Implied Cost of Capital (ICC) as a new Macroprudential tool

(I-SCOR: a new framework to assess sources of financial risks)

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1. Introduction

The financial landscape during the most recent years, saw the development of a macroprudential orientation of prudential frameworks in order to improve the resilience of the broad economy to the building up of imbalances in the global financial markets. The enhancement of macroprudential analysis in the assessment of the health of financial systems requires to enrich the so-called macroprudential indicators with a measure which is both forward-looking and based on a "theory" more consistent with actual market practices for stock valuation and asset pricing in general. Macroprudential indicators can be classified in two main areas: the first refers to composite stress indicators for the financial system as a whole, which are aimed at measuring the current levels of frictions and strains in different parts of the financial market at the same time (equity, corporate, sovereign, interbank) to come up with a single measure of stress. Example of such indicators are the CISS index from the ECB (Hollo et al. 2011), the index of the IMF (Cardarelli et al. 2009) and the index developed for the Canadian financial system (Illing, Liu 2006). The second class of indicators aim to assess the common distress present in the whole system, modelling the joint evolution of risk among financial institutions to detect the linkages of the probability of distress within the banks or the influence of the single institution on the stability of the system. Examples of such indicators are: CoVaR proposed by Adrian and Brunnermeier (2010), MES suggested by Acharya et al. (2010), JPod proposed by Segoviano and Goodhart (2008).
This research work, that refers to the first class of models, tries to overcome some of the main drawbacks of those indexes due to their nature of lagging and backward-looking indicators - since they are based on macroeconomic or balance sheet data, available only with a time lag and referred to past events - or to their approach not consistent in an "arbitrage-free" setting, since they are developed through an aggregation mechanisms based on "econometrics" instead of a financial theory, consistent with financial market pricing conventions.

Provided that both the new index I-SCOR (Implied – Systemic Cost Of Risks) and the other macroprudential composite stress indicators are based on "raw" financial indexes such as: volatility, credit spread, liquidity spread and interest rate, the main difference relates to the path chosen in their development. The indicators of the first area are characterized by a bottom-up approach: they start from "raw" financial indexes, that after passing through some econometric aggregator, set a macroprudential index. On the contrary I-SCOR, the new macroprudential index, has a top-down approach, because it starts from an indicator based on a financial theory - consistent with actual market practice for stock relative value assessment - which considers some "raw" financial indexes and after a further splitting of the index, consistently with market pricing standards for corporate bond, achieves a granular breakdown of the macroprudential index.

Furthermore, this new index is coherent in the tenors of the "raw" financial indexes used for its computation, while many others use financial time series referred to different tenors (i.e. 3 months volatility, 5 years CDS and 10 years IRS)[1].
Another positive feature of the index is that it is expressed as a percentage on a yearly basis of the cost of the different risk drivers. Therefore it is easy to interpret and to compare with the actual evolution of fiancial market indexes such as CDS, interest rates, stock market returns[2].

[1] A further development could be to the computation of the term structure of the ICC index in order to analyse market assessment of the spreading of the effects of a crisis thought tenors and the different evolution over time of risk factors for different tenors.

[2] Another further development could be to obtain a measure of the impact of the crisis on a "dollar basis", because increments in the I-SCOR index represent an increase in the risk premia to apply to the single risk factor sensitivities to get the

2. Index description

2.1 McNulty's original framework

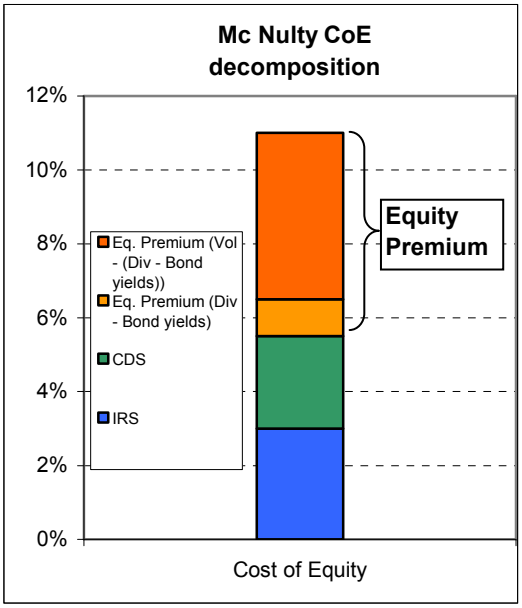
The Implied Cost of Capital (ICC or COE, Cost of Equity) can be exploited to develop a comprehensive framework aimed at analysing investors' assessment about weaknesses and risks which could affect financial markets in the near future. The ICC exploits market quotes of securities such as stocks, corporate and sovereign bonds, CDS, equity volatility, IRS and represents a forward looking measure as it is based on market expectations. Moreover, it is derived from the methodological framework by J. McNulty (2002), which is consistent with stock market valuation[3] and market standards as B&S formula for option pricing, moreover its further splitting is based on a "arbitrage free" relationship between bond yield and CDS.

The ICC framework is a unified approach, and allows to assess both the cost of equity and the cost of bond for listed companies, but it is also possible to extend its application not only to single stocks but also to general and sectoral indexes.

