
CDS: LIQUIDITY SHORTAGE OR STRUCTURAL INSOLVENCY?

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ABSTRACT

A Credit Default Swap is typically explained as the price to insure the investor from a default of a specific issuer. In this paper we will analyze the behaviour of CDS for financial issuers from 2008 to current times.

We will derive a simple theoretical framework where liability management and liquidity will play a central role in determining CDS levels: such framework will be also useful to evaluate the impact of monetary policy, in the extent it modifies liquidity supply, on CDS spreads.

Usually monetary policy is assumed to have immediate consequences on interest rates levels; this work adds a different perspective arguing, by also providing some empirical evidence, that Liquidity, seen as a direct input of monetary policy, has a strong explanatory power on levels of financial CDS.

QUESTIONS POSED BY THIS PAPER.

Since 2007 policy makers have been facing unprecedented times, which required their intervention in more than one occasion and sometimes jointly across different monetary areas. Liquidity within the banking system has played a crucial role in the last 4 years: the banking system saw the intervention of regulators and sovereign states across the whole capital structure (in guaranteeing senior debt issuance and in subscribing shares/ subordinated debt). Debt, be it sovereign or private, is scrutinized in its sustainability and correction measures are being taken by sovereign states and by the banking system in a common aim of deleverage.

This paper analyzes the crucial role of liquidity in a deleverage process and finds that under certain conditions central banks can no longer rely on an efficient transmission mechanism of their monetary input through the banking system. Rather than considering the latter a transmission tool, central banks try to preserve liquidity at critical level for the survival of the banking system.

Ultimately this paper provides an answer to how important liquidity is for the purpose of explaining CDS levels in an economy characterized by a financial crisis, credit deterioration and deleverage.

For the avoidance of doubt this paper will never adopt the term “Liquidity” to denote efficiency in the financial market with respect to the price of one particular instrument, but will always refer to the portion of the monetary base readily available to the banking system, as a cash reserve or for the purpose of redeeming debts.

RELATED LITERATURE.

This study contributes to, at least, two strands of literature.

The first one is represented by the field of studies investigating the determinants of CDS spreads, with a focus on the recent years of financial turbulence. The main contribution of this work is in the emphasis of the role of liquidity, meant as degree of cash availability, in explaining the evolution of CDS whose reference entities are Banks. Many other factors are identified by literature: Dieckmann and Plank (2010) find evidence that government CDS of various

countries find explanatory variables in the country's domestic financial system and the state of the world financial system (represented via variables respectively "Country Specific" and "Global"). Fontana and Scheiche (2010) identify the main determinants of the bond and CDS Spreads. Furthermore they employ a lead-lag analysis for bonds and CDS to determine which market is more important in terms of price discovery. They also explore the evolution of the Basis between bonds and CDS, variable which is also central in this work.

The second strand of literature is related to the link existing between sovereign CDS and banks CDS. On this topic the main contribution of this work is in expanding such link from a regional viewpoint (typically literature investigates the link between government CDS and its local banks) to a more aggregated monetary area perspective. In emphasizing such wider approach we refer to "Global Consolidation" as the consolidation of the entire banking sector and we strive to draw conclusions (via an econometric approach) on the entire banking sector rather than a regional subset. Acharya et al. (2011) provide a model for the interrelation of banks and government credit risk. Focusing on the current financial crisis, Demirguc and Huiziniga (2010) find that banks CDS level react to the deterioration of public finances conditions. High levels of public debt hamper the support to the financial sector and too big to fail banks may turn into too big to be saved. Ejsing and Lemke (2011) investigate the relationship between Sovereign and Banks CDS via a common risk factor, i.e. the Itraxx CDS Index of non-financial corporations (this work instead will analyze the evolution of the Itraxx CDS Index of financial corporations and use as one of the regressors the CDS Index of non-financial corporations). Alter and Schuler (2012) investigate the interdependence of the default risk of several Eurozone countries and their domestic banks. Knaup and Wagner (2009) have found that correlation between banks stock returns and an index of corporate CDS spreads provides a good indication of bank asset risk exposure during the financial crisis.

Another field of literature considers liquidity as a feature to take into account as a deviation from a frictionless market. This leads theoretical works to redefine self-financing trading strategies with additional restrictions on hedging strategies (Cetin, Jarrow and Protter). Liquidity may also be considered when defining a Liquidity Stochastic Discount Factor (Chen, Cheng and Wu, 2005, and Buhler and Trapp, 2006 and 2008). Various empirical approaches consider liquidity as one of the risky factors to include in the framework of CAPM to explain the return of a portfolio of CDS contracts.

This paper emphasizes a different meaning of liquidity and it does not consider it as just one of the factors to explain the CDS levels for the portion that cannot be related to credit risk: liquidity during the financial crisis is an important variable in explaining the levels of the CDS whose reference entities are the most levered players in financial markets: Banks and, in general, financial institutions. This angle of liquidity is also analyzed by Vento and La Ganga (2009), who deal with Liquidity in a perspective of risk management addressing the Bank Liquidity Risk Management in light of the market turmoil experienced in recent years. Angelo Baglioni deals with liquidity crunch in the interbank market (2009): his model can explain the phenomenon of “flight to overnight” in traded volumes and produce outcomes of high spreads between interest rates at different maturities.

INTRODUCTION

This paper is an attempt to address some topics of central importance during the current financial crisis:

- o Balance Sheet Deleverage
- o Debt Markets not capable of addressing the refinancing needs of the banking sector
- o Capital Structure
- o Evolution of Sovereign CDS and Banks’ CDS
- o The role of monetary policy and its reliance on the banking system as a transmission mechanism

These topics will ultimately lead to addressing the main questions of this paper: What is the role of liquidity in explaining the level of Banks’ CDS? For the portion not attributable to Liquidity are we dealing with systemic risk or simply an entity specific risk?

Economic models typically describe equilibrium as a point of convergence of different agents acting within an economy: one interesting aspect is to consider the forces into play after a shock. What exactly connects variables and how do they interact until economy stabilizes after the shock? The current financial crisis can be conceived as a long (and harsh) adjustment process, often with the bold intervention of Central Banks and governments, where no market player can properly foresee the next point of equilibrium. In the acknowledgment that

policy makers may have to make decisions through uncharted waters, one of the focus of research, is shedding light on the interaction across variables during these uncertain times. The difficulty in the description of a transmission mechanism is in determining the contribution of all the aforementioned variables, and their cross interaction to produce a final outcome. Any model can hardly consider all these variables via a general equilibrium approach. A conclusion, if not corroborated by empirical evidence, would be of no use.

This paper contributes to the search of the meaningful factors (and their interaction) during the current crisis; it emphasizes that Liquidity scarcity is the main transmission vehicle of an inadequate capital structure. Admittedly, analyzing a crisis from a financial viewpoint only is reductive since literature and intuition argues in favour of a crisis as a result of real and financial imbalances. Nevertheless, real variables take a long period to adjust and policy makers are left with the short term goal of dealing with systemic risk and sustainability of the monetary areas. What is conceived by standard literature as the transmission mechanism is today the first concern when addressing survival of the system: the banking sector is indeed a transmission mechanism, but no longer of central bank monetary inputs. It is transmitting to the economy a deleverage wave which is demanded by the market as the very first step to achieve sustainability of the capital structure. In this context research has the delicate task of shedding light on such new (and unknown) transmission mechanism, where variables interaction is very difficult to guess. Hence this paper is composed by a simple theoretical framework where the key role is played by a liquidity constraint of the banking sector. We will impose a liabilities rolling constraint in the ordinary functioning of the banking sector. We will analyze the same liquidity constraint when instead the debt market does not clear. We will justify this event with a drop in profitability of the banking sector, such that the endogenous growth for equity is inferior to the endogenous growth of debt, thus forecasting an amount of equity far too low to protect bond holders from insolvency risk. Satisfying the liquidity constraint will be considered as the event of No Default: if the market for financial debt does not clear, the role of liabilities towards central bank will be crucial to avoid default. Such liabilities imply injection of liquidity, hence the liquidity may have an explanatory value on probabilities of default. We will show whether this intuition is confirmed by a linear regression model applied to a set of financial data.

How realistic is in current days that Return on Equity for Banks is inferior to interest paid to roll liabilities? If this were the case, the capital structure evolves endogenously towards a higher percentage of debt: this inevitably will be discounted by financial markets when pricing Debt and when subscribing new

issuances. When Equity estimated by the market is too low compared to the stock of debt, the debt market no longer clears.

The author has dedicated a paper to the concept of endogenous capital structure, as opposed to the accounting (static) measure proposed by regulators and by the management of the banking industry. The transmission mechanism proposed here is that a suboptimal capital structure causes a rise in the CDS of the bank, and a decrease in the speed of growth of equity (due to profitability reduction). A necessary condition for a bank capital structure to be stable (hence resilient to shocks) is that speed of growth of equity is equal or higher (within a certain timeframe) than the debt growth rate. If such necessary condition is not satisfied, the market prices a reduction of the equity percentage in the capital structure: financial debt is then forecast to bear equity risk. Market may then not clear, in the sense that no demand can absorb the supply of the financial debt which is meant to be rolled to finance imminent redemptions. In a framework where the level of CDS is assumed to be the credit spread for the new issuance (when the market for financial debt clears), financial CDS rise with a strong signalling power for central bank. Central bank then is called to assess how sound is the transmission mechanism of monetary policy. Intervention by the central bank is crucial in shaping the future capital structure of the bank, by controlling the refinancing rules. By setting a credit spread for refinancing below CDS, central bank addresses the problem by reducing the speed of growth of debt, thus not compressing the percentage of equity relative to debt.

By enlarging or reducing the set of constraints in defining the refinancing rules, the central bank influences the forward capital structure of a bank. The incentive for the central bank to intervene is mainly in preserving an orderly transmission mechanism of monetary inputs: a capital structure controllable in its evolution does not force management to a drastic deleverage (as a way to implement a debt reduction).

