financial CDS index increases during the US financial crisis period but decreases to negative during the EU sovereign debt crisis period; meanwhile, we observe positive basket-index spread in the Western Europe Sovereign CDS index from 2010 to early 2011 but dropped into negative right after the agreement of Greece Private Sector Involvement (PSI) announced in late 2011. The finding of EU financial sector suggests the potential mechanisms of a double bailout schemes. That is, during the financial crisis, while EU sovereigns are still capable of of bailing out failing banks, we observe increase basket-index spread since the systemic risk is shifted from banking sector to sovereign sector by government intervention. However, when the sovereign's creditability deteriorated since late 2009, the systemic risk that embedded in the financial sector started surge and push down our basket-index spread, which did not recover until early 2012 when the European Central Bank (ECB) as granted the Single Supervisory Mechanism (SSM) and since when the European Stability Mechanism (ESM) bank recapitalization packages became paid directly to the banks in the financial sectors in late 2012 [1]. The decreasing basket-index spread in the sovereign CDS index since 2012 shed a light on similar story regarding the influence of government intervention in aggregative systemic risk. Any negative events that decreasing the bailout probability indicates that private sector has to bear the losses, and hence increase the systemic risk premium in the CDS index and decrease the basket-index spread.

Figure 1 about here

We perform panel regression analysis on the basket-index spread of various CDS indices by considering several fundamental and technical factors widely used in the literature to explain the divergence of CDS index/portfolio prices from their theoretical values. The results suggest that there is considerable variation in the basket-index spread across different indices and geographic locations. For example, we find that the absolute mean spread for the CDX NAIG Financial sub-index is 40.067bps (basis points), with a standard deviation of 59.133bps, while it amounts to 2.394bps for the iTraxx Eur Sr Financial index, with a standard deviation of 12.179. Furthermore, High Volatility and CrossOver sub-indices are relatively riskier than the other sub-index within the same family, besides the CDX NAIG FIN. It is important to point out that there is no banks in the CDX NAIG FIN sub-index, most of the references names are investment funds, insurance, asset management funds, which would imply the difference reactions of the financial index to the crisis between the EU area and the US areas. Secondly, we find massive crisis risk premium in the US market. All US based index spread level drop drastically over the financial

[1] Decision on 19 October 2014, outlined in December 2012

crisis period, suggesting massive increases in the CDS index premium versus its basket level. Thirdly, We find statically significant impacts of government news announcement dates. Besides local impacts of bailout policy announcement on the subject region, we find cross board reactions among different geographic locations, for example, the iTraxx EU financial index reacts positively and significantly to US federal government's policy announcement. Fourthly, our finding aligned with previous literature[2] suggestiong that common risk factors, such as volatility risk premium and excess stock return, impact the price difference between the CDS index and its intrinsic price value. However, the highly persistent nonzero basket-index spread level suggests that factors other than liquidity are at play during the crisis, such as correlation risk premium and the pricing of bailout options.

The paper is organized as follows. In the next section, we provide a link with the existing literature. In section 2, we introduce the basket-index spread measure, and outline the main hypotheses we would like to test. Section 3 describes the data and empirical strategy. Section 4 presents our findings. Section 5 concludes.

1.1 Related literature

Our work contributes to at least three strands of literature. First, we contribute to the literature on sovereign credit risk, by looking at the Euro area. The late 1990s and early 2000s was featured with a series of emerging countries sovereign defaults, such as the Latin American debt crisis of the 1980s, and the Mexican and Russian debt crisis of the 1990s. There was essentially no sign or concerns regarding the sovereign credit risk of advanced economies. Recently, however, the past Eurozone sovereign debt crisis has draw the public attention to the importance of sovereign credit uncertainties embedded developed economies in global financial market. The repeated occurrence of sovereign debt crises as well as the growing public consensus on sovereign credit risk have attracted researchers in various fields, such as Tomz and Wright (2013) and Cruces and Trebesch (2013). In terms of instruments that measure sovereign credit risk, earlier literature has used syndicated loans (Boehmer and Megginson, 1990) or sovereign bond (Mauro, Sussman, and Yafeh, 2002; Duffie, Pedersen, and Singleton, 2003; Geyer, Kossmeier, and Pichler, 2004). Recent studies have been employing the Credit Default Swap (CDS) contracts to capture the sovereign

[2] See (Longstaff, Pan, Pedersen, and Singleton, 2011; Ang and Longstaff, 2013; Pan and Singleton, 2008).

credit risk (Duffie, Pan, and Singleton, 2000; Duffie and Singleton, 2003; Pan and Singleton, 2008; Zhang, 2008; Longstaff, Pan, Pedersen, and Singleton, 2011; Ang and Longstaff, 2013; Li, Li, and Yang, 2014).The past two decades have experienced spectacular growth in credit derivative market. In particular, the sovereign CDS contract is a new generation of insurance products that protect lenders from the potential defaults of their borrowers. Up to 2012, the sovereign credit market has covered approximately 48 trillion USD public debt market [3]. Moreover, comparing to sovereign bond, sovereign CDS has additional advantages in measuring sovereign credit risk, such as its simplicity and standard contract terms (Li, Li, and Yang, 2014), better liquidity condition (Fontana and Scheicher, 2011)and less exposed to taxation (Beinstein, Sbityakov, Le, Goulden, Muench, Doctor, Granger, Saltuk, and Allen, 2006). Several authors[4] use a reduced-form approach to estimate the dynamics of sovereign default risk from CDS prices. Pan and Singleton (2008) finds that a common principal component explains more than 90% of variation in Mexican, Turkish and Korean sovereign CDS spreads. Longstaff, Pan, Pedersen, and Singleton (2011) find that changes in CDS spreads across 26 emerging countries are largely driven by common risk factors, such as the VIX index, US equity returns, and high-yield corporate spreads. Ang and Longstaff (2013) try to isolate a systemic risk factor from sovereign-specific risk factors, based on the CDS spreads of the US federal government and states, as well as 11 EMU nations. They find that such systemic risk factor is largely linked to financial market factors. An alternative approach to sovereign default risk is the use of rating-based models.[5] Li, Li, and Yang (2014), for example, study the impact of ratings on sovereign CDS spreads of 34 countries. They develop a model that generates superior out-of-sample performance. The authors then back out the common risk factor and the credit risk premium, and confirm that such common risk factor is closely linked to financial market variables, such as the VIX index and MSCI word stock index. Furthermore, a time-series studies show that the risk premium increases intensively during the financial crisis and the European debt crisis, with increasing pronounced impact on CDS with higher ratings and longer matures. Our paper contributes to this sovereign credit risk literature by looking at the sovereign credit default swap index (CDS Index), which is a portfolio of CDS contracts on individual sovereigns. The merits of using the sovereign CDS index rely on the direct

[3] www.economist.com

[4] See Duffie and Singleton (1999, 2003); Ang and Longstaff (2013); Longstaff, Pan, Pedersen, and Singleton (2011); Pan and Singleton (2008), for example.

[5] See Remolona, Scatigna, and Wu (2008); Li, Li, and Yang (2014), for example.

address of the latent common risk factors because individual sovereign risks are diversified away by portfolio construction. Furthermore, CDS index are widely used by investors to express their generic views on aggregate systemic credit risk, such as potential extreme events of clustering defaults scenarios.

Second, our paper attempts to investigate the impact of government bailout by considering the existence of sovereign risk of the subjective governments. In dire financial crisis, government tends to bailout systemically important firms/financial intuitions to save the market from catastrophic losses. Hence, the losses that would be suffered by the private investors are partially subsidized by the government. The expectation of such bailout would lower the catastrophic insurance products relative to its corresponding theoretical price. Kelly, Lustig, and Van Nieuwerburgh (2012) compare the cost of a basket of put options on individual banks and the price the financial-sector index put option. They find the difference between the put option basket and the index option index increases for the financial sector, while decreases for all other sectors. They further prove that such positive basket index basis is caused by the under-pricing of crisis insurance products for the U.S. equity market since the private investors expect government intervention during financial crisis by bailing out the systematically important banks.Chen, Joslin, and Ni (2013) also explore the out-of-The-Money (OTM) put option and they find that higher demand (prices) for crash insurance products when financial intermediates face constraints in their tail risk-sharing capacity. Acharya, Drechsler, and Schnabl (2014) investigate the risk transfer mechanism between the sovereign sector and financial sector during the past financial crisis by using the sovereign and bank CDS products. They found significant risk transfer action from private banking sector to the public sovereign sector right after the announcement of the government bailout policies, while the two tend to illustrate stronger co-movement afterwards, suggesting a second feedback effect from the sovereign sector to the banking sector. On the other side, Pástor and Veronesi (2012, 2013) shows that political uncertainty commands a risk premium in the stock market. The magnitude is larger in weaker economic conditions. Furthermore, such political uncertainty would reduce the value of the implicit put protection that the government provides to the market, which leads to higher volatility risk and correlation risk among different assets.

2 Measuring the CDS Basket-Index Spread

This section presents a brief description of credit indices before turning to a replication strategy that uses a basket of single name CDS contracts to reproduce the cash flow of the index contract. We define the cost difference between the basket and the index as the *basket-index spread* and show that in prefect capital markets should be close to zero because of simple arbitrage arguments. In periods of financial distress, however, the difference between the cost of these insurance schemes deviates substantially from zero as it incorporates market participants' expectations about sector-wide government guarantees.