McNulty's ICC is based on the consideration that an equity investor expects a remuneration for bearing three kind of risks: 1) interest rate risk, 2) default risk 3) equity risk. The latter one is related to "the extra risk that an equity investor bears, because his residual claim in the company's earnings is secondary to debt holders' claim in bankruptcy or otherwise"[4]. The yields for bearing the first two risks are easy to compute because they are quoted in financial markets through corporate bond, IRS and CDS. The third risk remuneration is less straightforward to calculate[5] and it is defined in McNulty's framework as the "price that an investor would be prepared to pay in order to ensure against the chances that equity returns a yield below corporate bond. This is the premium that reflects the extra risk of equity over debt"[6].

As mentioned above it is possible to split the McNulty's formula for the cost of capital in its constituent elements such as:

1. interest rate risk = IRS
2. credit risk = CDS
3. equity premium (Py) = is the option price (Pp) expressed on a yearly basis



$$ICC = Py + CDS + IRS \qquad (1)$$

The option price (Pp) is derived from the Black & Scholes pricing formula $Pp(S;K;\sigma_T;IRS_T;T)$ where:

S: is the current stock price;

K: is the option strike price, calculated as the break even stock price which allows equity holders to obtain a yield at least equal to bond holders as stated above;

σ_T : is the quoted volatility for the tenor of the analysis;

IRS_T : is the swap rate for the tenor of the analysis;

T : is the tenor of the analysis.

By : is equal to $CDS + IRS$

To express the option price (Pp) on a yearly basis (Py) McNulty exploited the following formula:

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assessment of the impact on asset fair value or the whole impact on the fair value thought discounting the expected asset cash flows, such as equity or corporate bond, with the new yield coming from the new risk premia.

[3] Equity investors use ICC, whit in a comprehensive valuation framework, to identify relatively undervalued and overvalued stocks.

[4] McNulty et al. "What's your real cost of capital?" Harvard Business Review October 2002.

[5] Most of the literature and market practice so far set, on historical long term basis, the yearly equity risk premium at 5 p.p.

[6] Cf. McNulty (2002)

$$Py = \frac{\frac{Pp}{S}}{\frac{1}{By} - \frac{1}{By*(1+By)^{T}}}$$

The yearly equity premium (Py) can be split in two components as represented in equation (2): one referred to the yearly expected cash flow difference between a stock and a bond and the other one (which is complementary to the first) is related to the level and distribution of volatility, such as:

$$Py = (Py - (ExpDVDy - By)) + (ExpDVDy - By) \quad (2)$$

Volatility level & distrib. Exp cash yield stock vs bond

The ICC, after the splitting of the yearly equity premium (Py), can be expressed as in equation (3):

$$ICC = \underbrace{(Py - (ExpDVDy - By)) + (ExpDVDy - By)}_{\text{Equity Premium}} + CDS + IRS \quad (3)$$

credit interest rate

2.2 Extensions and improvements to the original framework

The original framework of McNulty needs some adjustments and extensions, in particular in the part referred to fixed income because the yield of a bond is not deeply analysed[7], therefore it does not capture adequately some of the main risks materialized during the current financial crisis, such as credit risk in the form of "collateral" and "liquidity".
As a matter of fact, the current financial crisis highlighted the difference between secured and unsecured lending and, as for the latter, it also showed the differences according to the quality of the posted collateral, those risks all surfaced during financial market strains through the phenomena called "flight to quality". In order to analyse those two risks (liquidity and collateral) McNulty formula can be enriched taking into account: 1) the spread between Euribor and OIS, that can be considered as an index of the cost of secured vs unsecured borrowing, in order to assess liquidity risk and 2) the spread between Bund and OIS, a proxy of the market preference for collateral in order to analyse collateral issues.
The extended ICC (Ext ICC) is represented in equation (4)

$$ExtICC = Py + CDS + (IRS - OIS) + (OIS - Bund) + Bund \quad (4)$$

Liq risk: Unsec/sec *collateral risk*

Furthermore McNulty's framework needs also to be adjusted in the component referred to credit risk, because considering CDS can lead to take into account twice the liquidity risk component. The CDS is a derivate contract that embed a liquidity risk in relation to the "arbitrage free" relationship between bond and CDS (cash and derivative market for credit risk) which set a CDS is equivalent to the bond yield minus the repo rate paid to finance the position (5), if interest rate risk is hedged through a swap, the yield of the bond is equal to the credit spread (z) plus the Euribor rate[8] (6):

Derivative market		Cash market		
CDS	=	y – repo rate	where: y = z + IRS	(5)
CDS	=	z + IRS – reporate		(6)

[7] In 2002, when the ICC was formulated for the first time, it was acceptable to proxy the bond yield with a CDS plus IRS, but nowadays it needs to be updated in relation to liquidity risk issues that emerged in the mean time due to the current crisis.
[8] The collateral issue of the relationship is tackled in financial market in a more sophisticated way with dynamic collateral posted in relation to the MTM, the Hair Cut (HC) applied to the collateral and the counterparty credit risk of the protection seller which can be proxy by the following expression: $CDS = z + IRS - repo \times (1 - HC) - (CDS_S + IRS) \times HC$

Where: *y*: is the yield of a corporate bond

IRS: is the swap rate and represents the fixed yield for unsecured borrowing

Bund: is the yield on sovereign bond of the German Republic

repo rate: is the rate for collateralised borrowing with the bond as collateral

OIS: is the Overnight Interest rate Swap and represents the risk free rate

z: is the spread over IRS of the yield on a corporate bond

From the "arbitrage free" relationship (6) we can proxy *reporate* with OIS, obtaining equation (7):