In this paper we show that the liquidity availability for financial institutions is a good explanatory variable for levels of CDS. The ability to satisfy liquidity constraints then influences the probability of default of the entire European banking sector. Hence the contribution of this paper is in emphasizing that a probability of default can be decomposed into a systemic component which can no longer be attributable to the insolvency of one specific bank. If variations across time of CDS levels could be explained by systemic variables, then the approach to liquidity and solvency by addressing such themes to the specific financial institution is arguable.

A second theme relates to “Global Consolidation”: plenty of econometric analysis shows the strong link between the banking sector within one region and the financial strength of the corresponding sovereign state. We will show that the daily variations of the CDS of the financial sector across Europe can be explained by including, among the explanatory variables, the variations of CDS of selected countries which have experienced financial stress during the current financial crisis. Such a result shows that financial institutions are so interconnected across each other that, not only their CDS is strongly affected by the financial health of the sovereign state where they operate, but isolation from other countries experiencing financial pressure is not achievable. Global consolidation is then the theory that proposes a picture of the banking sector where even if one balance sheet has no exposure to a specific country or to a specific sovereign state within the same monetary area, then it is still affected by its financial health. Such a statement would require a huge effort to be proven via a theoretical model, which is why we find it more appropriate an econometric investigation showing that the daily variations of a European basket of CDS are affected by the daily variations of the CDS of one or few sovereign countries. We then deduce that the transmission mechanism of the current crisis goes well beyond the realm of intuition and that Global Consolidation, although an abstract concept is useful to interpret the evolution of debt across financial institutions. We also deduce that this financial crisis may not be handled with a set of microeconomic measures.

MODELLING BANKS' CAPITAL STRUCTURE

We represent the assets of a bank as a sequence of assets $A(t)$. Every year there will be a decision made by management on new loans and financial assets which we will denote by the sequence $A_n(t)$. Every year some of the assets will redeem in a certain percentage of the total Nominal Amount of the assets. Such percentage of the assets redeeming will be denoted by $a(t)$. Also, some assets will have to be impaired by a certain percentage $d(t)$, so that in a year the amounts of assets on balance sheet are

$$A(t) = A(t - 1) + A_n(t) - d(t) * A(t - 1) - a(t) * A(t - 1).$$

Hence the evolution of the assets is described by

$$\{A_n(s), a(s), d(s)\},$$

Such assets are financed with a mixture of liabilities, namely

- $D(t)$: Deposits at time t
- $B(t)$: Bond outstanding at time t
- $CB(t)$: Liabilities against the central bank at time t
- $S(t)$: Capital at time t

As with assets, every year there will be an amount of issued bonds redeeming and a new issuance of bonds. For this reason the amount $B(t)$ can be rewritten as the sum of all past issuance from time $t - y_b(t)$ until time t . We are implicitly assuming that the past $y_b(t)$ years contribute to the stock of issued bonds. Whereas all bonds issued more than $y_b(t)$ years ago redeemed, the stock of current liabilities, $B(t)$ is described by the following

$$B(t) = \sum_{s=t-y_b(t)}^t B_n(s)$$

Similarly, assets are mainly legacy from past investment decisions: namely last $y_a(t)$ years contribute to the new composition of assets, so that the stock of assets is given by the sum of the investment decisions from time $t - y_a(t)$ until time t

$$A(t) = \sum_{s=t-y_a(t)}^t A_n(s)$$

The bank typically runs a transformation of maturities from liabilities to assets, in the sense that we should expect that the maturity of the assets be higher than the maturities of the liabilities. This maturity gap will prove of crucial importance when the banking system goes through a financial crisis: we will explore this aspect in a section below, when analyzing the liabilities rolling constraint.

A given capital structure as represented above will originate a certain profit for the year: adopting a framework similar to the one specified in a previous work by the same author¹, we will assume that the bond issuance produces a cost of $\text{Euribor}^2 + \text{CDS}$, where CDS is the credit default swap of the issuer, at the time of issuance. Euribor may be defined as the rate of interest at which panel banks borrow funds from other panel banks, in marketable size, in the interbank market, for short term maturities.

¹ Optimal Capital Structure of a bank: the role of asymmetry of information and Equityization of Debt.

² Euribor may be replaced by an analogous short term rate valid in monetary areas other than Euro. The rationale does not change: we are assuming that the cost of issuing debt is Short term rate + CDS level for the reference entity selling its own debt.

From the description of the liabilities above, then the actual cost paid by the bank for its bond issuance is given by a historical average of the CDS levels over the last $y_b(t)$ years. We will denote such average across past years as $CDS_H(t)$

The assets are a differentiated pool of credits towards various sectors of the economy, hence yielding a spread of $CDS_{all H}(t)$; $CDS_{all H}(t)$ is the level of the average CDS across all industrial and financial names (denoted as $CDS_{all}(t)$) over the past $y_a(t)$ years. Clearly the bank may include among its assets credits towards firms which may not be reference entities in the CDS market: we are implicitly assuming that the CDS market may provide a proxy for the yield of assets by observing the average level of all traded CDS. Similarly, the cost for the liabilities is given by the sum of Euribor and $CDS_H(t)$; the latter is an average across the past $y_b(t)$ years of the level $CDS(t)$.

More formally, for all s between $t - y_b(t)$ and t

$$CDS_H(t) = \frac{1}{B(t)} \sum_{t-y_b(t)}^t B_n(s) * CDS(s)$$

And

$$CDS_{all H}(t) = \frac{1}{A(t)} \sum_{t-y_a(t)}^t A_n(s) * CDS_{all}(s)$$

DEPOSITS AND CENTRAL BANK FINANCING

For the sake of simplicity we will consider the cost for liabilities composed by Deposits equal to Eonia³. The liabilities against the central bank will instead produce a cost of $v(t)$. Eonia may be defined as the weighted average of overnight Interbank Offer Rates for inter-bank loans.

Central banks publish criteria to distinguish assets that may represent an admissible guarantee when the bank requires financing. Assets that comply with such criteria are denominated “Elegible Assets”: such criteria then lead to identifying a fraction of the assets, to be denoted⁴ as ρ , which represents admissible collateral for repo transactions with the central bank. A higher number of eligibility criteria means a restrictive policy input. On the contrary, relaxation of parameters and longer tenor available for repo transactions

³ The notation so far introduced clearly shows that the author is primarily thinking of European variables: yet it is easy for every monetary area to find the equivalent rate with identical meaning.

⁴ Such percentage of assets is referred to the pool of assets in the banks' portfolio.

represent an accommodative policy input. In this model such monetary input, in the form or number of eligibility criteria will be summarized by the variable ρ ($0 < \rho < 1$).

Deposits include liabilities versus the retail sector, redeemable with no notice. They also include unsecured lending in the interbank market and repo transactions with collateral where a repo market has developed⁵.

The purpose of this paper is to consider the banking system as an aggregate sector, hence the interbank deposit market will not be considered when evaluating the tools for liabilities management of the consolidated banking sector.

Deposits are by far the cheapest and the most stable⁶ liability for the banking sector. This paper will focus on the difficulties arising when debt issuance is no longer a tool for the purpose of liability management. Modelling a deposit run would be beyond the purpose of this paper: a deposit run, if assumed against the entire banking sector would produce the collapse of the banking system and financial markets. We would thus enter the field of tail events which calls for extreme measures of economic policies. Modelling such scenarios, dominated by frictions and panic is a pure theoretical exercise which would be of no use in this framework.

We will then rewrite the profit, as determined every year when publishing financials as

$$A(t) * [Euribor + CDS_{allH}(t)] - B(t) * [Euribor + CDS_H(t)] - D(t) * eonia(t) - \rho * A(t) * v(t) - A(t) * d(t) - C.$$

The reader may argue that the banking system may not use the full amounts of refinancing facilities offered by the central bank; hence the amount of assets refinanced may be lower than ρ . We would need then to introduce a different notation for the portion of assets actually refinanced with the central bank within this general framework. We avoid doing so since the model will soon focus on condition of distress of the financial markets, and the first reaction of the banking system is to use the central bank facilities at maximum potential as we will discuss below.

C is a generic cost that is not linked to the capital structure and to the investment decisions of the bank. Within this framework the potential profit for the banking system depends on the evolution of $CDS_{allH}(t)$ relative to $CDS_H(t)$.

⁵ Typical repo markets where the banking system can enter repo transactions are the repo markets on government bonds and the Stock lending market.

⁶ Maybe it would be more appropriate to write the least unstable, especially when compared with senior debt.

When such difference decreases, financial markets question the capability of the banking sector to produce profits in the foreseeable future. Reluctance to subscribe financial debt with long maturities follows, which leads to levels of $CDS_H(t)$ closer and closer to $CDS(t)$. Higher levels of Financial CDS typically are correlated with high levels of $d(t)$, a further reason for disputing the future profitability of the banking sector. This theme will be analyzed in more detail in the next paragraph.

NO CLEARING PRICE FOR DEBT.

We have analyzed how to decompose the profit for year t into revenues from the assets and costs on liabilities.

The market will cast a doubt on the sustainability of the capital structure when observing the yield of assets approaching the cost of liabilities. In this section we will ignore the operational/ administrative costs of a bank, a variable beyond the purpose of this paper.

The market will then be reluctant to show a demand for financial debt when the difference between the credit spread on the assets and the credit spread on the issued debt (respectively $CDS_{all H}(t)$ and $CDS_H(t)$) is too small. A market confident reader would argue at this point that the market will adjust the price, i.e. the CDS level, to make sure that a certain supply for debt will find a price where to clear. Financial debt though is not like any other good, due to its systemic relevance and to the link implicitly existing with real economy. A low growth economy⁷ cannot bear that the cost of liabilities be addressed by imposing a higher yield on assets: that would lead to a higher level of nonperforming loans, since the Return on equity of the economy is too low and not capable to cover for further costs in terms of more interest to pay; higher interest would lead to a higher percentage of bankruptcies.

Hence management cannot issue debt, thus forcing itself to shorten the tenor of its liabilities, running a maturity transformation which decreases the average maturity of the debt: this leads to increase the risk that even higher amount will have to be issued in the future, with a significant risk that supply in the future be not met by available demand.