2.1 Credit Indices: Description

An investor can acquire protection against credit risk exposure in a given sector of the market by trading a credit default swap (CDS) index. It is an equally weighted basket of actively traded single-name CDS contracts that offers insurance against any defaults among its constituents. In contrast to single-name contracts, a credit index is a highly standardized instrument and thus more liquid than its reference entities.[6] Credit indices are generally traded on over-the-counter markets for a specific maturity ranging from one to ten years, a fixed spread and a defined basket of reference entities. In our empirical analysis, we use the five-year maturity contract as this is the most liquid segment of the market.

A CDS index can be viewed as an insurance contract that provides default protection on each entity included in the index. The buyer of the CDS index buys credit risk exposure (sells index protection). She receives periodic payments based on a fixed spread but takes the losses if there is any credit events such as a failure to pay, bankruptcy and restructuring affecting the underlying portfolio. The seller of the CDS index takes the opposite position, i.e., she sells credit risk exposure (buys index protection).[7] It follows that the CDS index is quoted as the cash

[6]The Market Activity Report for the period December 20, 2013 through March 19, 2014 of the Depository Trust & Clearing Corporation (DTCC) shows that the average daily notional amount for the 1000 most actively traded single-name CDS is approximately 32 million USD whereas the daily notional amount of untranched index transactions is about 800 million USD.

[7]Note that the CDS index market uses the opposite convention of the single-name CDS market. Here, the buyer of a single-name CDS buys protection whereas the seller sells protection against credit risk events. This difference is due the different roles of these two markets. The single-name CDS market is essentially a market used by banks to hedge their credit risk, hence buying a CDS contract means buying protection. In contrast, the CDS index market is largely populated by investors that want to gain risk exposure to a diversified portfolio of credits, hence buying an index means bearing credit risk in order to receive a premium (O'Kane, 2011).

amount paid by the protection seller (the index buyer) to enter into a CDS contract. When an underlying single name defaults, it is removed from the index and settled separately. Assume for instance that the index consists of N underlying names. If one of the N underlying names were to default, the protection seller (the index buyer) pays $1/N$ of the face value of the contract to the protection buyer in exchange for the deliverable obligation on $1/N$ of the contract notional. The notional of the contract is then reduced by a factor of $1/N$, and the absolute amount of index coupon is reduced.

The constituents of a credit index are revised every six months, in March and September of each year, using credit and liquidity criteria. When an index constituent fails to maintain a given credit rating or its liquidity declines significantly, it is replaced by the most liquid reference names satisfying the credit rating requirements. Although the previous series continues trading, liquidity is typically concentrated on the most recently updated series. They are referred to as the on-the-run CDS index series. We will focus on these series in our empirical analysis.

The credit indices used in this paper are from Markit, who sets the rules and the procedures underlying the revision of the indices on the roll dates. These indices are traded by a group of licensed dealers providing, and Markit computes daily index levels based on the spread quotes.

2.2 Credit Indices: Replication

An investor can obtain credit risk exposure by selling protection either on the index contract or on a replicating portfolio of single-name CDS instruments. Denote as C_t^{INDEX} and C_t^{BASKET} the cost of acquiring CDS index protection and the implied cost of acquiring protection via a basket of single-name CDSs, respectively. The difference between the latter and the former represents the basket-index spread on time t

$$S_t = C_t^{BASKET} - C_t^{INDEX}. \tag{1}$$

Index arbitrage makes the cash flows for the seller of the index protection and the seller of protection via single-names CDS identical (e.g., Junge and Trolle, 2014), and hence the spread should be close to zero.

The recent financial crisis experienced large negative basket-index spreads, especially for financial and sovereign credit indices. A simple explanation for the negative basket-index spread due to the fact that while single-name CDS contracts were traded at par, CDS indices were executed significantly above their fixed spreads. We argue that this nonzero spread incorporates market's expectation about sector-wide government guarantees. Specifically, in absence of government bailout interventions, investors are concerned about systemic credit defaults and buy aggressively CDS index protection thus driving the basket-index spread into negative territory.

3 Data and preliminaries

This section describes data that are used in this study and measure constructions.

3.1 CDS Data

The CDS data including the CDS indices and single-name CDS is obtained from Markit.Our main focus is on Europe financial and sovereign CDS markets. For robustness purpose, we also perform the same study on the US CDS market. Our data include three main CDS index families: the CDX North American (CDX NA), the iTraxx Europe (iTraxx Eur) and the iTraxx Sovereign (iTraxx SovX).We focus on CDS contracts with 5-Year maturity since 5-Year CDS contracts are of the highest liquidity. For CDX NA and iTraxx Eur families, the data sample covers period from September 20, 2006 to March 31, 2014. For iTraxx SovX, which was issued in 2009, the sample period is from September 20, 2009 to March 31, 2014. We focuses on-the-run series. To exclude potential impacts of liquidity issue of off-the-run series, we prioritize the on-the-run of CDS index.Whenever multiple versions of the on-the-run series trade simultaneously, we opt to the latest version.[8] For dates when there are no quotes on the latest version, we choose the version with the highest market depth is chosen for liquidity reason.

For the Europe market, the CDS indices studied in this project are iTraxx Europe (iTraxx Eur) Sovereign Western Europe (West EU), Non Financial (Non Finl), Senior Financial (Sr Finls), High Volatility (HiVol) and CrossOver (Xover). For the US market, we use CDX North American

[8] For example, on 9 March 2012, following the announcement of the credit event associated with Hellenic Republic, Markit re-versioned with the new Index Name (i.e. iTraxx SovX Western Europe Series 6 Version 2). With the new version, the weight of Hellenic Republic has been set to zero and the notional of the index was reduced by the weight of the defaulted entity. Under this circumstance, the CDS index series 6 version 2 is adopted and replaces the previous version 1 since the 9 March 2012.

Investment Grade (CDX NAIG) Consumption (CONS), Telecommunications, Media and Technology (TMT), Financial (Fin) High Volatility (HVOL) and CrossOver (XO). In particular, iTraxx Sovx WE is a index on 15 single name sovereign CDSs. iTraxx Eur HiVol (CDX.NAIG.HVOL) contains thirty reference names that with the widest five-year CDS premium constitutes. The iTraxx Eur Sr Finls include 25 CDS on the senior debt of Europe banks and financial firms (There is no banks in the CDX.NAIG.Fin CDS index). The iTraxx Eur Xover is 75-name basket on the riskiest non-financial firms of the iTraxx Europe main index (The CDX.NA.XO is on 35 reference names that are at the crossover point between investment grade and junk). iTraxx Eur Non Fin contains 100 reference names of non-financial firms (CDX.NAIG.TMT is sub-index on 20 telecommunications, media and technology; the CDX.NA.IG.CONS is on 30 names of manufacturers of consumer products).

3.2 Brief Basket Construction and Data

To calibrate the insurance cost of replicating CDS basket perform, we matches the constituent names of the CDS index of each series based on the annex documents provided by Markit. Then we collect the credit term structure of the marching constituent, from six-month, one-year, two-year, three-year, four-year, five-year and up to seven-year. We then calibrate the default intensity from the credit term structure of each company, wherein the discount zero rate used in this step are bootstrapped from libor from 1- month to 12-month,and interest rate swap of maturity from 2-year to 7-year [9]. With the default intensity , we reprice the single name CDS by using the index documentation clauses. [10] By doing so, the impact of differences between the recovery rates of single name CDS and the index are strapped out.Besides, we also matching the single name CDS contract with the index to have the same currency of the notional (i.e. USD for the CDX North American and iTraxx Sovereign families, and Euro for the iTraxx Eur family), restructuring clauses[11], seniority of the underlying debt.The monetary price of the CDS index is calculated as the equally weighted average across the single name CDS prices, which is converted

[9]We follows the Markit 'locked-in' Libor rate convention, the zero rates are fixed on the previous day for discounting purpose.

[10]For example the CDS on Greece is actually has a recovery of 25% while the iTraxx SovX has recovery rate of 40%. We calibrate the default intensity with 25% recovery rate and then reprice the CDS on Greece with the same recovery rate of index (i.e. 40%).

[11]When there are multiple clauses exist, we choose the Modified Modified Restructure (MMR) for the CDX NA family, No Restructure(XR) for the iTraxx EU family, and Full Restructure(CR) for the iTraxx SovX family

into index level (basis point) [12].

3.3 Explanatory Variables

The following explains the details of the explanatory variables used in the subsequent regression analysis. The data construction are based on (Longstaff, Pan, Pedersen, and Singleton, 2011; Ang and Longstaff, 2013; Acharya, Drechsler, and Schnabl, 2014).

Stock Market Returns: The U.S. stock market excess return is the daily value-weighted returns on all NYSE, AMEX, and NASDAQ stocks from CRSP in excess of the one-month Treasury bill return from the Ibbotson Associates. The data are publicly available on Kenneth French website(http://mba.tuck.dartmouth.edu /pages/faculty/ken.french/date_library.html). For the European market, we use the STOXX 50 Index daily return minus the 1 month Libor rates, both data sets are obtained from Bloomberg.

Exchange Rates: Exchange rate is the return of the spot JPY/USD rate for the U.S. market, and of the spot Euro/JPY rate for Europe market. Implied volatility of the two exchanges rates are also used for robust purpose. All data are extracted from Bloomberg.

Corporate Spread: Two measures are used to capture the market condition for the corporate sector. Daily changes in investment -grade yield spreads are the daily changes in the basis point yield spread between the Bank of America/ Merrill Lynch US Corporate BBB and AAA Effective yield. Daily changes in the high-yield spreads are the monthly changes in the basis -point yield spread between the Bank of America/Merrill Lynch US High Yield BB and Corporate BBB Effective yield.