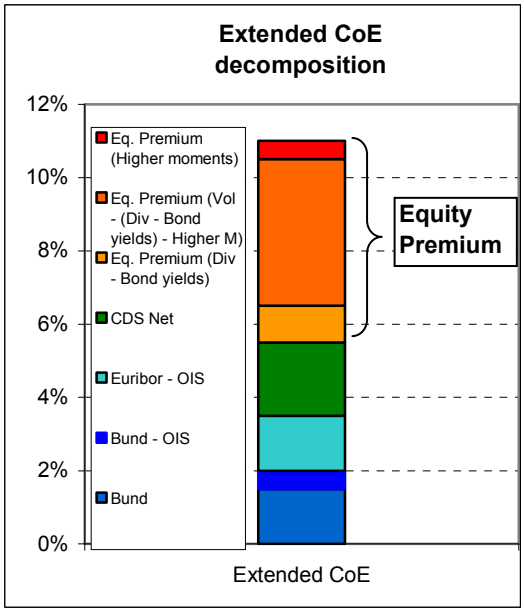
$$CDS = z + IRS - OIS \quad \text{with: } reporate \cong OIS \qquad (7)$$

$$CDS - (IRS - OIS) = z = CDSnet \qquad (8)$$

Equation (7) shows that CDS depend not only on probability of default (PD) and loss given default (LGD), which are embedded in the (z) spread, but also feel the effects of liquidity issue, related to the cost difference between secured vs unsecured borrowing in the interbank market. Therefore to get and assessment of the spread over IRS of a cash bond it is necessary to consider CDSnet as represented in equation (8) otherwise the use od CDS in equation (4) leads to consider twice the liquidity component (IRS-OIS) since the relationship in (7). The ExtICC can be expressed as in equation (9):

$$ExtICC = Py + CDSnet + (IRS - OIS) + (OIS - Bund) + Bund \qquad (9)$$

The last improvement of McNulty's framework refers to the equity premium although it is well analysed, because it considers the main elements (stock price, expected dividends and volatility) used by market analysts to get an overall assessment of firms' equity value. The extension of the framework can be achieved with the inclusion of an element which takes into account the skewness and kurtosis, which are the higher moments of the distribution of equity returns implied by the volatility option curve[9]. The inclusion of "higher moments" (HM) of equity options can give important insight, in the presence of fat-tails, about higher probability of default or extreme events (IMF 2009) Thus it's relevant to take into account higher moments in order to get market assessment for future sharp market crash or risk aversion for extreme events (tail risk).



In this version of the research "higher moments" are taken into account adopting a simplified approach that considers the price difference of two options: one with a 95% OTM volatility and the other with a 105% OTM volatility. The use of volatility of "out of the money" options to price the put option can be acknowledged as a good proxy to take into account both skewness and kurtosis in a way easy to implement[10]. The choice to consider the 95% OTM moneyness for volatility relates to the fact that it's a good proxy over the analysis period of the average moneyness of the put option in the ICC calculation, moreover the choice for

[9] Volatility skew refers to the difference between prices (thus implied volatility) of two "out of the money" options (one a call and the other a put) whose strikes are far away to the same extent from the "at the money" strike (i.e 5% from ATM means a 95% OTM put, and a 105% OTM call); for equity option skewness represents the market assessment of the fear for future sharp down movements (since the 1987 market crash, the skew is negative because option prices factor in the fear for future "tail" events).

[10] A forthcoming development of the index will consider distinctly skewness and kurtosis, so that kurtosis is equal to the pricing difference between the volatility of the actual moneyness of the put option and the one of an ATM put. The skewness is equal to the pricing difference between the actual volatility of the put and the one of a call with the same moneyness away from ATM as the one of the put.

a 105% OTM is done to be specular in the moneyness in relation to the put 95% OTM volatility.
It is possible to enrich equation (2) taking into account both the 95% OTM volatility for Py and "higher moments" ($HM = Py_{95} - Py_{105}$) to get (10):

$$Py_{95} = (Py_{95} - Py_{105}) + \underbrace{(Py_{95} - (Py_{95} - Py_{105})) - (ExpDVDy - By))}_{\text{Pure volatility}} + (ExpDVDy - By) \qquad (10)$$

Higher Moments — Exp Yield stock vs bond

The improvements carried out in McNulty's framework allows us to pass from a breakdown of the original formula, which deals with al least 4 elements (Equity: split in the form of volatility and dividend yield, CDS and IRS) to and extended ICC (ExtICC) which takes into account at least 7 elements, represented for the equity component by "higher moments", dividend yield and volatility, while for the fixed income components by Net CDS, Liquidity spread, Collateral spread and risk free interest rate represented by the yield on German sovereign bonds.

$$ExtICC = (HM + (PutY - HM - B) + B) + CDSnet + (IRS - OIS) + (OIS - Bund) + Bund \qquad (11)$$