⁷ The financial crisis experienced since 2007 is mainly located in highly developed countries, where it proves impossible to sustain a high cost of debt given the low growth of underlying economies. The latter signals a low (aggregated) ROE of the corporate sector

In a more analytical framework the market evaluates the financial sustainability of assets and liabilities by comparing financial revenues and costs to be associated to the current stock of assets and capital structure. It is reluctant to subscribe financial debt if

$$A(t) * [Euribor + CDS_{all H}(t)] - B(t) * [Euribor + CDS_H(t)] - D(t) * eonia(t) - \rho * A(t) * v(t) - A(t) * d(t) < k * A(t)$$

Where k is to be interpreted as a minimum return on assets after costs. If we divide both sides by the amount of assets, then

$$Euribor + CDS_{all H}(t) - b(t) * [Euribor + CDS_H(t)] - \delta(t) * eonia(t) - \rho * v(t) - d(t) < k$$

Where $b(t)$ is the percentage of assets financed by debt issuance, $\frac{B(t)}{A(t)}$, and $\delta(t)$ is the percentage of assets financed by a stock of deposits. The relevance of these ratios is not only emphasized here, but also common market reports consider the importance of “Loans to deposit ratios” when publishing relevant summary statistics. The condition above can be rewritten as

$$Euribor + CDS_{all H}(t) - [1 - \delta(t) - \frac{1}{\lambda(t)}] * [Euribor + CDS_H(t)] - \delta(t) * eonia(t) - \rho * v(t) - d(t) < k$$

Where we have defined $\lambda(t) = \frac{A(t)}{S(t)}$, i.e. the leverage factor in the balance sheet.

Some important aspects to note at this stage are the following. The simple rule of a minimum profitability of the banking sector so that debt issuance may have a clearing price ultimately depends from a number of important variables. We will briefly comment on some of them

1. $d(t)$ or the depreciation of assets is a random variable whose values are particularly high during economic crisis. Particularly high values could see the condition above satisfied.
2. $\lambda(t)$ is introduced in static terms as a ratio; in a previous work the author has explored its endogenous character and its dependency on the evolution of the credit market. During financial crisis, even if the “nominal” capital structure” is not subject to particular changes, leverage increases due to the drop in value of the assets⁸.
3. $CDS_{all H}(t)$ and its evolution compared to $CDS_H(t)$. Both these variables can be considered, from an empirical point of view, as a moving average. The former is the moving average over the last $y_a(t)$ years of a basket of

⁸ This aspect is explored in length in “Optimal Capital structure of a bank: the role of asymmetry of information and Equityzation of debt”

the most liquid CDS traded, with no distinction for the industrial sector where the reference entities belong to. The latter is a moving average over the last $y_b(t)$ years of all CDS whose reference entities are a financial institution. The reason why we look at a financial index rather than the CDS of one issuer only is because the financial crisis is affecting the entire banking sector and conclusions for a specific issuer could be biased by the specific situation and events proper of one financial institution only. Considering the entire sector rather than a single financial institution is also consistent with the theory of global consolidation, mentioned in a previous work by the same author.

EVOLUTION THROUGH TIME OF CREDIT INDICES AND IMPACT ON THE PROFITABILITY OF THE BANKING SECTOR.

This brief section aims at describing the evolution of CDS in recent years, for the purpose of providing an intuition on the higher costs of the financial sector in managing their liabilities, compared to a small increase in the yield of the assets (for their portion redeeming, hence rolled with higher yields). It is evident that even if assets and liabilities were due and rolled in the same amount, then the increase of the Itraxx financial senior since 2008 means a drop in profitability of the banking sector (if the index can be considered as a proxy for the cost of liabilities and the yield of assets may be represented by the index Itraxx Europe Main⁹). This is witnessed by the substantial decrease in the net Interest Margin¹⁰ of the banking sector, ultimately leading to a downgrade of profit forecast and to the unattractiveness of the financial sector for investors. We have assumed above that the actual profit for a bank depends on the evolution of a backward looking average of CDS. Also the cost of liabilities is backward looking, since liabilities still due at time t may have been issued various years ago. From an empirical point of view it is easier to observe the evolution of the CDS with no average over past years, in the understanding that the number of years to look back for liabilities is typically lower than the number of years required for the assets¹¹. Hence we have that a higher cost of

⁹ More detail on the composition and the rationale of construction is provided in the empirical section and the appendix of this work.

¹⁰ From Wikipedia: "Net interest margin (NIM) is a measure of the difference between the interest income generated by banks or other financial institutions and the amount of interest paid out to their lenders (for example, deposits), relative to the amount of their (interest-earning) assets. It is similar to the gross margin of non-financial companies".

¹¹ Due to the transformation of maturities proper of the banking balance sheet, we would expect that assets are financed with shorter dated maturities liabilities. Hence the Rolling speed of liabilities is typically higher on liabilities, if compared to the assets.

debt issuance, even if matched by an identical move on the yield of assets available in the market, affects negatively the Net Interest Margin of the bank and reduces profits. If instead the rise in financial CDS is stronger than the movement in non financial CDS we can conclude a fortiori that such scenario is negative for the banking sector, even without considering that the effective cost of liabilities depends (likewise for the assets) on a backward looking average. The more such move (rise in the difference between financial and non financial CDS) takes place, the more likely it is that the market may move towards a state described as “no clearing price for debt”.

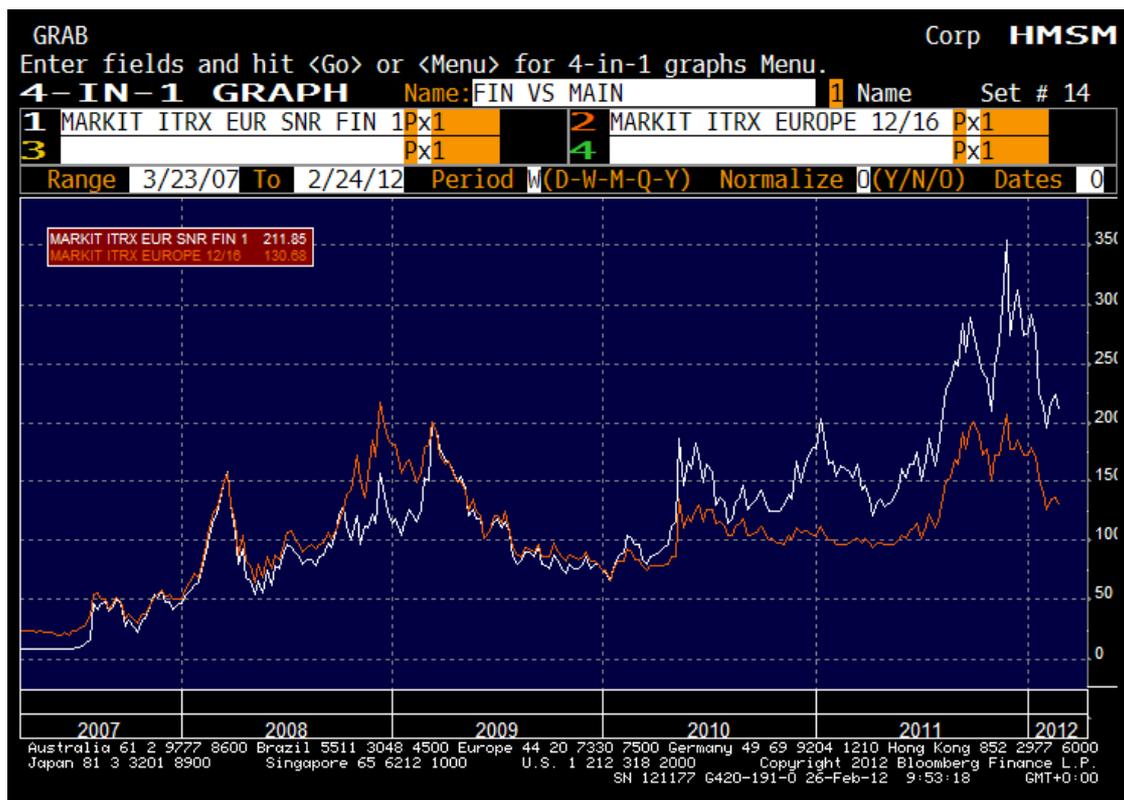


FIGURE 1

The graph above (source: Bloomberg) shows indeed that the financial CDS (white line) has evolved, since 2010, drastically higher than the average of all Most liquid CDS. We are in this graph looking at the European (Euro denominated) indices in the family of Itraxx Indices. Itraxx financial senior (white line) and Itraxx Main Europe (red line) are here considered representative of, respectively, the average cost of the liabilities for the European banking sector (to be added to Euribor rates) and the average yield of the assets for a diversified pool (Itraxx Main is to be added to Euribor, too). Descriptions of such Indices are in the appendix.

LIABILITIES ROLLING IN PERIODS OF FINANCIAL CRISIS

Every year some previously issued bonds are due for redemption. During ordinary times it would be realistic to assume that financial markets would determine a price for the new issuance so that demand is equal to supply.

We have determined that high debt interests may reduce the trust in the banking sector; hence management may be forced to plan the evolution of the capital structure with limited or no recourse to debt issuance.

The general constraint is

$$\Delta A(t) = \Delta D(t) + \Delta B(t) + \Delta CB(t) + \Delta S(t)$$

For the sake of simplicity we assume that deposit will not change from one year to another and that there will be no rights issuance¹². Hence

$$\Delta A(t) = \Delta B(t) + \Delta CB(t)$$

$$A_n(t) - a(t) * A(t - 1) = B_n(t) - b(t) * B(t - 1) + \rho * [A_n(t) - d(t) * A(t - 1)]$$

Hence the minimum¹³ amount to issue at time t, is equal to

$$B_n(t) = b(t) * B(t - 1) + A_n(t) * (1 - \rho) + A(t - 1) * [\rho * d(t) - a(t)]$$

Such minimum amount to issue is immediate to interpret: further debt issuance is at least equal to the debt due for redemption at time t; it is decreased by the assets redeeming their capital; new issuance is also required for the non eligible portion of new investments.