For the EU market, the daily changes in the investment grade yield spreads are the daily changes in the iBoxx BBB and AAA effective yield. the daily changes in the high yield spreads for is the daily changes in the Bank of America/Merrill Lynch EU High Yield effective spread rates. All data series are obtained from the Federal reserve Bank of St. Louis.

Volatility Risk Premium: The volatility risk premium is calculated as the difference between the VIX index and the realized 30 days volatility for the S& P 500 index for the US market; for the EU market, volatility risk premium is measured as the difference between the VDAX index and the realized 30 days volatility of the DAX indices. All data series are obtained from the

[12]The construction of basket measure follows exactly the steps listed by the Markit CDS model documents, and is intrinsic theoretical value of the CDS index.(O'Kane, 2011; Junge and Trolle, 2014; Brigo and Mercurio, 2007)

Bloomberg.

Term Premium: The term premium is the difference of the 10 year USD (Euro) Interest Rate Swap rates and the 1 month USD (Euro) Libor rates. All data are downloaded from Bloomberg.

Funding Risk: The funding risk is calculated as the difference between the 3-month USD(Euro) Libor rate and the USD (Euro) OIS rates. Furthermore, to consider the market liquidity condition, we use additional two measures, "heat" and "depth" provided by Markit to capture the liquidity condition of the CDS indices, wherein 'heat' captures how many contributors to composite quote on the five-year continuous on-the-run CDS indices. The depth captures the number of good contributions used to calculate the composite for this instrument. The heat calculated as today's absolute change in spread divided by the absolute average heat calculated as daily absolute change in spread divided by the absolute average daily change over current month excluding today's change. To capture the single-name CDS liquidity, we construct the bid-ask spread on each individual names at daily basis, in order to capture the liquidity risk.

3.4 News

Bailout Action: To capture the government bailout action, series of event dates variables are constructed, which equal to 1 if there is any government or authority news announcement or event statement public release on that day, and equal to 0 if nothing happens. The event data are collected from four public resource. In particular, we use the crisis timeline provided by Federal Reserve Bank of St. Louis for the US event dates. For the EU ares, three main public authority resources are used, including International Monetary Fund (IMF), European Commission (EC), and European Central Bank (ECB) Furthermore, to minimize the selection bias, we first include all dates listed on these web-sites, without referring the content of the news or event content, or filtering.

However, potential measurement error exist. Various days in the IMF calenders are merely transcripts release, instead of policies that of immediate action or news announcement. Bear this in mind, we first tailor down the news variables, for example, we further divide the ECB news into around 5 categories based on the sections the news is listed, such as banking, cooperation, monetary policy and stability; we also subdivide the IMF and EC news into country specific ones for robustness check.

Furthermore, we perform simple textual check based on works by Kaminsky and Schmukler (1999) and Baig and Goldfajn (1999) in order to qualify good versus bad news. The signed news variable has a value of 1 stands for positive news regarding the government bailout, -1 stands for the negative news, while 0 stands for neutral. The basic rules of including a piece of news in the sample is purely based on the criteria of whether the news event represented changes in the fundamentals of the bailout events. To clarify the news events in terms of positive and negative news, we used the following specific criteria:

- **Good News**

  a. Successful formation of bailout arrangements;

  b. Announcement of rescue package by international and regional organizations;

  c. Specific measures to stabilize the markets.

- **Bad News**

  a. Breakdown in negotiation with multilateral agencies;

  b. Announcement that indicates the involvement of private sector;

  c. Worse than expected announcements and confusing policy moves;

3.5 Preliminaries

Table 1 the mean, median, standard deviation (S.D), minimum (Min) and maximum (Max) statistics of insurance cost for CDS index, replicate basket and basket index spread. The U.S. CDS index includes CDX North American Investment Grade (CDX NAIG) Consumption (CONS), Telecommunications, Media and Technology (TMT), Financial (Fin) High Volatility (HVOL) and CrossOver (XO). The Europe CDS index includes iTraxx Europe (iTraxx Eur) Sovereign Western Europe (West EU), Non Financial (Non Finl), Senior Financial (Sr Finls), High Volatility (HiVol) and CrossOver (Xover). Panel A reports index insurance cost that extracted from Markit. Panel B reports the insurance cost for the replicating basket of CDS. Panel C reports the basket-index spread. There is considerable difference across different CDS indices on the basket index spreads. Within each index family, the standard deviation of index levels increase as we consider indices that referring names that of lower credit quality. For example, High Volatility and CrossOver are relatively riskier than the other indices within the same family and contain a much higher standard deviation than other subindices. It is important to point out that there is no banks in the CDX NAIG FIN sub-index, most of the references names are investment funds, insurance, asset management funds.

Comparing the EU versus US market, the CDX NA family sub-indices illustrate relatively larger amount of basket-index spread than the iTraxx EU family, in terms of absolute value of the spread, as well as in terms of the volatility. For example, the absolute mean basket-index spread for CDX NAIG Financial sub-indix is 40.067 basis point with 59.133 standard error, while it is 2.394 for iTraxx Eur Sr Financial with 12.179 standard error.

Table 1 reports the mean of basket-index spread across different sub indices for the whole period and three sub-sample periods. In particular, the subsample constitutes the before, during and after crisis stages. For the CDX NA family, the corresponding period is from 02 Jan 2006 to 30 July 2007, 1 Augst 2007 to 30 June 2009 and 1 July 2009 to 10 April 2014. The before, during and after crisis periods for iTraxx EU family is from 2 Jan 2006 to 30 Oct 2009, 1 Nov 2009 to 30 Sep 2012 and 1 Oct 2012 to 10 April 2014.

For the CDX NAIG families, almost all sub-indices illustrate massive drop in the basket index spread measures during the crisis period. According to Kelly, Lustig, and Van Nieuwerburgh (2012), since the index is an insurance against the extreme events that clustered default happening, hence index normally illustrate higher price than its basket theoretic value thanks to the hedge against correlation risk premium. For the same reason, during the financial crisis when the correlation premium among basket constituents peaks, the index insurance product is perceived as more valuable since it provides higher marginal value of hedging, and hence the index price would increase relatively higher than the corresponding basket, leading the basket index spread measures drop. The huge drop in the US CDS market illustrate exactly the story as illustrated above, suggesting surges of correlation premium or systemic risk during the financial crisis.

Across different index families, the CDX NA family sub-indices illustrate relatively larger amount of basket-index spread than the iTraxx EU family, in terms of absolute value of the spread, as well as in terms of the volatility. For example, the absolute mean basket-index spread for CDX NAIG Financial sub-indix is 40.067 basis point with 59.133 standard error, while it is

2.394 for iTraxx Eur Sr Financial with 12.179 standard error.

Table 2 separates the mean of Basket-Index Spreads for U.S. and Europe CDS index into three main subperiods of the sample. For the U.S. market, The before crisis period is from January 2006 to July 2007, the crisis period follows and lasts until June 2009, and the after crisis period ends in April 2014. For Europe market, the crisis period is specified as the EU sovereign crisis period from November 2009 to September 2012. The U.S. CDS index includes CDX North American Investment Grade (CDX NAIG) Consumption (CONS), Telecommunications, Media and Technology (TMT), Financial (Fin) High Volatility (HVOL) and CrossOver (XO). The Europe CDS index includes iTraxx Europe (iTraxx Eur) Sovereign Western Europe (West EU), Non Financial (Non Finl), Senior Financial (Sr Finls), High Volatility (HiVol) and CrossOver (Xover).

We observe collective massive drop in the basket-credit spreads during the financial crisis for both US and Europe market, except the Sovereign index. [13], suggesting potential systemic risk emerged over the crisis period.

To address our question as that whether intervention of government and central banks impacts the systemic risk that is perceived by the market. We perform panel regression of of our basket-index spread on government news announcement dates.

Table 1 about here

Table 2 about here

4 Methods and Empirical Analysis

Table 4 and 5 investigate the extent to which different factors,fundamental,technical and market,contribute to explain the persistent non-zero basket-index spread. In selecting relevant variables to be included in the regression, we refer to the studies by (Longstaff, Pan, Pedersen, and Singleton, 2011; Ang and Longstaff, 2013; Pan and Singleton, 2008) or economic and financial market factors, including exchange rate return, stock market excess return, high yield spread, investment grade spread, volatility risk premium, term premium. For liquidity factors, we refer the standard 3 Month Libor and OIS spread in literature Junge and Trolle (2014).

[13]For the iTraxx Eur Xover, the peaks in the spread is caused by insufficient reading of the CDS index

Table 4 about here

Table 5 about here

Furthermore, to capture impacts of the government policy intervention, we construct a category variables that equal to one when there is policy action conducted by the corresponding government authority, and equal to zero if nothing is reported on the authority official website. The public event resources used in this paper are Federal Reserve Bank of St. Louis (US), Europe Central Bank (ECB), Europe Commission(EC), and International Monetary Policy. For the Federal Reserve bank of St.Louis, the event dates is constructed according to the crisis time line published on the website. For the other three public sources, we use its news and events category for relevant policy action (i.e. ECB for banking, cooperation, stability, others,monetary policy); as well as for relevant country (i.e. for EC,actions on each sovereign Greece, Cyprus, Ireland, Portugal and Spain can be traced at country-specific level; for IMF, relevant actions at individual national can also be traced). We aggregate each sources event and news count and construct the four dates category variables. Later, we apply simple sentiment analysis on the news content, and categorize the event into positive, negative and neutral news regarding the change on potential government bailout intervention. The detailed construction steps are summarized in the appendix. Correlation among main regressors are reported in 6 and 7.