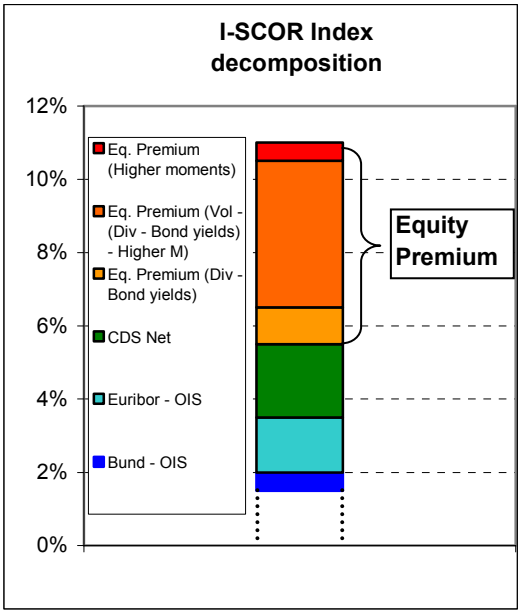
where $ExpDVDy - By$ as B

2.3 I-SCOR definition

The new and more detailed formulation of ICC can be considered as a macroprudential index aimed at analysing market assessment of the different risks that could affect financial markets. To pass from implied ICC to the macroprudential I-SCOR index it's sufficient to consider only the components related to financial risks, leaving apart, for the moment, the risk free rate for cash instruments (represented by the German sovereign bonds)[11].

The macroprudential I-SCOR index thus takes into account the following sources of risk:

- Higher Moments: risk aversion for extreme negative events (tail risk);
- Volatility: future assessment of the average cost of risk aversion;
- Div - Bond yields: represents the component of the formula related to "fundamental analysis", because it refers to the difference between the cash flow expected from dividends and the cash flows from the bonds of the same company;
- Net CDS: is the "pure" credit risk of the firm analysed;
- Euribor-OIS spread: represents the price difference between secured and unsecured lending (i.e. the liquidity risk).
- Bund-OIS spread: represents the cost to offset counterparty risk with a collateral considered by the market of very high quality;



The risk components forming I-SCOR are illustrated in equation (12):

$$I - SCOR = HM + (PutY - HM - B) + B + CDSnet + (IRS - OIS) + (OIS - Bund) \qquad (12)$$

high moments — volatility — dvd — credit — sec/unsec — collateral

[11] Further developments of this new macroprudential framework could consider also the element represented by the "real interest rate" through the inclusion of inflation break even rates to get the market assessment about inflation expectations (risk neutral).

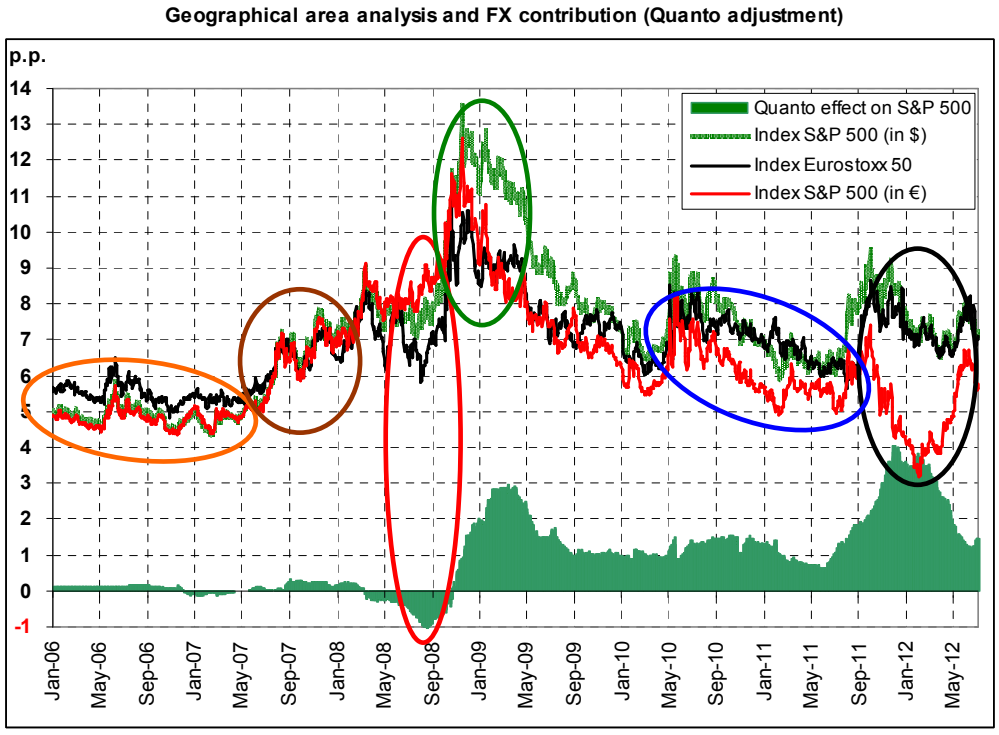
3. Empirical evidence

3.1 General market analysis

The I-SCOR indexed used in the following analysis are computed with "raw" financial indexes[12] with a tenor of 2 years, in order to capture long term changes in risk factors, skipping short term noise.