During last four years there were various periods when no issuer could approach the primary market¹⁴, a fact described within this framework as “debt markets no clearing conditions”. In light of these difficulties management may be forced to set $A_n(t)$ equal to zero or to start a deleverage program, which in most cases requires that the bank accept to sell assets at discounted value: indeed the market will determine the value of an asset also computing a liquidity premium, due to the structural search of liquidity and to the supply of illiquid credit from the banking sector to the financial market.

Until this point we have analyzed all variables from a financial point of view, in a framework that makes an attempt to model evolution of assets and liabilities

¹² Even if we assumed that in a financial crisis Deposit reduced their amounts, then results would not change substantially.

¹³ Management could issue more debt than such minimum, for various reasons: for prudential reasons or because it forecasts that soon too many redemptions will be due.

¹⁴ As in all definitions of primary markets, here the primary market for financial debt is the market that changes the supply and introduces new debt freshly issued by the bank. The secondary market is where such debt, along with all existing (and older) issues trade at so called “secondary market price”.

through time. From a broader perspective $A_n(t)$ equal to zero is ultimately a reaction of the banking industry which transmits a deleverage system to the real economy: a central bank is thus losing control of the transmission mechanism of monetary policy. A crunch in financial liabilities is generating a crunch in liquidity which is immediately being transmitted to the real economy.

EVENT OF DEFAULT AND MATURITY GAP.

A default is typically defined as the event when the value of the assets drops below the value of liabilities. In a scenario characterized by non clearing market conditions, then the deleverage impulse is such that the condition of default, which relates to the value of assets, cannot even be assessed due to the illiquid prices of loans & receivables. When the debt market cannot achieve a clearing price for financial debt, then condition for default is that liabilities can no longer be rolled or just redeemed. The market in such scenario looks at the distribution of maturities for debt issued until that date.

We define

$$\beta(t, t + s) = \int_{x=0}^s b(t + x)$$

so that at time t the bank faces in the next s years an amount of debt to redeem equal to $\beta(t, t + s) * B(t)$

We define also

$$\alpha(t, t + s) = \int_{x=0}^s a(t + x)$$

so that at time t the bank faces a natural reduction in assets in the next s years (due to redemptions) equal to $\alpha(t, t + s) * A(t)$.

We also define a random variable $d(t, t + s)$ which represents the percentage of losses (due to impairment, defaults and deterioration of the loans and receivables portfolio) of the aggregate $A(t)$ occurring from time t until time $t+s$.

Then managing liabilities from time t until time $t+s$ means imposing that the minimum issuance required from time t until time $t+s$, $B_n(t, t + s)$,

$$B_n(t, t + s) = \beta(t, t + s) * B(t) + A_n(t, t + s) * (1 - \rho) + A(t) * [\rho * d(t, t + s) - \alpha(t, t + s)]$$

Default is the event

$$B_n(t, t + s) < \beta(t, t + s) * B(t) + A_n(t, t + s) * (1 - \rho) + A(t) * [\rho * d(t, t + s) - \alpha(t, t + s)]$$

The maturity mismatch typical of the banking sector is such that liabilities have a shorter maturity than assets. In terms of the framework here adopted, this translates into

$$\beta(t, t + s) * B(t) > \alpha(t, t + s) * A(t)$$

Hence if financial markets were operating in the scenario of “no clearing conditions for financial debt”, it would be inevitable that $B_n(t, t + s) = 0$ and that the default condition above would be verified.

The reader may argue that these strong conclusions find mitigation with the consideration that bonds are eventually subscribed by the banks customers, i.e. sold to retail. The industry indeed makes a strong differentiation between retail and wholesale issuance. For the purpose of this model, bonds issued to retail should represent a percentage of the aggregate here denoted as $D(t)$. Retail customers accept a lower yield in view of their limited information and knowledge. Their wealth, be it under the technical form of Deposits or retail bonds, tends to be a stable liability of the bank which, for this reason, is categorized under the form of deposits in this simple framework of liabilities management.

SUBOPTIMAL CAPITAL STRUCTURE AND CENTRAL BANK REACTION

The scenarios of no clearing price for the financial debt market, in this paper, and “Equityzation of debt” in a previous work by the same author point at the same direction when analyzing why financial CDS reflect systemic risk rather than a specific issuer risk of default: banks may run their activity off their optimal capital structure. In a previous work¹⁵ the author gives some reasons why that may take place: it is worth reminding the accounting criteria applying

¹⁵ See footnote number 1

to loans and receivables and the political suasion to grant credit especially in a deteriorating environment¹⁶.

While banks experience difficulties in adopting an optimal capital structure when a deleverage is optimal, financial CDS grind higher to reflect a higher risk. The more banks operate under a suboptimal capital structure, the more the transmission mechanism of monetary policy is ineffective, due to the interaction with a banking system not capable of quickly adjusting its key variable: the capital structure.

When the market moves towards no clearing conditions in the financial debt market, then the central bank is forced to avoid a major liquidity restriction (practitioners typically refer to “credit crunch”) in the banking and real sector.

Central bank is then forced to relax refinancing parameters to avoid a default.

We have already analyzed that when the market scrutinizes the capability of the banking sector to roll liabilities, then probability of default in the next s years may be written as¹⁷

$$P\{B_n(t, t + s) < \beta(t, t + s) * B(t) + A_n(t, t + s) * (1 - \rho) + A(t) * [\rho * d(t, t + s) - \alpha(t, t + s)]\}$$

Where $A_n(t, t + s) = 0$ when the issuer is under severe stress and aims at minimizing the probability of default¹⁸.

The central bank then reacts to such estimated probability of default, by changing the parameter ρ to $\tilde{\rho}$. The event of default in the next s years is the event that (for no change in parameter, it is identical to the condition of default above)

$$B_n(t, t + s) < \beta(t, t + s) * B(t) + A(t) * [\tilde{\rho} * d(t, t + s) - \alpha(t, t + s) + \rho - \tilde{\rho}]$$

On one side the central bank needs a functioning transmission mechanism, which requires a low probability of default; on the other lowering such probability of default moves credit risk from the balance sheet of the borrower to the central bank balance sheet¹⁹.

¹⁶ For an in depth analysis please refer to the paper “Optimal Capital structure of a bank: the role of asymmetry of information and Equityzation of debt”

¹⁷ Here $P\{.\}$ denotes the probability of an event. We will not specify any probability distribution; adding formal introduction of such Probability function does not add strength to the conclusions of this paper.

¹⁸ $A_n(t, t + s) \leq 0$ is indeed the failure of transmission in monetary policy since an accommodative monetary input (central banks are intervening for the survival of the system) turns into a deleverage signal to the economy ($A(t)$ decreases).

¹⁹ Ultimately, the central bank compelled to lower the probability of default of the banking system, will see its currency devaluate versus all other countries (provided that other countries have not registered such a shift of credit from financial institutions to the public sector). At the peak of the financial crisis, flexibility on exchange rates, when available, has been fully exploited by major countries . It goes beyond

If the primary market for financial debt is completely inactive (as per conditions of no clearing price for financial debt), then the expected value of $B_n(t, t + s)$ is zero and the central bank is called to set $\tilde{\rho}$ so that the condition of default is not satisfied. For $B_n(t, t + s) = 0$ then event of default is

$$\beta(t, t + s) * B(t) > A(t) * [\alpha(t, t + s) - \tilde{\rho} * d(t, t + s) + \tilde{\rho} - \rho]$$

Such a definition of event of default shows the crucial role of liquidity: $\tilde{\rho} - \rho$ is the amount of liquidity injected in the system (as a percentage of assets) by monetary policy. CDS of financial institutions, ultimately quoting probabilities of default will then reflect, according to this approach, the amount of liquidity in the system. Hence the author will move now to an empirical approach aimed at assessing such linkage between financial CDS levels and amount of liquidity existing in the system. If confirmed by data, such relationship will emphasize the transmission mechanism existing from monetary policy to CDS levels of financial institutions. Liquidity may also be seen then as a tool to avoid default, hence with an immediate consequence on financial CDS. A high level of the CDS of financial institutions is to be interpreted also as an unhealthy transmission mechanism. A central bank may then intervene to make sure that the level of liquidity is such that failure to pay is not met on a daily level due to a liquidity shock.

Probability of default will approach zero for $\tilde{\rho}$ sufficiently high: a monetary policy made in terms of rules on eligible collateral rather than changes in interest rates does depict current days, where tenor of refinancing and enlargement of criteria to identify admissible collateral are key parameters released by central banks.

If we find that we can explain the level of the index of financial CDS by means of liquidity variables we can then exclude that financial CDS are pricing a default risk due only to insolvency reasons. We could then conclude that financial CDS price the probability of default due to a liquidity crunch, possibly arising from the effort to roll liabilities.

If such conclusions were deemed acceptable, a central bank should consider that only certain values of CDS are affordable by the banking sector. After a certain threshold, then the debt market can no longer clear and the central bank has to lower the value of CDS moving some leverage on its balance sheet, at least

the purpose of this paper to extend the analysis to the evolution of exchange rates in light of the financial crisis. We will limit ourselves to few numerical examples illustrating that once we compare the economies mostly affected by the financial crisis with the least exposed, then Euro and dollar depreciated versus the Australian dollar by approximately 20% in the last 5 years; The sterling depreciated versus the Australian dollar by approximately 40%.

temporarily. It does so by relaxing the refinancing parameters and by extending the maturity of such financing.

A GLANCE TO THE EVOLUTION OF MONETARY AGGREGATES

If the reasoning exposed above were confirmed by empirical evidence, then the correlation between growth of different monetary aggregates should decrease during financially turbulent times. The picture below shows the evolution of the rate of growth of the aggregate M1(white line), M2 (red line), M3(yellow line) and inflation in Euro Area (green line)²⁰. In this case we only have monthly data, hence we will not explore the time series of these aggregates in length. It is important to note that before the financial crisis, until 2006, the aggregates had a decent correlation, higher than 2008, when the European central bank intervenes with a growth of M1 rarely experienced before, yet not accompanied by a similar evolution of M2 or M3. Surprisingly the growth of M3 is below the rate of inflation (green line), which means that the overall liabilities are growing in nominal terms, but shrinking in real terms.