Table 6 about here

Table 7 about here

However, it is necessary to consider potential information leakage as well as timing for the market in reacting to the news, we run the following three regression. For equation (3) and (4), we only reports the coefficient of the dates γ and reports the other statistics based only on equation (1). The results barely changes when we use different lags of the dates. Univariate regression are also performed for robust purpose, no coefficient does not change much when we moved into multivariate regression.

$$spread_{i,t} = \alpha_i + \beta_i X_{i,t} + \gamma_i Dates_{i,t} + \epsilon_i \tag{2}$$

$$spread_{i,t} = \alpha_i + \beta_i X_{i,t} + \gamma_i Dates_{i,t-1} + \epsilon_i \tag{3}$$

$$spread_{i,t} = \alpha_i + \beta_i X_{i,t} + \gamma_i Dates_{i,t-2} + \epsilon_i \tag{4}$$

The results suggest besides reacts to regional news and policy, US non financial CDS sectors reacts significantly to the Europe commission's policy announcement, while EU financial sector reacts strongly to the US market news announcement.Furthermore, different sectors reacts to news differently.

Under the limits to arbitrage theory, high persistent nonzero basket index spread suggest investor is unable to trade to push the index back to its intrinsic value. Therefore, factors that suggest relevant level of limits to arbitrage should be significant explains the spread measure if the limits to arbitrage is cause of the non-zero spread. On the other hand, if the macro-economic risk factors are significant cross sectionally, the basket index spread measure is aligned with (Longstaff, Pan, Pedersen, and Singleton, 2011; Ang and Longstaff, 2013; Pan and Singleton, 2008) as a risk premium measure that would be sensitive to certain common risk factor. Our interest is on the dates variables to investigate whether government bailout could impacts the insurance produces price to diverge from its fundamental value.

The empirical results suggest after controlling for potential causes of liquidity risk factor, economic and financial market impacts, government intervention still has considerable significant impacts on the basket index spread, and would potentially cause the parity relationship fails in real life. (Studies on changes in the spread levels are also performed). However, to explore the exact impact mechanism or the risk transfer dynamics of the government policy, further studies should be conducted.

5 Conclusions

We investigate the impact of bailout intervention from local government and central banks on the sector wide systemic risk during the crisis based on our measure of basket-index spread of CDS index. We found common risk factor such as volatility risk premium and high yield risk premium significantly influence the spread level cross sectionally. Liquidity factor suggested by limits-to-arbitrage literature does not fully explain the non-zero spread. On the other hand, we find government policy and bailout intervention news have impact on the sector wide basket-index spread.

On going work contain theoretical motivation behind the basket-index measure with a reduce-form literature; further robustness check with the news variables and robustness checks and extend with direct crisis economic condition measures [14].

[14] (Kallestrup, Lando, and Murgoci, 2013; Kelly, Pástor, and Veronesi, 2014; Billio, Getmansky, Lo, and Pelizzon, 2012; Schweikhard and Tsesmelidakis, 2012)

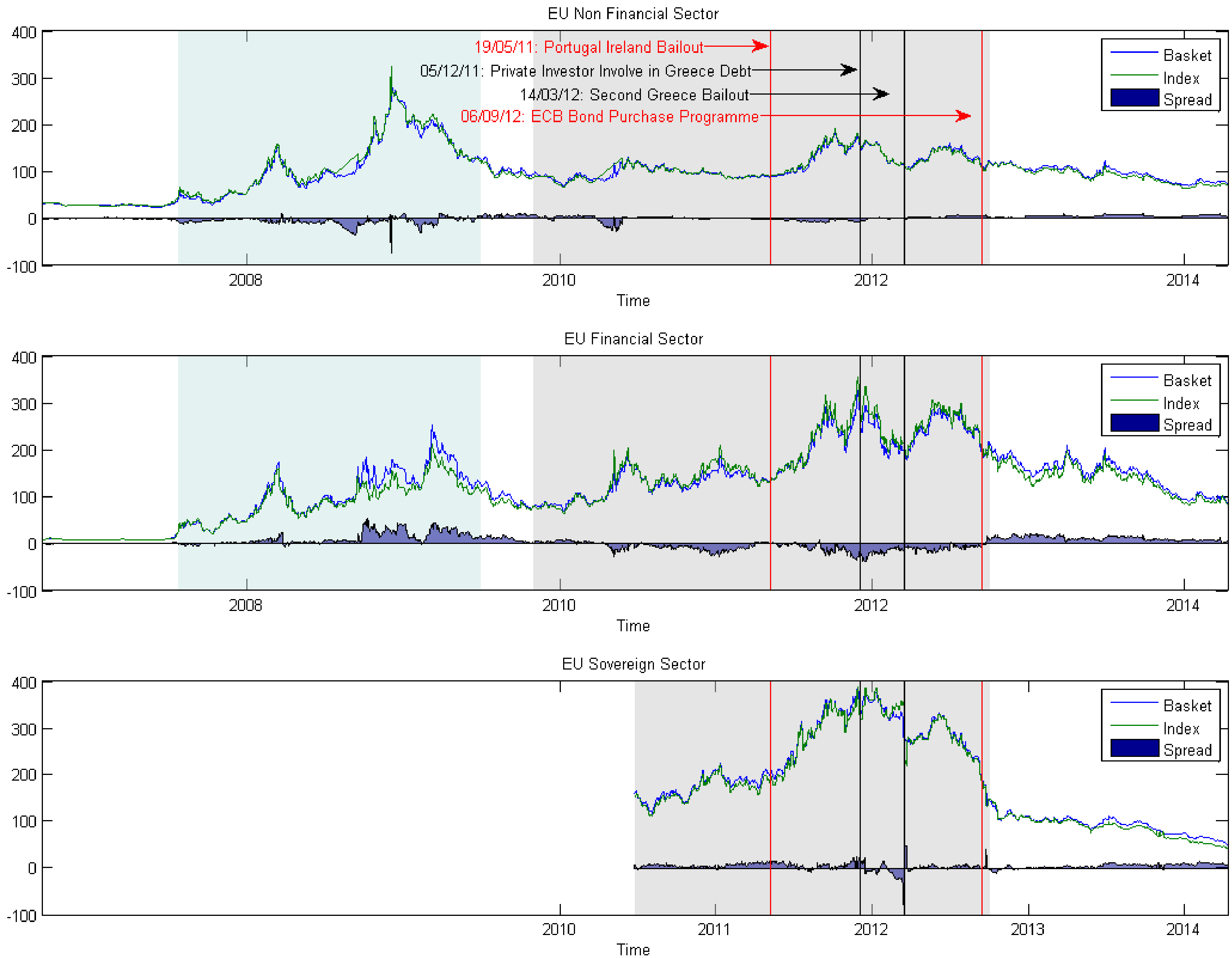

Figure 1: Time Series of 5- Year CDS Index, Basket and Basket-Index Spread

The figure plots the time series of insurance cost of 5-Year CDS index, the replicate basket, and the time dynamics of the basket index spread which measures the price difference between the basket and the index for the European Non-Financial sector (top), Financial sector (middle) and Sovereigns (bottom). All measures are at basis point. The Sovereign CDS index is issued in Sep 2009.