The analysis through time – before the beginning of the crisis in January 2006 up to nowadays - of the I-SCOR indexes, referred to different general stock markets indexes, allow to better assess where risks are growing from a geographical point of view but also to take into consideration strains in the foreign exchange market. Chart 1 shows the index referred to EU (Eurostoxx 50, black line) and US (S&P500, green line): the latter is expressed both in its original currency (US dollar) and in euro (red line) through a "quanto" adjustment[13]. The US index expressed in euro is necessary to analyse the indexes (EU and US) on a uniform currency; but also the comparison of the same index expressed in different currencies reveals tensions within the foreign exchange market. Before the beginning of the first strains of the sub-prime crisis, in August 2007, the two indexes where on average near 5% - a level in line with the long term equity premium used in CAPM – and ranged between 4,5% and 5,5%, with the US index below the EU one (Chart 1 orange circle). At the beginning of the sub-prime crisis the I-SCOR referred to US got higher than in Europe, highlighting that the geographical epicentre of the crisis was in the USA (Chart 1 brown line). The gap between the indexes increased steadily before the default of Lehman, in particular considering the US index expressed in euro (Chart 1 red line), which is higher than the one expressed in dollar, underscoring that also the dollar was under stress during the sub-prime crisis with the green area in Chart 1 below zero.

Chart 1



Data Source: Bloomberg

The consequences of Lehman's default spread also to Europe, as the index referred to EU increased sharply but remained below the US one. After the massive intervention of the US authorities (Treasury and FED) during the last months of 2008, financial markets recovered trust in the dollar, which strengthened, as highlighted in Chart 1 by the green area, that became positive.

The first part of the Greek crisis experienced the opposite trends saw during Lehman's default, underlining that this crisis episode was striking Europe; indeed EU index was above the US one and the difference between the two increased due to the currency effect, because this time euro denominated US

[12] Data are from Bloomberg for all financial time series, apart for dividends, which are from IBES Thomson Reuters.

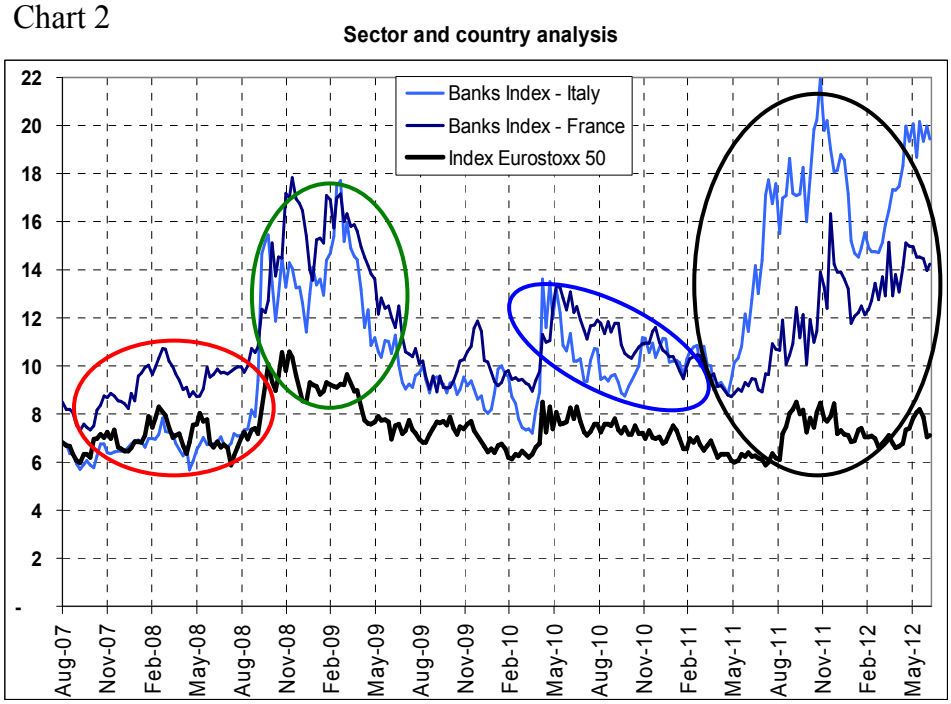
[13] The "quanto adjustment" is performed considering the volatility of the index, the one of the FX rate and their correlation, obtaining the spread to express a financial index in another currency different from the original one as represented in Hull (2006).

index was below the dollar denominated one (Chart 1, blue circle). The "quanto effect" increased remarkably with the worsening of the EU sovereign crisis, in particular after the involvement of Italy (after June 2011), reaching the peak at the end of 2011 (Chart 1, black circle). The monetary policy decision by the EBC to run two LTROs let the currency strains to get back.
The influence of the "quanto effect" on the relative performance of the indexes clearly emphasizes the importance to consider this effect in assessing the level of stress in a financial system, otherwise there is the risk of misinterpreting the signals coming from the indicator. An example of this can be traced during all the EU sovereign crisis, when the value in original currency of the EU and US index were similar, therefore the indication coming from the indexes could be interpreted as the crisis was hitting the two areas in the same way. On the contrary, considering the indexes on the same currency (euro), the indicator signals that the crisis was hitting Europe more than US and also strains were spreading to the foreign exchange market. The analysis of the level of the indexes shows that a level higher than 8% is reached during stressed periods, while below 6% is a level of relative quiet or is attained during the recovery from a period of strains.