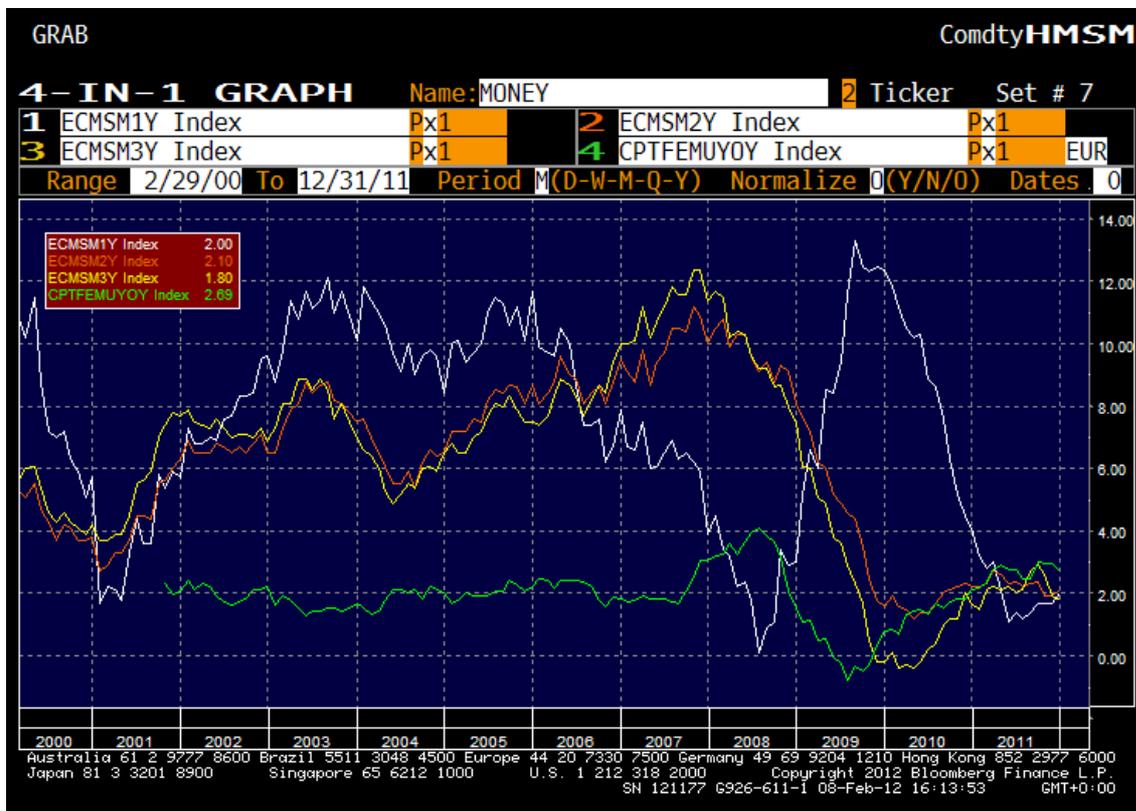


Figure 2

²⁰ Source: Bloomberg

The effort to inject liquidity is not only the autonomous effort of central banks considered individually in their monetary policy management: an example is the joint monetary policy intervention as described below by the press release available on the web site of all central banks on the 30th of November 2011 (below an extract of what published by the Board of Governors of the Federal reserve System²¹):

The Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, the Federal Reserve, and the Swiss National Bank are today announcing coordinated actions to enhance their capacity to provide liquidity support to the global financial system. The purpose of these actions is to ease strains in financial markets and thereby mitigate the effects of such strains on the supply of credit to households and businesses and so help foster economic activity.

These central banks have agreed to lower the pricing on the existing temporary U.S. dollar liquidity swap arrangements by 50 basis points so that the new rate will be the U.S. dollar overnight index swap (OIS) rate plus 50 basis points. This pricing will be applied to all operations conducted from December 5, 2011. The authorization of these swap arrangements has been extended to February 1, 2013. In addition, the Bank of England, the Bank of Japan, the European Central Bank, and the Swiss National Bank will continue to offer three-month tenders until further notice.

As a contingency measure, these central banks have also agreed to establish temporary bilateral liquidity swap arrangements so that liquidity can be provided in each jurisdiction in any of their currencies should market conditions so warrant. At present, there is no need to offer liquidity in non-domestic currencies other than the U.S. dollar, but the central banks judge it prudent to make the necessary arrangements so that liquidity support operations could be put into place quickly should the need arise. These swap lines are authorized through February 1, 2013.

LIQUIDITY OF FINANCIAL INSTITUTIONS: HOW DOES IT AFFECT FINANCIAL MARKETS?

Financial markets see the banking sector as one player across the wide range of institutional agents: the banking sector is active on bond issuance (supply) in various currencies; it is also buyer of various securities and participates to the repo markets with two main purposes: yield enhancement and liquidity management.

Liquidity is typically a concept relating to the efficiency of a particular market. In this paper we mean instead the cash management position of the banking sector, meant as sum of cash reserves and credit lines available to pay for any kind of obligation: be it a cash versus settlement obligation (upon purchase of a bond, for example), or to face payment of capital/interest on outstanding self

²¹ Available in its entire content at <http://www.federalreserve.gov/newsevents/press/monetary/20111130a.htm>

issued bonds. As such, liquidity is not an observable variable. Recently it has become the centre of attention for regulators and for management: yet financial market players can only make an inference on its level by observing variables showing a strong correlation with the evolution of liquidity.

Such variables, which we will briefly comment on, are

- Difference between Euribor and Eonia
- Level of CDS of a sovereign issuer versus the actual yield of the bond issued by the same issuer.
- Levels of the cross currency swap EUR/ USD.

INFERENCE ON LIQUIDITY BY FEW FINANCIAL VARIABLES

In this paragraph we provide the rationale why the variables listed above are deemed relevant estimators for the purpose of investigating the liquidity aggregates available to the banking sector. Euribor and Eonia are two indices that are considered respectively proxies for the unsecured interbank deposit rate (e.g. 3-month EURIBOR) and the secured interbank deposit rate (i.e. deposits which are secured against collateral). These parameters have daily fixings and clearly a secured deposit rate should be lower than an unsecured one. In a world where the health of the banking system is not questioned then we would expect that such difference be stable and not large. A negligible magnitude of such difference and a low volatility were features of the financial markets prior to 2007. The degree of financial distress is typically summarized in industry research and ECB papers²² by means of graphs summarizing the evolution of such difference. The picture below is included in the work by Michele Lenza, Huw Pill and Lucrezia Reichlin published in the working paper series released by ECB.

²² See for example “Monetary policy in exceptional times”, October 2010, in working paper series no 1253.

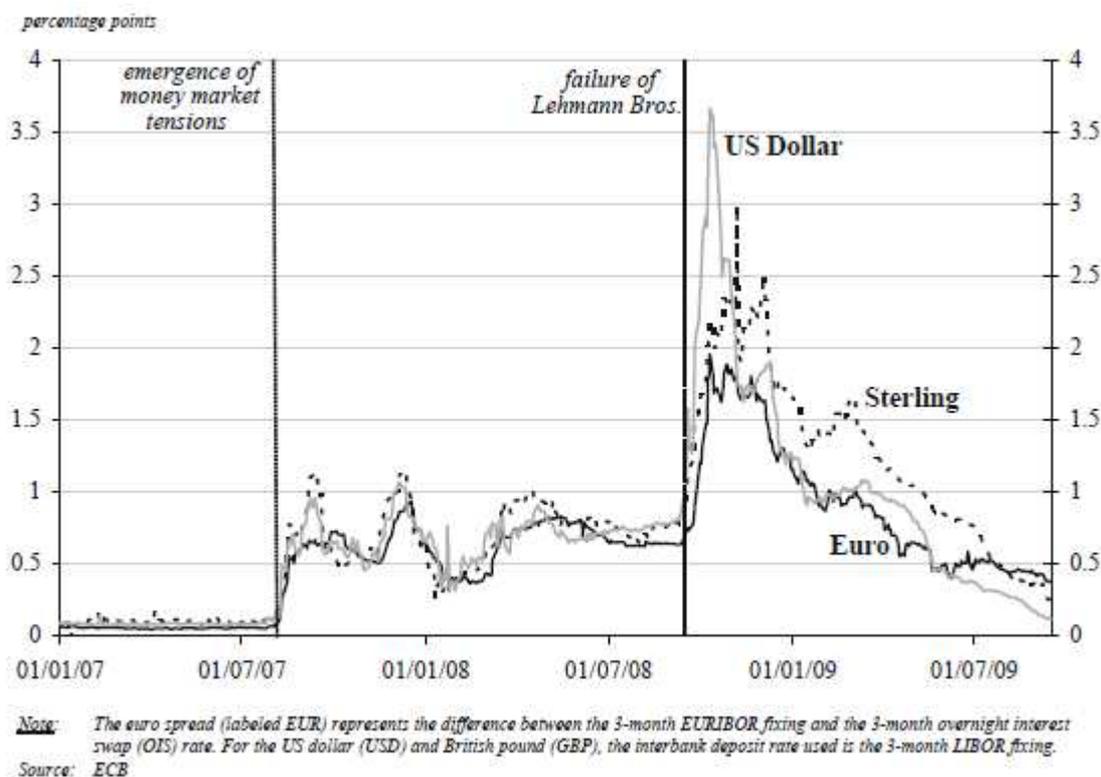


FIGURE 3: FROM “MONETARY POLICY IN EXCEPTIONAL TIMES”, WORKING PAPER SERIES NO 1253

In this paper we deem the difference between Euribor and Eonia as crucial to make inference on the liquidity available in the system. We use, though a more forward looking measure of it, since we do not necessarily need to make inference on the liquidity available for one day only, but we investigate what the market believes will be the average evolution of liquidity in a horizon of 2 years. This approach reduces also the Fixing risk, i.e. the risk that the analysis may be misleading since some days may enter the sample with particularly high values due to a shock in liquidity which is 1 day only specific.