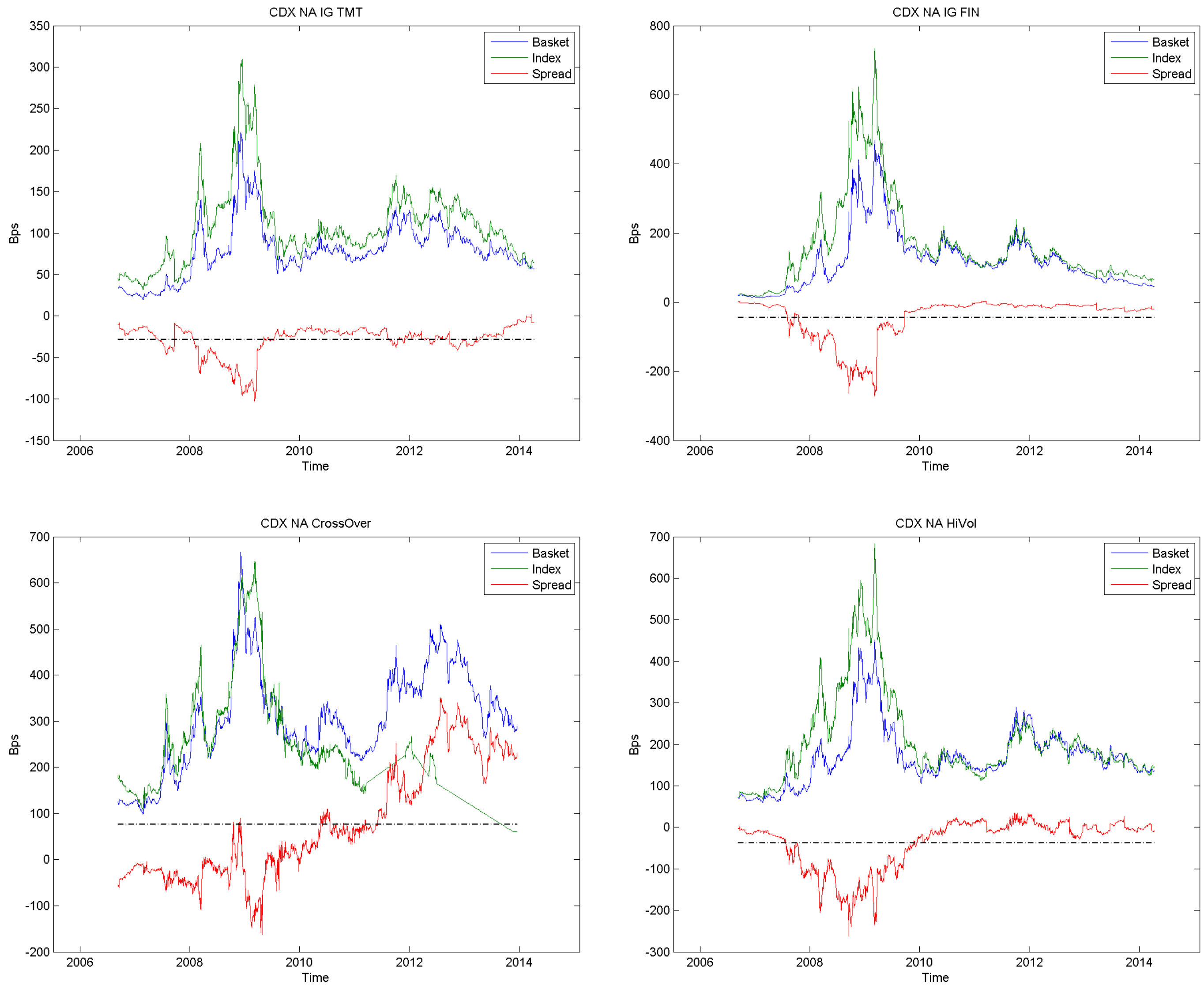

Figure 2: Basket,Index and Spread: Theoretical Measures for US CDS Indices

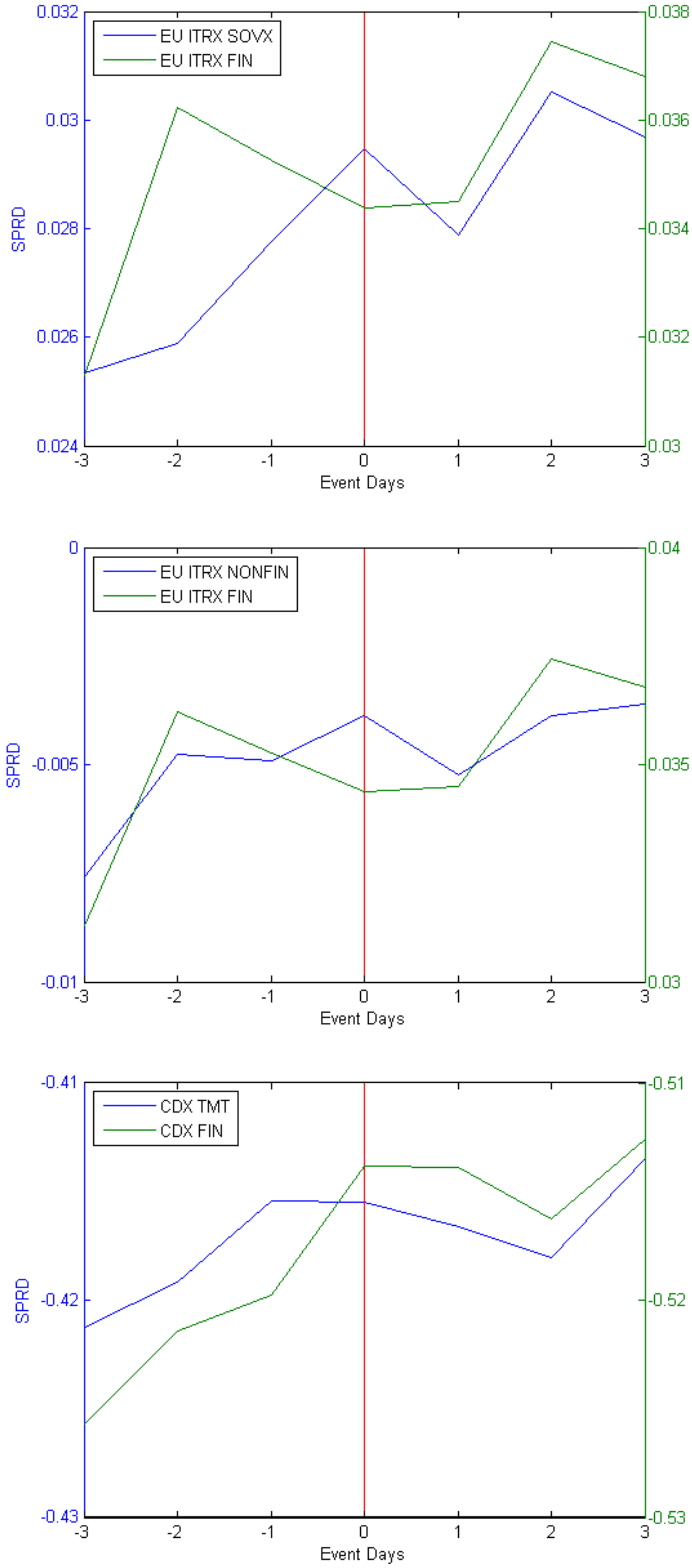

Figure 3: Event Study: Basket Index Spread Level Average Across All Event Dates

Table 1: Summary Statistics

The table reports the mean, median, standard deviation (S.D), minimum (Min) and maximum (Max) statistics of insurance cost for CDS index, replicate basket and basket index spread. The U.S. CDS index includes CDX North American Investment Grade (CDX NAIG) Consumption (CONS), Telecommunications, Media and Technology (TMT), Financial (Fin) High Volatility (HVOL) and CrossOver (XO). The Europe CDS index includes iTraxx Europe (iTraxx Eur) Sovereign Western Europe (West EU), Non Financial (Non Finl), Senior Financial (Sr Finls), High Volatility (HiVol) and CrossOver (Xover). Panel A reports index insurance cost that extracted from Markit. Panel B reports the insurance cost for the replicating basket of CDS. Panel C reports the basket-index spread.

Panel A: Index Premium (Basis Point)

Index ID	Mean	Median	S.D	Min	Max	N
CDX NAIG CONS	85.540	81.750	37.310	35.973	269.683	2158
CDX NAIG TMT	102.676	97.197	48.168	31.693	309.252	2158
CDX NAIG FIN	151.896	120.464	129.494	17.133	733.062	2158
CDX NAIG HVOL	198.226	170.496	110.283	64.389	682.821	2158
CDX NA XO	226.178	206.939	113.527	60.000	647.000	2078
iTraxx SovX West EU	167.484	141.327	95.562	41.961	385.663	1096
iTraxx Eur Non Finl	95.154	93.927	46.903	24.172	324.524	2158
iTraxx Eur Sr Finls	116.028	116.274	77.271	6.811	353.000	2158
iTraxx Eur HiVol	159.003	153.408	88.754	38.688	550.000	2158
iTraxx Eur Xover	480.412	448.708	200.993	170.750	1150.333	2158

Panel B: Basket Theoretical Premium (Basis Point)

Index ID	Mean	Median	S.D	Min	Max	N
CDX NAIG CONS	75.411	78.390	33.082	24.242	213.934	2,158
CDX NAIG TMT	75.914	74.833	34.000	19.868	221.094	2,158
CDX NAIG FIN	111.808	102.421	86.158	13.223	466.701	2,158
CDX NAIG HVOL	162.735	155.979	73.540	56.881	451.837	2,158
CDX NA XO	290.640	290.323	113.662	98.730	666.048	2,078
iTraxx SovX West EU	172.690	146.009	94.395	47.954	384.746	1,096
iTraxx Eur Non Finl	94.701	94.653	46.165	23.168	279.640	2,158
iTraxx Eur Sr Finls	118.391	123.623	75.042	7.135	325.680	2,158
iTraxx Eur HiVol	147.671	139.012	81.635	39.027	537.713	2,158
iTraxx Eur Xover	464.764	455.109	222.682	108.796	1039.039	2,158

Panel C: Basket-Index Spread Theoretical Premium (Basis Point)

Index ID	Mean	Median	S.D	Min	Max	N
CDX NAIG CONS	-10.119	-10.392	13.027	-55.749	12.122	2,158
CDX NAIG FIN	-40.067	-13.622	59.133	-272.074	2.742	2,158
CDX NAIG HVOL	-35.467	-11.152	58.407	-261.962	35.084	2,158
CDX NAIG TMT	-26.755	-22.421	18.309	-103.396	2.068	2,158
CDX NA XO	64.383	26.701	122.778	-162.437	350.798	2,078
iTraxx SovX West EU	5.197	5.024	7.158	-76.135	51.385	1,096
iTraxx Eur HiVol	-11.324	-6.926	19.056	-69.595	37.735	2,158
iTraxx Eur Non Finl	-0.442	0.345	6.418	-73.142	12.350	2,158
iTraxx Eur Sr Finls	2.394	0.863	12.179	-40.207	53.951	2,158
iTraxx Eur Xover	-15.641	-32.825	107.129	-311.003	234.371	2,158

Table 2: Basket-Index Spread for Crisis and Non Crisis Sub-Periods

The table separates the mean of Basket-Index Spreads for U.S. and Europe CDS index into three main subperiods of the sample. For the U.S. market, The before crisis period is from January 2006 to July 2007, the crisis period follows and lasts until June 2009, and the after crisis period ends in April 2014. For Europe market, the crisis period is specified as the EU sovereign crisis period from November 2009 to September 2012. The U.S. CDS index includes CDX North American Investment Grade (CDX NAIG) Consumption (CONS), Telecommunications, Media and Technology (TMT), Financial (Fin) High Volatility (HVOL) and CrossOver (XO). The Europe CDS index includes iTraxx Europe (iTraxx Eur) Sovereign Western Europe (West EU), Non Financial (Non Finl), Senior Financial (Sr Finls), High Volatility (HiVol) and CrossOver (Xover).