3.2 Sectoral and country analysis

Beyond the geographical analysis it is possible to perform a more specific one at sectorial or country level, in order to identify the economic sector and/or the country where crisis was hitting. Chart 2, which represents the EU general stock market index and the one referred to the banking sector of Italy and France[14], shows that during the first part of the financial crisis - before Lehman's default - Italian banks were not deeply involved in the crisis, because they were considered out of the sub-prime business; on the contrary, French banks were among the most affected (because of the liquidability problems incurred by a BNP investment fund): these two events are well highlighted by the indexes, since the one referred to Italian banks was below the European equity index, while the one referred to French banks was above it (Chart 2, red circle). The default of Lehman caused a generalised sharp and higher increase of all the EU banking I-SCOR than the EU stock exchange general index, showing that the sectorial centre of the crisis was the banking one. The I_SCOR reached a level above 16% (Chart 2, green circle) highlighted, during the first months of 2009, the crisis period suffered by the Italian and French banking sectors due to the East Europe strains, reaching a level. During the first part of the Greek crisis the indexes show French banks were suffering more than Italian ones, as a consequence of a wider exposure to Greece (Chart 2 blue circle). The improvements in the Italian index during the first months of 2011 (from 11% to 9%) were also due to the capital increases completed by

Chart 2



Data Source: Bloomberg

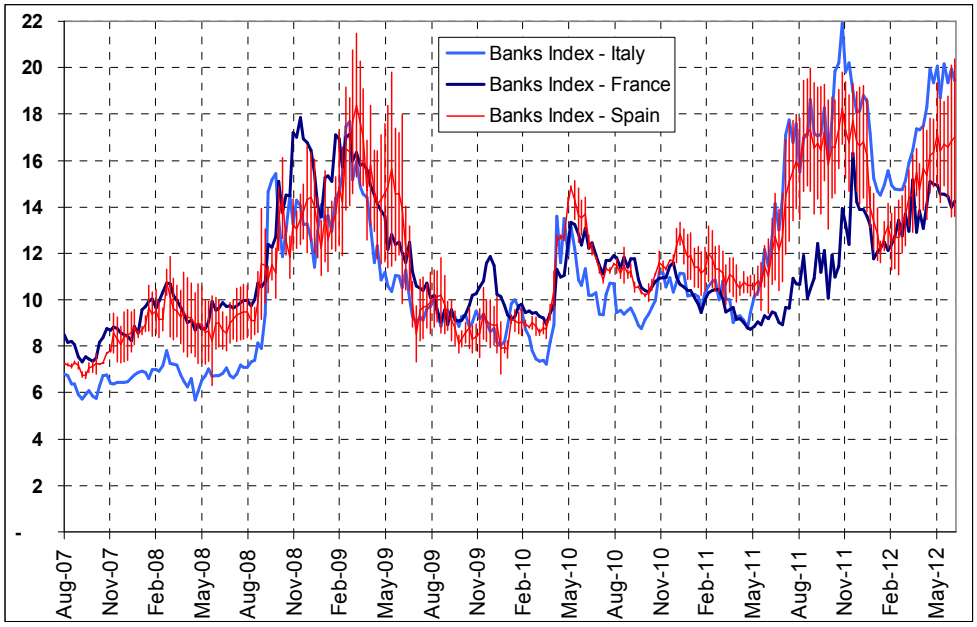
[14] Each banking sector index is computed as the simple average of the single indexes referred to the main banks of each country (3 or 4 banks per country on average) so that country index represents more than 60% of the banking sector activity in each country.

many of the main Italian banks; from May 2011, afterwards the deepening of the European sovereign crisis. The I-SCOR clearly shows that Italian banks were the most badly struck from the speculative attack on sovereign bonds of "non core countries". The peak of the I-SCOR referred to the Italian banking sector was reached in November 2011, when the sovereign and CDS curves were inverted, as a sign of extreme market stress. The strong reduction of the index during the first quarter of 2012 is linked to the capital increase performed by UniCredit and the reduction of the sovereign spread strains due also to the two LTROs given the liquidity drawn by the Italian banking sector. The deepening of the Greek crisis in May 2012 and the strains on Italy caused a pull back of the index at 20%, near the former peak of 2011, emphasizing that the current crisis is worse for Italy than the Lehman's one and that the actual level of market strains even for other countries is near the one reached with Lehman and worse than those recorded at the onset of the Greek crisis.

Going deeper in the analysis, another element worth of attention relates to the variance of the single indexes with in the sectoral index, because if all the banks in the index move in a correlated way, the average of the index is a representative value, otherwise if the variance is high the signalling power of the average index is reduced. It is important to consider also the variance of the sectoral I-SCOR in order to have an insight about different situations within the banking sector of a country. A clear evidence of this phenomena is the I_SCOR for the Spanish banking sector, since it is composed of four banks such as Santander, BBVA, CAIXA and Banco Popular. The first two are internationally diversified banks, that suffered less from the idiosyncratic problems of the Spanish economy, while the last two banks better represent the strains borne by the rest of the Spanish banking sector for the real estate bubble. The variance of the single indexes inside the sectorial index (Chart 3, red bars) well represents this situation, because the current market assessment of the two international Spanish banks (Chart 3, lower red bars) is more in line with French banks, while the two more problematic Spanish banks are considered by the market more in line with Italian banks (Chart 3, upper red bars).