Financial markets quote the average of floating parameters for almost any tenor via swaps markets. These markets, although not regulated and left to the OTC transactions without being centralized (in some cases) into one exchange, are the very few derivatives whose pricing proved reliable even during the core of the financial crisis. Hence rather than the difference on one day between Euribor and Eonia, we will analyze the difference with daily frequency between the swap rate equivalent to the parameter Euribor and the swap rate equivalent to the parameter Eonia. Both swap rates are considered for maturity 2 years and we thus obtain a measure forward looking at the evolution of liquidity for the next 2 years. The reason why we consider the tenor 2 years is simply because swaps with 2 years maturity are exchanged in very large Notional Amounts, therefore making published rates very reliable.

The second variable we will analyze to make inference on the liquidity of the banking sector is the difference existing between CDS of a sovereign state and the yield of securities issued by the same sovereign state for a maturity similar to the tenor of the CDS.

Whereas CDS reflect the actual risk of default, the securities exchanged in the market have a demand which depends not only by the risk-return trade off, but also by the liquidity available in the system. Furthermore credit default swaps are unfunded transactions, i.e. no upfront payment is required at inception (which makes their values not dependent by liquidity constraints of market agents). Bonds purchases instead require the payment of the price. It is intuitive that for large amounts of liquidity there will be a higher amount of investments into securities as opposed to the synthetic purchase by selling protection on Sovereign CDS. More importantly it is a fact that the CDS market and the securities market are segmented, i.e. for various reasons, a market player participating in the cash market may not participate into the CDS Market. Hence whereas CDS do reflect mostly the risk of default, then the cash market, compared to the CDS, is also driven by the liquidity available in the system.

The difference between CDS and the yield of the bond with same tenor would not be very meaningful for sovereign states where the market does not generate a high number of transactions: for this reason (and the plethora of securities existing) we select an issuer whose debt is traded very actively. Among others we will consider the CDS whose reference entity is Republic of Italy and issued securities will be BTPS or “Buoni Poliennali del Tesoro”. We will consider the most traded maturity for CDS, 5 years, and we will compose a basket of BTPS whose average maturity is 4.5 years²³. We will avoid considering BTPs when monetary policy intervenes on the secondary market to stabilize prices: hence on that occasion we would have prices biased by the central bank interventions which would bias the econometric analysis. This explains why the Italy basis is considered as a regressor in the first part of the sample but not in the last year of financial data, when central bank purchased amounts of BTPs to stabilize the market. In the second part of the sample we will consider instead the Germany basis, which instead cannot be considered in the beginning of the sample since there CDS on Germany was not traded in amounts such as to make it meaningful.

The third variable we will use in the effort to make an inference on the liquidity available for the financial system is the level of cross currency swaps quoted in

²³ The reason why we build a basket of 4.5 years and not 5 years (to match the maturity of CDS) is purely technical: the new issuance targets typically the benchmark 5 years (among others), hence on the day of issuance there would be a jump from the basket to the newly issued bond, which typically trades at premium to encourage investors to new subscriptions. This jump may bias the econometric analysis.

the market. A cross currency swap is a derivative instrument where 2 parties exchange a principal amount at inception and at maturity²⁴, denominated in 2 different currencies. After exchanging such principal amounts, they also pay each other the interests on the exchanged amounts (hence denominated in the 2 different currencies). If the 2 currencies were EUR and USD, then the counterparty receiving USD principal at inception would pay Libor and the counterparty receiving EUR at inception would pay Euribor, for the life of the swap. In practice the cross currency swaps are quoted in terms of spread that the USD recipient would pay over Libor, although receiving Euribor with no spread. In simpler terms the market deviates from a theoretical value of zero and quotes a positive spread when the currency received has a structural higher demand than the one paid at inception of the swap. In intuitive terms, during periods of financial crisis foreign currency denominated liabilities may be even more problematic to manage (and roll) than domestic currency denominated ones. Hence some issuers sometimes address their demand for foreign currency by tapping into the cross currency market. This market allows them to exchange foreign currency with domestic currency. This is achieved by entering a swap where the bank receives foreign currency at inception versus paying domestic currency (initial exchange of notional). This initial transaction is reversed at maturity of the swap; during the life of the swap parties exchange interest on the notional borrowed. The difference between the floating parameters paid by the parties is the so called “cross currency basis”.

We will analyze if we can find a meaningful relationship between the Itraxx Index of financial CDS and the 3 variables just presented (as instruments to make inference on the liquidity of the banking sector).

CDS: LIQUIDITY SHORTAGE OR STRUCTURAL INSOLVENCY?

As anticipated, we will test some of the conclusions drawn in this paper against daily data. We will describe the composition of the data and then mention the results. The appendix will provide further detail.

The data is composed by a database of 1054 daily observations, for the period elapsing from 14th of January 2008, until 11th of June 2012. We emphasize that this sample contains the entire data history representing the financial crisis, with inception before the Lehman collapse and the government financial pressure experienced more recently. Such database includes the event of the Private

²⁴ So called initial and final exchange of notional.

Sector Involvement (PSI)²⁵ in relation to the bonds issued by the Hellenic Republic and the bailout of the Spanish banking sector.

Such database includes

1. The levels of the index Itraxx Europe, with tenor 5y maturity: the index, also known simply as 'The Main', is composed of the most liquid 125 CDS referencing European investment grade credits, subject to certain sector rules as determined by the IIC and also as determined by the SEC. More specifically, The iTraxx® Europe index comprises 125 investment grade rated European entities selected from the Liquidity List²⁶. All entities must satisfy the membership determination criteria²⁷. Among such criteria it is disposed that the final index comprises 125 entities and is constructed by selecting the highest ranking entities in each sector on the Liquidity List, subject to the following sector restrictions:
 - a. – 30 Autos & Industrials
 - b. – 30 Consumers
 - c. – 20 Energy
 - d. – 20 TMT
 - e. – 25 Financials (separate Senior & Subordinated indices)

2. The levels of the index Financial Senior (more properly iTraxx Europe Senior Financials), with tenor 5y maturity, which intuitively includes all financial senior CDS of reference entities as listed in the appendix. More specifically, this index is the weighted average of the 25 names belonging to the Financial sector and included in the index Itraxx Europe (as per description above, point e).

3. The yield of a basket of securities with average maturity 4.5 years of BTPs (issued by the Tesoro Italiano), FRTR (issued by the France Tresor), DBR (issued by Republic of Germany). From such yield we obtain the Par Asset swap level, via comparison with the swap rates with maturities similar to the securities.

²⁵ Friday, 24th of February 2012 (announcement date)

²⁶ The Liquidity List is broadly defined in terms of trading volumes. For the precise definition of the composition of the Liquidity List, the reader may refer to the Markit iTraxx Europe Index Rules, available on the web site <http://www.markit.com/assets/en/docs/products/data/indices/credit-and-loan-indices/iTraxx/>

²⁷ Membership determination criteria are listed on the documents available on the web site as per previous footnote: among others such criteria refer to the requirement of investment grade according to Fitch, Moody's or S&P. Entities with an Entity Rating of BBB-/Baa3/BBB- (Fitch/Moody's/S&P) with negative outlook or below are excluded.

4. The level of the 5 year maturity CDS contract with reference entity Republic of Italy, Republic of Germany, French Republic, all quoted on Dollar notional.
5. The swap (fixed) rate with 2 years tenor quoted versus the floating rate eonia
6. The swap (fixed) rate with 2 years tenor quoted versus the floating rate euribor 6m
7. The cross currency spread for a tenor of 5 years, on EURO/USD, with initial and final exchange of notional

One important implication of analyzing such a wide sample in time is that CDS indices at the beginning of the sample, with 5y maturity, are almost about to expire at the end of the sample. This observation explains why the author prefers to select a new series of the index after 2 years of financial data, so that at the end of the sample the CDS indices have still no less than 3 years residual maturity. Sovereign CDS, instead, are not considered within an index, hence they have a constant maturity of 5 years. This technical aspect anticipates why, although we will also present regressions on the entire sample, the sample will be separated in two sub sample of approximately 530 observations each. In both subsamples the CDS indices will be iTraxx®-Financials and Itraxx Europe. We will consider in the first subsample the series 7; In the second subsample we will consider the 13th series of the indices. A new series is released every 6 months, hence 6 subsequent series allow for the rolling of the indices taking place in a timeframe of 3 years. We will also analyze a regression applied to the entire sample with one series only (number 7): even in this case we will derive a very high adjusted R squared.

The ultimate purpose of the paper is to explain the daily variations of the index iTraxx Europe Senior Financials in terms of a liquidity factor and one more variable representing the component of credit risk which cannot be related to liquidity only. In the previous sections of the work we have provided a model to hint that when Debt market no longer clears, then liquidity plays a primary role in defining the event of default.

Under market not clearing conditions, probability of default for a bank can be represented as

$$P\{\beta(t, t + s) * B(t) > A(t) * [\alpha(t, t + s) - \tilde{\rho} * d(t, t + s) + \tilde{\rho} - \rho]\}$$

Limited appetite of the market in subscribing senior and even secured issuance has been witnessed especially during the second half of 2011 until current days: we will then expect that the role of liquidity in explaining the daily variation of CDS will be more relevant in the second part of the sample.

In analyzing the first 528 days of the sample we will then regress the daily variations of the iTraxx Europe Senior Financials on 4 regressors, where 3 will be “liquidity variables” and 1 will represent the absolute level for credit in the Non financial world. Hence we may see the variations for CDS of financial corporations as explained by the variations of CDS for non financial corporations and the variations of the variables apt to infer on the conditions of liquidity in the economy. More specifically the regressors will be the (daily) variations of the following variables:

- a. The difference between Euribor and Eonia swap rates
- b. The difference between the CDS on Italy (for a maturity of 5years) and the Par Asset Swap of a basket of BTPS (with an average maturity of 4.5 years). It will be termed “Italian Basis”.
- c. The difference between the CDS on France (for a maturity of 5years) and the Par Asset Swap of a basket of securities issued by the France Tresor (with an average maturity of 4.5 years). It will be termed “French Basis”.
- d. The level of iTraxx Europe Non-Financials, obtained from the (weighted) difference between the iTraxx Europe and the iTraxx Europe Senior Financials.