Index ID	**Whole Sample**	**Before Crisis**	**During Crisis**	**After Crisis**
CDX NAIG CONS	-10.119	-13.884	-26.297	-2.372
CDX NAIG FIN	-40.067	-3.735	-128.485	-16.39
CDX NAIG HVOL	-35.467	-12.511	-126.409	-6.386
CDX NAIG TMT	-26.755	-14.453	-49.035	-21.822
CDX NA XO	64.383	-42.331	-38.232	145.925
iTraxx SovX West EU	5.197	1.671	4.973	5.866
iTraxx Eur HiVol	-11.324	-6.831	-18.211	-9.428
iTraxx Eur Non Finl	-0.442	-2.591	-0.459	4.967
iTraxx Eur Sr Finls	2.394	6.623	-7.672	11.014
iTraxx Eur Xover	-15.641	-110.093	51.038	93.431

Table 3: Sample Correlation

The table reports the correlation matrices of variables used in the linear regressions for U.S. and Europe markets. The correlation pools all observation within the region together. among the independent variables for both EU and US markets. Variables include High Yield Spread (HY), Investment Grade Spread (IG), Stock Excess Return (Stock), Funding cost spread (Funding), Term Spread (Term),Volatility Risk (Vol Risk), return on Foreign Exchange Rate (FX Rate). Event dates for Europe Central Bank (ECB), Europe Commission (EC), US Federal Reserve Bank of St. Louis (US) and Internal Monetary Fund (IMF).

Panel A: Explanatory Variables US

	HY	IG	Stock	Funding	Term	Vol	FX	ECB	EC	US	IMF
HY	1.000										
IG	-0.057	1.000									
Stock t	-0.313	-0.029	1.000								
Funding	0.041	0.042	0.101	1.000							
Term	-0.052	-0.072	0.106	0.081	1.000						
Vol Risk	0.207	-0.023	-0.768	-0.115	-0.089	1.000					
FX Rate	-0.286	-0.023	0.254	0.027	0.179	-0.227	1.000				
Events ECB	0.022	0.006	-0.006	0.055	0.022	-0.022	0.048	1.000			
Events EC	0.006	-0.003	-0.016	-0.001	0.006	0.012	-0.011	0.105	1.000		
Events US	-0.043	0.065	-0.025	-0.011	-0.035	-0.011	-0.026	0.054	-0.073	1.000	
Events IMF	0.031	0.012	-0.030	0.006	-0.034	0.025	-0.030	0.101	0.088	-0.061	1.000

Panel B: Explanatory Variables EU

	HY	IG	Stock	Funding	Term	Vol	FX	ECB	EC	US	IMF
HY	1.000										
IG	-0.313	1.000									
Stockt	-0.156	-0.090	1.000								
Funding	0.058	-0.019	-0.007	1.000							
Term	0.004	0.263	0.004	0.031	1.000						
Vol Risk	0.093	-0.212	0.000	0.010	-0.217	1.000					
FX Rate	-0.131	0.251	0.037	0.003	0.403	-0.272	1.000				
Events ECB	0.014	0.023	-0.000	-0.025	0.017	-0.012	0.008	1.000			
Events EC	-0.002	-0.000	0.170	-0.013	-0.000	-0.013	-0.029	0.105	1.000		
Events US	0.000	0.001	-0.118	-0.014	0.070	-0.023	-0.009	0.054	-0.073	1.000	
Events IMF	0.007	-0.037	0.118	0.003	-0.001	0.024	-0.020	0.101	0.088	-0.061	1.000

Table 4: Multivariate Regression: Country Specific Event

The table summarizes the results of panel regression of basket-index spread (log basket minus the log index) on daily changes of High Yield Spread (HY), changes of Investment Grade Spread (IG), changes of Funding cost spread (Funding), changes of Term Spread (Term), and changes of Volatility Risk (Vol Risk), Stock Excess Return(Stock), return on Foreign Exchange Rate (Exchange) and country specific event dates of government intervention, US Federal Reserve Bank of St. Louis (US) and Internal Monetary Fund (IMF) for US, Europe Central Bank (ECB), Europe Commission (EC) and IMF for Europe. The regression includes country and year fixed effects, also controls for the clustering around news announcement dates. All Variables pass the unit root test.

$$spread_{i,t} = \alpha_i + \beta_i X_{i,t} + \gamma_i Dates_{i,t-j} + \epsilon_i \qquad j = 0, 1, 2$$

	Panel A: CDX NA IG					**Panel B: iTraxx EU**				
Index ID	**CONS**	**FIN**	**HVOL**	**TMT**	**XO**	**SOVX**	**HVOL**	**NON FIN**	**FIN**	**XO**
Funding	-0.002	-0.009	-0.000	-0.005	0.005	-0.001	0.005	0.002	0.004	0.009
Term	-0.011	0.002	0.011	-0.028	-0.002	0.055*	0.069**	0.078**	0.109*	0.041**
Volatility Risk	0.001	0.001	0.004	0.000	-0.003	-0.003	-0.006**	-0.003*	-0.008**	-0.007***
IG	0.000	0.001	0.001	0.000	0.000	0.027***	0.003	0.018***	0.018*	0.002
HY	-0.001***	-0.001**	-0.001***	-0.001***	-0.001**	-0.034*	-0.091***	-0.063***	-0.098***	-0.070***
Exchange	-0.426	-0.428	-0.073	-0.413	-0.014	0.538***	0.267	0.366*	0.62	0.043
Stock	0.008***	0.011**	0.014**	0.007***	0.002	0.036***	0.093***	0.063***	0.021**	0.023***
Event IMF$_t$	-0.001	0.002	-0.001**	-0.000	0.001	-0.001	-0.001	-0.001***	-0.000	-0.001**
Event IMF$_{t-1}$	-0.001***	0.001*	-0.001*	-0.000	0.002*	-0.001**	-0.001*	-0.002**	-0.001	-0.002**
Event IMF$_{t-2}$	-0.000	0.002**	-0.000	0.001	0.003***	0.000	-0.000	-0.001	-0.000	-0.001*
Event US$_t$	-0.011**	0.004	-0.004	-0.016	-0.024					
Event US$_{t-1}$	-0.011	0.007	0.001	-0.013**	-0.022**					
Event US$_{t-2}$	-0.011*	0.006	0.004	-0.011	-0.022**					
Event ECB$_t$						0.003	0.001	0.002	0.010*	0.007**
Event ECB$_{t-1}$						0.002***	-0.000	-0.000	0.009**	0.006***
Event ECB$_{t-2}$						0.002	0.002	0.001	0.012***	0.009***
Event EC$_t$						-0.002	-0.006**	-0.004**	0.004	-0.001
Event EC$_{t-1}$						-0.004	-0.004	-0.005**	0.005*	-0.001
Event EC$_{t-2}$						0.001	-0.002	-0.004***	0.004*	-0.002
Constant	-0.354***	-0.022***	-0.132***	-0.260***	-0.344***	0.065***	0.416***	0.175***	0.043*	-0.386***
$\mathbf{R^2}$	0.859	0.774	0.763	0.622	0.932	0.551	0.689	0.497	0.466	0.914
$\mathbf{\bar{R}^2}$	0.858	0.772	0.762	0.619	0.931	0.544	0.687	0.493	0.462	0.913
N	2157	2157	2157	2157	2077	1094	2156	2156	2156	2156

$* : p < 0.1 \quad ** p < 0.05 \quad *** p < 0.01$

Table 5: All Sourced Events Multivariate Regression

The table summarizes the results of panel regression of basket-index spread (log basket minus the log index) on daily changes of High Yield Spread (HY), changes of Investment Grade Spread (IG), changes of Funding cost spread (Funding), changes of Term Spread (Term), and changes of Volatility Risk (Vol Risk), Stock Excess Return(Stock), return on Foreign Exchange Rate (Exchange) and all event dates of government intervention sourced from Europe Central Bank (ECB), Europe Commission (EC), US Federal Reserve Bank of St. Louis (US) and Internal Monetary Fund (IMF).The regression include country and year fixed effects, also controls for the clustering around news announcement dates. All Variables pass the unit root test.

$$spread_{i,t} = \alpha_i + \beta_i X_{i,t} + \gamma_i Dates_{t-j} + \epsilon_i \qquad j = 0, 1, 2$$