Chart 3

Intra Index distribution (the Spanish case)



Data Source: Bloomberg

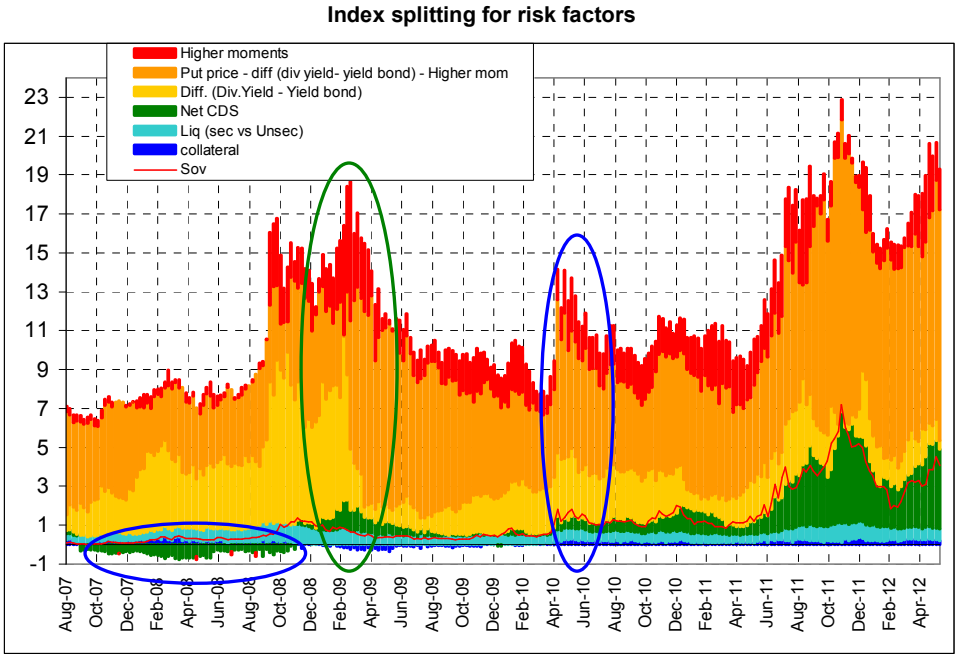
3.3 Risk factor analysis

It is now possible moving from the analysis of the index as a whole from a geographical and sectorial point of view to an analysis over time of the different components of a single I-SCOR index. The study performed in this work deals with the index regarding the Italian banking sector[15] and it is the graphical representation over time of the components in (12) and aims to figure out the evolution of the main risk factors to detect the main sources of risk in the financial markets during the different phases of the crisis. At the beginning of the financial crisis - before Lehman's default – there was an increase of credit risk in the two components of liquidity and collateral from near nil to 1%, while the "pure" credit risk was not affected, confirming that, in the initial phase of the crisis, Italian banks were not engaged in the sub-prime business but were only slightly hit by systemic risk in the form of liquidity and collateral risks

[15] Italian banking sector I-SCOR index is computed as a simple average of the I-SCOR indexes of the main 3 Italian banks.

(Chart 4, blue circle). Moreover, during this first year of the crisis, the "higher moments" component kept relatively low, evidencing that market participants assigned a low probability to future marked crash or had a mild risk aversion for extreme events (tail risk) (Chart 4, red area). The Bearn Stearn's crisis caused an increase in the Macroprudential Index from 7 to 9%, that got back once the bank had been saved. On the contrary, Lehman's default caused a doubling of the Index, from 8% to 16%, mainly due to "higher moments" and to the equity premium components, highlighting that market assessment about extreme events changed radically and that general risk aversion in the medium term horizon (2 years) increased due to higher volatility, while liquidity and collateral risk remained stable near 1%. During the first month of 2009, I-SCOR increased at 19% due to the credit risk component (Chart 4, red line) as a consequence of the crisis of East European countries, showing that Italian banks were among the most exposed to that region, while Italian sovereign risk was not affected since it was an idiosyncratic event, hitting two main Italian banking groups (Chart 4, green circle). During the strong recovery of the stock markets, from March to December 2009, the index gradually declined because of the reduction in volatility, liquidity and collateral risks, but the "higher moments" component remained elevated, not getting back to pre-crisis level: investors now are scared about future market crashes and factor it in options' prices. The first part of the Greek crisis caused an increase in liquidity, collateral, volatility and "higher moments" risks but this time also the banking credit risk raised in relation to a stronger increase in sovereign credit risk (Chart 4, blue circle), underlining that during this period of stress the risk driver was sovereign and not idiosyncratic. After June 2011, the index experienced a sharp increase in all risk measures, from volatility to credit risk and liquidity/collateral risks, putting into evidence that for Italian banks this phase of the crisis was worse than the period after Lehman's default, because reached the all time high peak in relation to past stressed periods and the main driver of the risk was sovereign which increased at the same peace of banking credit risk.