We obtain (528 days) that the daily variations of the difference described in point d has the highest explanatory power and the regression gives an adjusted R squared of 51.9% (more detail in the appendix). It is interesting to note that the weight associated by the regression to the French Basis is over 5 times the weight associated to the Italian Basis. In this first Regression the explained variable is the daily variation of the iTraxx Europe Senior Financials as per series 7.

When analyzing the remaining part of the sample we are considering the most turbulent financial times where the entire Euro monetary area is under considerable pressure. The intervention of central authorities was not only in terms of liquidity, but also via purchases of bonds on the secondary market. Covered Bonds and, among others, BTPS were purchased by the central bank, thus making this variable potentially biased by the central bank intervention. Such intervention is priced by the bonds, thus making the variable “Italian Basis” biased by the central bank intervention. We will then consider, among the regressors, the German Basis in lieu of the Italian Basis.

More specifically the regressors in the second regression (applied to the remaining sample) will be the (daily) variations of the following variables:

- a. The difference between Euribor and Eonia swap rates
- b. The difference between the CDS on Germany (for a maturity of 5years) and the par asset swap of the securities composing a basket whose average maturity is 4.5 years. It will be termed “German Basis”.
- c. The level of EUR/USD cross currency swap.
- d. The level of iTraxx Europe Non-Financials, obtained from the (weighted) difference between the iTraxx Europe and the iTraxx Europe Senior Financials.

We obtain (542 days) that the daily variations of the difference described in point d has (again) the highest explanatory power and the regression gives an adjusted R squared of 67.2% (more detail in the appendix). It is interesting to note that the explanatory power of the “liquidity variables” has increased considerably, in line with the consideration that the senior debt market did not see a new issuance activity in line with the refinancing need of the banking sector. By adopting the terminology of this paper the senior Debt market did not clear, hence the liquidity variables have a much a higher weight and a higher explanatory power (from a statistical point of view). The weight associated by the regression to the spread Euribor –Eonia is almost 5 times the weight associated to the same variable in the first subsample. In this second Regression the explained variable is the daily variation of the iTraxx Europe Senior Financials as per series 13.

We then run a regression to the entire sample: 1054 days from January 2008 until June 2012. Unfortunately we do not have available the EUR/ USD cross currency level available for the entire sample. The reason why we strive to analyze the entire sample is to cover all years of the recent financial crisis. Even if practitioners find different reasons and tend to separate a credit crunch originating from the subprime crisis and culminating with a sovereign crisis, this model provides a unifying frame: a regression of daily data over such a long period sheds light on the robustness of the conclusions of the author and emphasizes the role of liquidity as a crucial driver in explaining the evolution (even at daily level) of financial CDS.

Hence we will regress the daily variation of the iTraxx Europe Senior Financials as per series 7 on 4 regressors, namely:

- i. The difference between Euribor and Eonia swap rates

- ii. The difference between the CDS on Italy (for a maturity of 5years) and the Par Asset Swap of a basket of BTPS (with an average maturity of 4.5 years). It will be termed “Italian Basis”.
- iii. The difference between the CDS on France (for a maturity of 5years) and the Par Asset Swap of a basket of securities issued by the France Tresor (with an average maturity of 4.5 years). It will be termed “French Basis”.
- iv. The level of iTraxx Europe Non-Financials, obtained from the (weighted) difference between the iTraxx Europe and the iTraxx Europe Senior Financials.

We obtain (1054 days) that the daily variations of the difference described in point (iv) has (again) the highest explanatory power and the regression gives an adjusted R squared of 48.9% (more detail in the appendix). It is interesting to note that the French Basis keeps a satisfactory explanatory power across such a large sample, with a weight very similar to the very first regression limited to the first half of the dataset.

We will run one more regression on the second part of the sample, where we will no longer make use of the regressor Itraxx Europe Non-Financials. This regressor is replaced by the daily variation of the Italy CDS. The meaning of this regression is twofold: on one side we assess that the explanatory role of the “liquidity variables” is confirmed also when 1 regressor is drastically changed (from index of CDS of Non-Financial entities to the CDS of a sovereign); Also, as mentioned in the section of the related literature, many authors have focused on the link between the banks and the sovereign state of the same region. This particular regression instead explains the variations of a basket of 25 financial European institutions by means of liquidity variables and by adopting Italy CDS as the remaining regressor. It may be then argued that, repeating the concept mentioned in the Introduction (Global Consolidation), financial institutions are so interrelated that, not only their CDS is affected by the financial health of the sovereign state where they operate (as shown by plenty of literature), but isolation from other countries experiencing financial pressure is not achievable.

Hence we will regress the daily variation of the iTraxx Europe Senior Financials as per series 13 on 4 regressors, namely:

- a. The difference between Euribor and Eonia swap rates
- b. The difference between the CDS on Germany (for a maturity of 5years) and the par asset swap of the securities composing a basket whose average maturity is 4.5 years. It will be termed “German Basis”.
- c. The level of EUR/USD cross currency swap.

- d. The level of the 5 year CDS contract with reference entity Republic of Italy.

We obtain (539 days) that the daily variations of the Italy CDS has the highest explanatory power and the regression gives an adjusted R squared of 66.9% (more detail in the appendix). The weights estimated by the linear regression for the liquidity variables are lower than the regression when the Italy CDS was not adopted as regressor²⁸. The sample analyzed in this regression represents a period of extreme pressure of funding for the Italian Treasury: it is debatable if the CDS of Italy reflects liquidity constraint or an insolvency issue. Hence in order to investigate the role of liquidity, the author prefers to choose as a regressor the index Itraxx Main Non-Financial, given that it represents the CDS of reference entities not so exposed to a liquidity crunch as the financial entities. The author has listed the results of the latest regression since they may be deemed meaningful when arguing that the link between sovereign and banks is not limited to the entities operating within the sovereign's territory.

CONCLUSIONS

This paper represents one of the first attempts to analyze financial CDS behavior in their daily evolution during the most turbulent times after the Great Depression. It provides explanatory variables for financial CDS which ultimately map into the concept of liquidity available to financial institutions. Such liquidity is crucial to interpret the evolution of CDS, which suggests that the credit risk of financial institutions is primarily a macroeconomic variable rather than a microeconomic topic. As such, the central bank may find it optimal to intervene with extraordinary measures of monetary policy to guarantee the survival of the system and to control the monetary transmission via the banking system.

²⁸ The second regression presented in this section.

APPENDIX

DETAILS AND RESULTS OF THE REGRESSION

Range: 14-Jan 2008 until 30-Mar-2010 (528 Days)

Regression Model	$\hat{y} = x_1 * b_1 + x_2 * b_2 + x_3 * b_3 + x_4 * b_4 + c$
Regressand (left axis)	y = changes of (s6)
Regressor 1 (right axis)	$x_1 = \text{changes of } ((125*s3)-(25*s6))$
Regressor 2	$x_2 = \text{changes of } (s2-s1)$
Regressor 3	$x_3 = \text{changes of } (s9-s7)$
Regressor 4	$x_4 = \text{changes of } (s10-s8)$
s1	Swap EONIA 2Y (Yield in %)
s2	Swap EUR... 2Y (Yield in %)
s3	iTraxx Euro:S7:All (5 Year CDS)
s4	Swap USD... 2Y (Yield in %)
s5	Swap USD... 2Y (Yield in %)
s6	iTraxx Euro:S7:Financial:Senior (5 Year CDS)
s7	4.5Y Smooth FRF (Par ASW in bp)
s8	4.5Y Smooth ITL (Par ASW in bp)
s9	France CDS 5Y (CDS)
s10	Italy CDS 5Y (CDS)

Regression Results

Parameter	Regression Result	t-test	p-value	R ²
b ₁	0.0050	17.79	0.000	0.464
b ₂	4.6210	0.43	0.333	0.035
b ₃	0.3720	5.54	0.000	0.222
b ₄	0.0720	1.73	0.042	0.118
c	0.0380	0.21	0.416	NaN
adj. R ²	F-test	p-value	lookback	
0.519	142.72	0.000	528	

Time Series Tests

Series	ADF	ADF-crit	KPSS	KPSS-crit	DW
Residuals	-16.185	-2.871	0.078	0.463	1.968
y	-7.644	-2.871	0.074	0.463	1.772
x ₁	-6.598	-2.871	0.292	0.463	1.954
x ₂	-17.052	-2.871	0.386	0.463	2.168
x ₃	-16.411	-2.871	0.076	0.463	2.043
x ₄	-15.267	-2.871	0.064	0.463	1.968

Range: 17-Mar 2010 until 11-Jun-2012 (542 days)

Regression Model	$\hat{y} = x_1*b_1 + x_2*b_2 + x_3*b_3 + x_4*b_4 + c$
Regressand (left axis)	y = changes of (s10)
Regressor 1	x_1 = changes of (s1)
Regressor 2	x_2 = changes of ((s3*125)-(s10*25))
Regressor 3	x_3 = changes of (s6-s4)
Regressor 4	x_4 = changes of (s8-s9)
s1	EUR USD Basis Spread (basis=3M-3M,tenor=5Y,fwd=0M in bp)
s2	Italy CDS 5Y (CDS)
s3	iTraxx Euro:S13:All (5 Year CDS)
s4	4.5Y Smooth GER (Par ASW in bp)
s5	4.5Y Smooth FRF (Par ASW in bp)
s6	Germany CDS 5Y (CDS)
s7	France CDS 5Y (CDS)
s8	Swap EUR 2Y (Yield in %)
s9	Swap EONIA 2Y (Yield in %)
s10	iTraxx Euro:S13:Financial:Senior (5 Year CDS)

Regression Results

Parameter	Regression Result	t-test	p-value	R ²
b_1	-0.8590	-5.05	0.000	0.311
b_2	0.0120	16.50	0.000	0.596
b_3	0.5080	7.87	0.000	0.412
b_4	19.6300	0.90	0.185	0.207
c	-0.0240	-0.11	0.457	NaN

adj. R ²	F-test	p-value	lookback
0.672	277.29	0.000	542

Time Series Tests

Series	ADF	ADF-crit	KPSS	KPSS-crit	DW
Residuals	-13.054	-2.871	0.062	0.463	1.788
y	-15.421	-2.871	0.042	0.463	1.784
x_1	-16.265	-2.871	0.080	0.463	1.753
x_2	-7.014	-2.871	0.092	0.463	1.875
x_3	-15.701	-2.871	0.065	0.463	1.874
x_4	-15.408	-2.871	0.134	0.463	1.788