	Panel A: CDX NA IG					Panel B: iTraxx EU				
Index ID	**CONS**	**FIN**	**HVOL**	**TMT**	**XO**	**SOVX**	**HVOL**	**NON FIN**	**FIN**	**XO**
Funding	-0.002	-0.011	0.000	-0.004	0.003	-0.001	0.005	0.002	0.004	0.009
Term	-0.011	0.001	0.012	-0.028	-0.004	0.055*	0.067**	0.078**	0.098	0.043**
Volatility Risk	0.001	0.001	0.004	0.000	-0.003	-0.003	-0.006**	-0.003*	-0.008**	-0.007***
IG	0.000	0.001	0.001	0.000	0.000	0.027***	0.004	0.018***	0.021*	0.001
HY	-0.001***	-0.001**	-0.001***	-0.001***	-0.001**	-0.034*	-0.090***	-0.064***	-0.092***	-0.071***
Exchange	-0.433	-0.474	-0.069	-0.406	-0.066	0.538***	0.262	0.366*	0.597	0.045
Stock	0.008***	0.011***	0.014**	0.007***	0.003	0.036***	0.094***	0.063***	0.027***	0.022***
Event IMF$_t$	-0.001	0.002	-0.001*	-0.000	0.000	-0.001	-0.001	-0.001***	-0.000	-0.001**
Event IMF$_{t-1}$	-0.001***	0.001*	-0.001	0.000	0.001	-0.001**	-0.001*	-0.002**	-0.001	-0.002**
Event IMF$_{t-2}$	0.000	0.002**	-0.000	0.001	0.002***	0.000	-0.000	-0.001	-0.000	-0.001*
Event US$_t$	-0.011**	0.003	-0.004	-0.015	-0.026	-0.008	0.008	-0.000	0.037***	-0.004
Event US$_{t-1}$	-0.011	0.006	0.002	-0.013**	-0.023**	0.009	0.010**	0.000	0.039***	-0.003
Event US$_{t-2}$	-0.010*	0.006	0.005	-0.011	-0.023**	-0.001	0.012***	0.002	0.041***	-0.000
Event ECB$_t$	0.001	0.009	-0.002	-0.002	0.014***	0.003	0.001	0.002	0.009	0.008**
Event ECB$_{t-1}$	-0.002	0.007	-0.005*	-0.005***	0.012***	0.002***	-0.001	0.000	0.007**	0.006***
Event ECB$_{t-2}$	-0.001	0.008	-0.002	-0.004*	0.016***	0.002	0.002	0.001	0.010***	0.009***
Event EC$_t$	-0.007**	-0.001	-0.011***	-0.006***	0.018***	-0.002	-0.006**	-0.004**	0.005	-0.001
Event EC$_{t-1}$	-0.008***	-0.003	-0.011***	-0.005***	0.019***	-0.004	-0.004	-0.005**	0.005*	-0.001
Event EC$_{t-2}$	-0.007**	-0.005	-0.012*	-0.005***	0.022***	0.001	-0.002	-0.004***	0.005*	-0.002
Constant	-0.355***	-0.023***	-0.132***	-0.260***	-0.346***	0.065***	0.422***	0.175***	0.064**	-0.386***
$\mathbf{R^2}$	0.859	0.774	0.764	0.622	0.932	0.55	0.691	0.497	0.49	0.914
$\mathbf{\bar{R}^2}$	0.858	0.772	0.761	0.619	0.931	0.544	0.688	0.493	0.485	0.913
N	2156	2156	2156	2156	2076	1094	2156	2156	2156	2156

$*: p < 0.1 \quad **p < 0.05 \quad ***p < 0.01$

Table 6: Country Specific Signed News Multivariate Regression

The table summarizes the results of panel regression of basket-index spread (log basket minus the log index) on country-specific signed news variables, US Federal Reserve Bank of St. Louis (US) and Internal Monetary Fund (IMF) for US, Europe Central Bank (ECB), Europe Commission (EC) and IMF for Europe. Other variables included in the regression are changes of High Yield Spread (HY), changes of Investment Grade Spread (IG), changes of Funding cost spread (Funding), changes of Term Spread (Term), and changes of Volatility Risk (Vol Risk), Stock Excess Return(Stock), Return on Foreign Exchange Rate (Exchange). The regression include country and year fixed effects, also controls for the clustering around news announcement dates. All Variables pass the unit root test.

$$spread_{i,t} = \alpha_i + \beta_i X_{i,t} + \gamma_i News_{i,t-j} + \epsilon_i \qquad j = 0, 1, 2$$

	Panel A: CDX NA IG					**Panel B: iTraxx EU**				
Index ID	**CONS**	**FIN**	**HVOL**	**TMT**	**XO**	**SOVX**	**HVOL**	**NON FIN**	**FIN**	**XO**
Funding	-0.002	-0.009	-0.000	-0.005	0.006	-0.001	0.004	0.002	0.002	0.007
Term	-0.009	0.002	0.013	-0.027	-0.002	0.052*	0.068**	0.077**	0.109*	0.043**
Volatility Risk	0.001	0.001	0.004	0.001	-0.003	-0.003	-0.006**	-0.003*	-0.008**	-0.007***
IG	0.000	0.001	0.001	0.000	0.000	0.026***	0.004	0.018***	0.018*	0.002
HY	-0.001***	-0.001**	-0.001***	-0.001***	-0.001*	-0.035*	-0.091***	-0.064***	-0.098***	-0.071***
Exchange	-0.414	-0.438	-0.065	-0.4	0.004	0.563***	0.272	0.378*	0.613	0.045
Stock	0.008***	0.011***	0.014**	0.007***	0.002	0.036***	0.093***	0.063***	0.021**	0.023***
News IMF$_t$	-0.000	0.006	0.004**	0.004***	-0.005*	-0.000	0.002	-0.001	-0.000	-0.005*
News IMF$_{t-1}$	-0.001	0.005**	0.003**	0.004**	-0.003	0.001	-0.001	-0.003**	-0.002	-0.005**
News IMF$_{t-2}$	0.001	0.006	0.004	0.005***	-0.003	0.005**	0	-0.001	-0.001	-0.004***
News US$_t$	-0.007	0.002	-0.004	-0.012	-0.016					
News US$_{t-1}$	-0.007	0.004	0.001	-0.010**	-0.013					
News US$_{t-2}$	-0.007	0.004	0.002	-0.009**	-0.013					
News ECB$_t$						0.005*	0.004	0.005	0.019**	0.013**
News ECB$_{t-1}$						0.006***	0.002	0.001	0.015**	0.010***
News ECB$_{t-2}$						-0.000	0.004	0.003	0.018***	0.013***
News EC$_t$						0.009***	-0.008**	0.001	-0.008**	-0.014*
News EC$_{t-1}$						0.004	-0.008*	0.002***	-0.007*	-0.013**
News EC$_{t-2}$						0.005*	-0.009	-0.001	-0.008**	-0.015*
Constant	-0.355***	-0.024***	-0.134***	-0.263***	-0.341***	0.065***	0.416***	0.174***	0.043*	-0.385***
$\mathbf{R^2}$	0.859	0.774	0.764	0.622	0.932	0.552	0.69	0.497	0.468	0.914
$\mathbf{\bar{R}^2}$	0.858	0.772	0.762	0.619	0.931	0.546	0.687	0.492	0.464	0.913
N	2156	2156	2156	2156	2076	1094	2156	2156	2156	2156

$* : p < 0.1 \quad **p < 0.05 \quad ***p < 0.01$

Table 7: All Signed News Multivariate Regression

The table summarizes the results of panel regression of basket-index spread (log basket minus the log index) on all signed news variables, Europe Central Bank (ECB), Europe Commission (EC), US Federal Reserve Bank of St. Louis (US), Internal Monetary Fund (IMF). Other variables included in the regression are changes of High Yield Spread (HY), changes of Investment Grade Spread (IG), changes of Funding cost spread (Funding), changes of Term Spread (Term), and changes of Volatility Risk (Vol Risk), Stock Excess Return(Stock), Return on Foreign Exchange Rate (Exchange). The regression include country and year fixed effects, also controls for the clustering around news announcement dates. All Variables pass the unit root test.

$$spread_{i,t} = \alpha_i + \beta_i X_{i,t} + \gamma_i News_{t-j} + \epsilon_i \qquad j = 0, 1, 2$$

	Panel A: CDX NA IG					**Panel B: iTraxx EU**				
Index ID	**CONS**	**FIN**	**HVOL**	**TMT**	**XO**	**SOVX**	**HVOL**	**NON FIN**	**FIN**	**XO**
Funding	-0.002	-0.009	-0.000	-0.005	0.006	0.000	0.005	0.003	0.001	0.008
Term	-0.01	0.002	0.013	-0.026	-0.004	0.055*	0.067**	0.078**	0.100*	0.045**
Volatility Risk	0.001	0.001	0.004	0.001	-0.003	-0.003	-0.006**	-0.003*	-0.008**	-0.007***
IG	0.000	0.001	0.001	0.000	0.000	0.026***	0.004	0.018***	0.020*	0.001
HY	-0.001***	-0.001**	-0.001***	-0.001***	-0.001*	-0.033*	-0.090***	-0.064***	-0.095***	-0.071***
Exchange	-0.408	-0.435	-0.069	-0.404	0.015	0.553***	0.281	0.393*	0.621	0.05
Stock	0.008***	0.011***	0.014**	0.007***	0.002	0.036***	0.094***	0.062***	0.025***	0.023***
News IMF$_t$	-0.001	0.005	0.004*	0.004***	-0.005**	0.017*	0.011	0.016**	0.013	0.005
News IMF$_{t-1}$	-0.001	0.004	0.003**	0.004**	-0.004	-0.028***	0.011	0.012*	0.001	0.005
News IMF$_{t-2}$	0.001	0.006	0.005	0.006***	-0.004	-0.025**	0.016**	0.015***	0.018	0.011***
News US$_t$	-0.007	0.002	-0.004	-0.012	-0.016	-0.008*	0.004	-0.001	0.023***	-0.003
News US$_{t-1}$	-0.007	0.004	0.001	-0.010**	-0.014	0.001**	0.006*	-0.000	0.025***	-0.002
News US$_{t-2}$	-0.007	0.003	0.003	-0.009**	-0.014	0.000	0.007**	0.000	0.027***	-0.000
News ECB$_t$	0.000	0.017*	-0.003	-0.005	0.014**	0.005*	0.003	0.005	0.017*	0.013**
News ECB$_{t-1}$	-0.003	0.013	-0.006**	-0.010**	0.011**	0.006***	0.001	0.001	0.014**	0.010***
News ECB$_{t-2}$	-0.002	0.014	-0.002	-0.008	0.017***	0.000	0.004	0.003	0.016***	0.013***
News EC$_t$	0.006**	0.003	-0.004	-0.004	0.010***	0.008***	-0.008**	-0.000	-0.008**	-0.015*
News EC$_{t-1}$	0.006***	-0.001	-0.003	-0.004***	0.009	0.005*	-0.009**	0.001	-0.007**	-0.014**
News EC$_{t-2}$	0.002	-0.003*	-0.004	-0.006	0.008***	0.005*	-0.011	-0.003*	-0.009*	-0.016*
Constant	-0.355***	-0.026***	-0.134***	-0.262***	-0.343***	0.065***	0.420***	0.175***	0.058**	-0.385***
$\mathbf{R^2}$	0.859	0.775	0.764	0.623	0.932	0.552	0.691	0.498	0.484	0.914
$\mathbf{\bar{R}^2}$	0.858	0.773	0.761	0.619	0.931	0.545	0.688	0.494	0.479	0.913
N	2156	2156	2156	2156	2076	1094	2156	2156	2156	2156