Range: 14-Jan 2008 until 11-Jun-2012 (1054 Days)

Regression Model	$\hat{y} = x_1*b_1+x_2*b_2+x_3*b_3+x_4*b_4+c$
Regressand (left axis)	y = changes of (s6)
Regressor 1	$x_1 = \text{changes of } ((125*s3)-(25*s6))$
Regressor 2	$x_2 = \text{changes of } (s2-s1)$
Regressor 3	$x_3 = \text{changes of } (s9-s7)$
Regressor 4	$x_4 = \text{changes of } (s10-s8)$
s1	Swap EONIA 2Y (Yield in %)
s2	Swap EUR _{cont} 2Y (Yield in %)
s3	iTraxx Euro:S7:All (5 Year CDS)
s4	Swap USD _{cont} 2Y (Yield in %)
s5	Swap USD _{cont} 2Y (Yield in %)
s6	iTraxx Euro:S7:Financial:Senior (5 Year CDS)
s7	4.5Y Smooth FRF (Par ASW in bp)
s8	4.5Y Smooth ITL (Par ASW in bp)
s9	France CDS 5Y (CDS)
s10	Italy CDS 5Y (CDS)

Regression Results

Parameter	Regression Result	t-test	p-value	R ²
b ₁	0.0070	20.97	0.000	0.403
b ₂	43.4710	3.67	0.000	0.090
b ₃	0.3770	9.12	0.000	0.237
b ₄	0.0920	3.84	0.000	0.107
c	0.1290	0.76	0.225	NaN

adj. R ²	F-test	p-value	lookback
0.489	253.15	0.000	1054

Time Series Tests

Series	ADF	ADF-crit	KPSS	KPSS-crit	DW
Residuals	-18.190	-2.871	0.133	0.463	1.816
y	-18.359	-2.871	0.078	0.463	1.821
x ₁	-9.389	-2.871	0.099	0.463	1.931
x ₂	-23.174	-2.871	0.136	0.463	2.043
x ₃	-21.510	-2.871	0.081	0.463	2.041
x ₄	-16.249	-2.871	0.034	0.463	1.816

Range: 17-Mar 2010 until 8-Jun-2012 (539 Days): Adopting Italy CDS among regressors in lieu of the Index Itraxx Europe Non-Financials.

Regression Model	$\hat{y} = x_1 * b_1 + x_2 * b_2 + x_3 * b_3 + x_4 * b_4 + c$
Regressand (left axis)	y = changes of (s10)
Regressor 1 (right axis)	x ₁ = changes of (s1)
Regressor 2	x ₂ = changes of (s2)
Regressor 3 (right axis)	x ₃ = changes of (s6-s4)
Regressor 4	x ₄ = changes of (s8-s9)
s1	EUR USD Basis Spread (basis=3M-3M,tenor=5Y,fwd=0M bp)
s2	Italy CDS 5Y (CDS)
s3	4.5Y Smooth ITL (Par ASW in bp)
s4	4.5Y Smooth GER (Par ASW in bp)
s5	4.5Y Smooth FRF (Par ASW in bp)
s6	Germany CDS 5Y (CDS)
s7	France CDS 5Y (CDS)
s8	Swap EUR _{cur} 2Y (Yield in %)
s9	Swap EONIA 2Y (Yield in %)
s10	iTraxx Euro:S13:Financial:Senior (5 Year CDS)

Regression Results

Parameter	Regression Result	t-test	p-value	R ²
b ₁	-1.1280	-6.74	0.000	0.315
b ₂	0.3440	16.25	0.000	0.603
b ₃	0.3940	5.77	0.000	0.411
b ₄	9.1300	0.41	0.340	0.208
c	-0.0830	-0.37	0.356	NaN
adj. R ²	F-test	p-value	lookback	
0.669	272.88	0.000	539	

Time Series Tests

Series	ADF	ADF-crit	KPSS	KPSS-crit	DW
Residuals	-16.773	-2.871	0.086	0.463	1.787
y	-15.297	-2.871	0.042	0.463	1.787
x ₁	-16.286	-2.871	0.089	0.463	1.753
x ₂	-15.053	-2.871	0.079	0.463	1.603
x ₃	-15.648	-2.871	0.065	0.463	1.875
x ₄	-15.386	-2.871	0.133	0.463	1.787

COMPOSITION OF THE ITRAXX FINANCIAL SENIOR

As mentioned above the Itraxx Financial senior is a simple average across a number of CDS levels. Such average is determined with equal weights and the CDS names (reference entities) included in computing such average are:

	Issuer
1	Aegon N.V.
2	Allianz SE
3	ASSICURAZIONI GENERA
4	AVIVA PLC
5	AXA
6	BANCA MONTE DEI PASC
7	BANCO BILBAO VIZCAYA
8	BANCO POPOLARE
9	BANCO SANTANDER, S.A
10	BARCLAYS BANK PLC
11	BNP PARIBAS
12	COMMERZBANK
13	CREDIT AGRICOLE SA
14	Credit Suisse Group
15	DEUTSCHE BANK
16	Hannover Rueckversicherung AG
17	Intesa San Paolo
18	LLOYDS TSB BANK PLC
19	Muenchener Rueckversicherungs-Ges. AG
20	SOCIETE GENERALE
21	Swiss Reinsurance Company
22	The Royal Bank of Scotlan
23	UBS AG
24	UNICREDIT, SOCIETA P
25	Zurich Insurance Company

COMPOSITION OF THE ITRAXX MAIN

As mentioned above the Itraxx Main Europe is a simple average across a number of CDS levels. Such average is determined with equal weights: the CDS names (reference entities) included in computing such average are:

1) Adecco S.A.	43) DIAGEO PLC	84) REED ELSEVIER PLC
2) Aegon N.V.	44) E.ON AG	85) RENTOKIL INITIAL PLC
3) Aktiebolaget Electrolux	45) Electricite de France	86) REPSOL YPF, S.A.
4) Aktiebolaget Volvo	46) EnBW Energie Baden-W	87) ROYAL DUTCH SHELL
5) Akzo Nobel N.V.	47) ENEL S.P.A.	88) RWE Aktiengesellschaft
6) Allianz SE	48) ENI S.P.A.	89) SABMILLER PLC
7) ALSTOM	49) European Aeronautical group	90) SAFEWAY LIMITED
8) Anglo American plc	50) EXPERIAN FINANCE PL	91) SANOFI
9) ArcelorMittal	51) FINMECCANICA S.P.A.	92) Siemens Aktiengesellschaft
10) ASSICURAZIONI GENER	52) Fortum Oyj	93) SOCIETE GENERALE
11) ATLANTIA S.P.A.	53) FRANCE TELECOM	94) SODEXO
12) AVIVA PLC	54) GAS NATURAL SDG, S.	95) Solvay
13) AXA	55) GDF SUEZ	96) STATOIL ASA
14) BAE SYSTEMS PLC	56) Glencore International	97) STMicroelectronics
15) BANCA MONTE DEI PASCHI	57) GROUPE AUCHAN	98) Suedzucker AG
16) BANCO BILBAO VIZCAY	58) Hannover Rueckversicherung	99) Svenska Cellulosa Aktiebolaget
17) BANCO POPOLARE	59) Henkel AG & Co. KGaA	100) Swiss Reinsurance Co.
18) BANCO SANTANDER	60) Holcim Ltd	101) TATE & LYLE PUBLIC L
19) BARCLAYS BANK PLC	61) IBERDROLA, S.A.	102) TELECOM ITALIA SPA
20) BASF SE	62) IMPERIAL TOBACCO G	103) Telefonaktiebolaget
21) Bayer Aktiengesell	63) INTESA SANPAOLO	104) TELEFONICA, S.A.
22) Bayerische Motoren Werke	64) JTI (UK) FINANCE PLC	105) Telekom Austria
23) Bertelsmann AG	65) KINGFISHER PLC	106) TELENOR ASA
24) BNP PARIBAS	66) Koninklijke Ahold N.V.	107) TeliaSonera Aktiebolag
25) BP P.L.C.	67) Koninklijke DSM N.V.	108) TESCO PLC
26) BRITISH AMERICAN TO	68) Koninklijke KPN N.V.	109) The Royal Bank of Scotland
27) BRITISH SKY BROADCA	69) Koninklijke Philips	110) TOTAL SA
28) BRITISH TELECOMMUN	70) LANXESS Aktiengesellschaft	111) UBS AG
29) CADBURY HOLDINGS L	71) Linde Aktiengesellschaft	112) UNICREDIT, SOCIETA
30) Carrefour	72) LLOYDS TSB BANK PLC	113) Unilever N.V.
31) CASINO GUICHARD-PE	73) LVMH MOET HENNESS	114) UNITED UTILITIES PLC
32) Centrica Plc	74) MARKS AND SPENCER	115) VALEO
33) COMMERZBANK Aktien	75) METRO AG	116) Vattenfall Aktiebolag
34) COMPAGNIE DE SAINT	76) Muenchener Rueckversicherungs	117) VEOLIA ENVIRONNEM
35) Compagnie Financiere..	77) NATIONAL GRID PLC	118) VINCI
36) COMPASS GROUP PLC	78) Nestle S.A.	119) VIVENDI
37) CREDIT AGRICOLE SA	79) NEXT PLC	120) VODAFONE GROUP P
38) Credit Suisse	80) PEARSON plc	121) VOLKSWAGEN AKTIE
39) Daimler AG	RED Name	122) Wolters Kluwer N.V.
40) DANONE	81) PostNL N.V.	123) WPP 2005 LIMITED
41) DEUTSCHE BANK AKTI	82) PPR	124) XSTRATA PLC
42) Deutsche Telekom AG	83) PUBLICIS GROUPE SA	125) Zurich Insurance Company

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