$* : p < 0.1 \quad ** p < 0.05 \quad *** p < 0.01$

Appendices

6 Basket-Index Spread

This appendix describes the steps of constructing the Basket Index Spread Measures. In particular, two types of Index spread measures are focused in this study in order to avoid model risk. That is, the theoretical intrinsic index value that follows the exact steps described in the Markit CDS model procedures; as well as a single tranche index measure that explicitly considers the correlation across the constituents names.

Measure Construction The following is a summarize steps to construct the intrinsic theoretical index premium from single-name CDS quoted premiums on the underlying entities.

- Bootstrap the zero curve from Libor and interest rate swap term structure, which is used to discount the present value of the future cash flows;
- With the bootstrapped zero rate and the term structure of CDS level across the 6 month, 1year, 2 year, 3 year, 4 year, 5 year 7 year maturities, as well as the recovery rates, we bootstrap the single name CDS default probabilities and default hazard rates across the term structure. Then, we calibrate and bootstrap the single name CDS premium with aligned document clauses of the corresponding CDS index, such as recovery rates, maturity date, fixed coupon rate.
- Single name CDS price are calculated under the new premium level, and the intrinsic index price is the sum of the constituents' CDS prices.The intrinsic theoretical CDS index premium is calculated based on the present price of basket
- The intrinsic basket index spread is the different between the basket premium and the observed index level that is provided from Markit.

The CDO single tranche CDS index premium follows exactly the same first two steps.The different follows when constructing the basket measure, instead of considering there is zero correlation across the single names, correlation based on the default intensities across single names are constructed. And then we simulate default scenarios based on the single name default probability , as well as the correlation across the names. The CDS basket premium level therefore is calculated on the default of constituents. Moreover, various correlation measures and simulation methods are examined for robustness purpose. For the reporting purpose, we use the tranche measure that follows t-copula and use monte carlo simulation algorithm. The following are the detailed steps.

Firstly, for each single name reference name, the corresponding risk neutral survival probabilities are calibrated to the quoted term-structure. The basic calibration algorithm is based on **?** with the following assumptions: i) the credit events occur randomly at the first jump times τ_m from a independent, inhomogeneous Poisson processes with deterministic intensities λ_m for $m = 1, ..., M$ across M constituents. ii) the risk neutral default intensities are constant among maturities of the single-name CDSs. iii) interest rates is indecent from the credit events. iv) creditors recover a constant fraction R of the reference obligation's par value in case of default events.

To calibrate the risk neutral default probability, we first bootstrap the zero-rate curve from the term-structure of the USD Libor rates, which is used as the discount factors for arbitrary horizons. Denote $Z(t, s)$ as the discount factor at time t that is applicable to risk free cash flows occurring at time $s, s \geq t$, then the Default Leg (DL) of a T year maturity single-name CDS on the reference name m is given by:

$$DL_{t,m} = \mathbb{E}_t[(1 - R_m)Z(t, \tau_m)\mathbf{1}_{1<\tau_m \leq T}]; \tag{5}$$

$$= \int_t^T (1 - R_m)Z(t, s)(-dQ_m(t, s)); \tag{6}$$

$$Q_m(t, s) = \mathbb{E}_t[\mathbf{1}_{\tau_m > T}]$$

where $Q_m(t, s) = \mathbb{E}_t[\mathbf{1}_{\tau_m > T}]$ is the risk neutral survival probability of entity m up to and including time point s, conditioning on entity m has not defauled before time t. R_m denotes the constant recovery rate for entity m. The corresponding premium leg for entity m is:

$$
\begin{aligned}
PV_{t,m} &= s_m \cdot \mathbb{E}_t[\sum_{n=1}^{N} Z(t,t_n)\mathbf{1}_{\tau_m > t_n}] \\
&= s_m \cdot \Big[\sum_{n=1}^{N} \Delta(t_{n-1},t_n)Z(t,t_n)Q_m(t,t_n) + \sum_{n=1}^{N}\int_{t_{n-1}}^{t_n} \Delta(t_{n-1},\tau_m)Z(t,\tau)(-dQ_m(t,\tau_m))\Big] \\
&= s_m \cdot RPV01_m
\end{aligned} \tag{7}
$$

With the quoted term-structure of the par spreads $s_m^{par}(t,T_1),...,s_m^{par}(t,T_K)$ for each individual reference name, given there have no triggered a credit event, the survival probabilities is obtained by bootstrapping over maturities $T_k, k = 1,...,K$ with the following equation

$$
\begin{aligned}
DL_m &= PV_m \\
0 &= \int_t^T (1-R_m)Z(t,s)(-dQ_m(t,s)) - s_m^{par} \cdot RPV01_m
\end{aligned}
$$

The key difference between this method versus traditional CDS index theoretical measure is that our measure utilizes the literature from the CDO tranche pricing, wherein the CDS index is priced as a single tranche CDO product with attachment point of 0% and de-attachment point of 100%. That is, the CDS index is a tranche product that provides protections on all the underlying names constitute the index. After extracting the risk-neutral survival (default) probabilities and default intensities from the market quote on single name CDS spread, the second step is to calculate the physical asset correlation based on (Merton, 1974). For each day and the group of entities that in the sample, we estimate asset return correlations on the basis of the associated time series of the default probabilities over the previous 30 days with with the formula 8. A more sophisticated algorithm that calibrating the correlation can be find in **?**.

$$
\begin{aligned}
\rho_{ij} &\equiv corr(\Delta \ln V_{i,t} \ln V_{j,t}) = corr(\Delta \ln DD_{i,t} \ln DD_{j,t}) \\
&\approx corr(\Delta\Phi^{-1}(q_{i,t}), \Delta\Phi^{-1}(q_{j,t}))
\end{aligned} \tag{8}
$$

where $q_{i,t}, q_{j,t}$ is the risk neutral default probability of entities i, j at time t.

Thirdly, with the calculated credit default correlations and the boothstrapped default probabilities, we generate the probability distribution of joint defaults in the given index portfolio with a Monte Carlo simulation technique, which is described as below.

Monte-Carlo Simulation for the joint probability distribution of defaults in a portfolio of M entities:

1. Generate N random draws x_0 from independent standard normal distributions;
2. Calculate $x = R'x_0$, where R denotes the Cholesky factor of the estimated asset return correlation matrix from the M entities;
3. Denoting the $m-th$ member of x by x_m $(m = 1, ..., M)$and the associated default probability by $PD_{m,t}$, entity m is considered as default if and only if $x_m \leq \Phi^{-1}(PD_{m,t})$
4. Repeat steps 2 and 3 a large number of times to estimate the probability of $n \in 0, ..., M$ default.

Single Tranche CDS Index Pricing

With this joint default probability distribution, the predicated levels of single tranche CDS index is generated based on **?**. For each day, the joint default probability for $k, k \in \{1, ..., M\}$ defaults up to the payment date $T_n, n \in \{1, ..., N\}$ is $p(k, T_n)$. Therefore, the expected default loss on the single tranche CDS index up to payment date T_n, denoted as $EL_n, n \in \{1, ..., N\}$, is denoted as

$$EL_n = \sum_{k=0}^{M} p(k, T_n) \cdot k \cdot A \cdot (1 - R)$$

where A is the notional amount. Since the CDS index is equally weighted, A is equalized across all constituents. R is the recovery rate, which is also equalized across all names, and is set as 40% as the index recovery rate. The expected present value of default leg across all payment dates up to the maturity of the index is

$$DL = \sum_{n=1}^{N} Z(t, T_n)(EL_n - EL_{n-1})$$

The expected present value of the premium leg is the discounted sum of the premium payment the protection buyer expects to pay:

$$PL = s \sum_{n=1}^{N} Z(t, T_n) \Delta_n (M \cdot A - EL_n)$$

$M \cdot A$ is the total notional of the index. Δ_n is the accrual factor for payment date n ($\Delta_n \approx T_n - T_{n-1}$). The single tranche CDS index premium level is therefore as:

$$DL = PL$$

$$s = \frac{\sum_{n=1}^{N} Z(t, T_n)(EL_n - EL_{n-1})}{\sum_{n=1}^{N} Z(t, T_n) \Delta_n (M \cdot A - EL_n)}$$

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