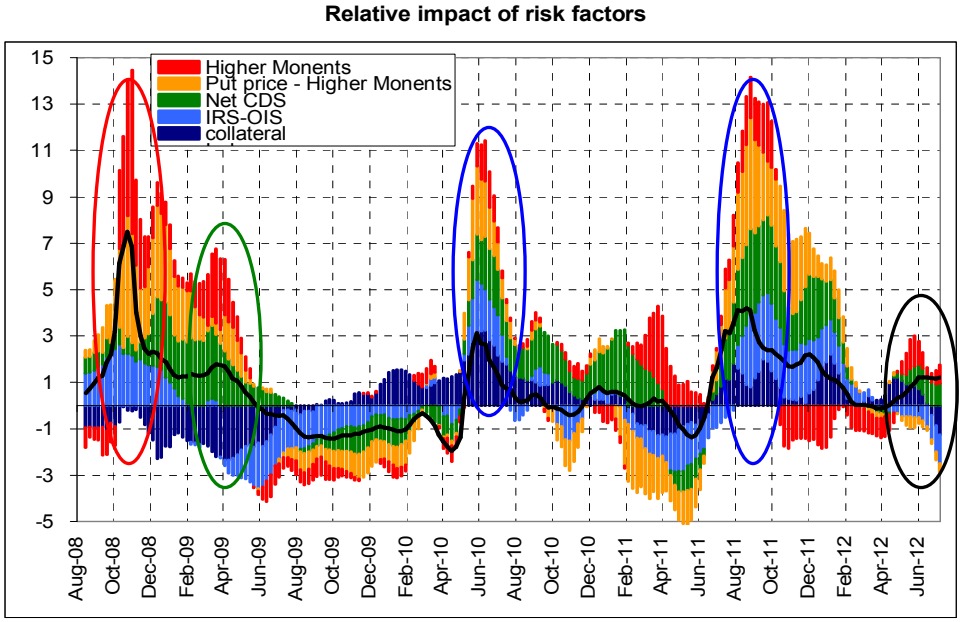
Chart 4



Data source: Bloomberg

In order to better analyse the single relative contribution of the risk drivers, because of their difference in absolute terms (i.e collateral risk is in absolute term a fraction of volatility risk, therefore its contribution is in absolute term smaller than the one of volatility) it is relevant to standardize all risk factors with a rolling yearly mean and standard deviation, in order to account for the relative performance of each risk factor during moments of stress.

Chart 5



Data source: Bloomberg

During Lehman's default the risk factors which contributed most in relative terms to the index increase (see Chart 5 red circle) are the ones referred to liquidity, volatility and higher moments, while credit and collateral were near zero or slightly negative, emphasizing the correct identification by the I-SCOR index of the main sources of risk during this phase. Even during the East Europe (see Chart 5 green circle) crisis, the index well identifies the main risk drivers as credit risk because the idiosyncratic elements were typical of this crisis - not sovereign risk that, on the contrary, helped to reduce the overall increase in the index - and "higher moments" because there was a lot of uncertainty surrounding this crisis episode that, once solved, led to a sharp decline of the latter risk component.

During the first part of the Greek crisis and during the deepening of the European sovereign crisis (see Chart 5 blue circles) there was a sharp increase in the collateral and liquidity components of the I-SCOR index related to the investors' strategy known as "fly to quality", which took place during the period of stress in the sovereign bond market. The strains in the sovereign component were reflected also in the credit risk one while higher moments and volatility had a relatively smaller contribution than during Lehman's crisis.

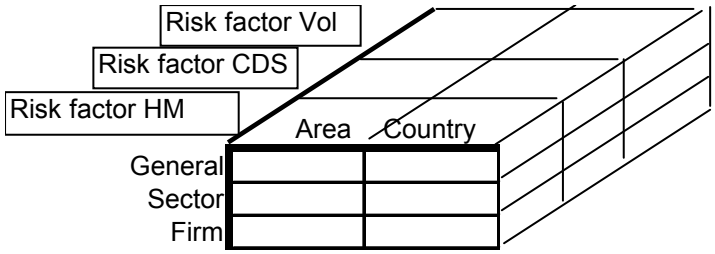
The relatively low movements of the risk factors during the last period of stress (Chart 5, black circle) is due to the high absolute level of the mean and standard deviation of risk factors which, by construction, leads to a relatively low increase (in terms of standard deviation) of the recent evolution of the risk factors. However, even in this last period of stress, the index underscores correctly that liquidity, is no more an issue after the two LTROs but that problems come upon credit risk in the form of collateral or idiosyncratic, moreover also "higher moments" component has a positive contribution to the index underscoring the presence of investors' fear of extreme events.

4. Conclusions

The new macroprudential I-SCOR index, derived from MCNulty's ICC and enriched to account for the risks materialized during this crisis such as collateral and liquidity but also to better assess tail risk with the inclusion of "higher moments", well highlighted and distinguish the risks that contributed to each phase of the financial turmoil (Lehman, East Europe, EU sovereign divided in two sub periods: Greek and "no core") and peaked during the highest moments of strain. The index has proved during all the period of analysis to rank correctly over time and over other dimensions of analysis (sectoral, geographical) where strains where growing. Moreover its expression in percentage points, linked to the fair value valuation of the underlining securities, make it and "easy to interpret" measure of a crisis.

Using this macroprudential index, it is possible to analyse financial markets conditions in a scalable way: starting from the high stage of a "geographical" and general index level, it is possible to drill down within each geographical area on the sector or the country in order to detect where the risk are growing. It is also possible to go further splitting the sectorial index in its single components to take into account the deviations between single firm within the indexes to study specific sub index issues (i.e the Spanish

case). Moreover the analysis can be completed taking into account risk drivers so that the overall analysis performed through the deployment of the I-SCOR index can be seen on three different dimensions.



The fourth dimension of the analysis is represented by the evolution over time of the former cube, while the fifth dimension is represented by the analysis of the risk factors over maturity tenors.
Therefore the I-SCOR represents a comprehensive and market consistent composite stress indicator that can be used as a first warning signal that need complementarily in depth analysis on specific risk factors or with common distress indicators (such as JPoD, CoVaR and MES).
Further upcoming developments of the index are:

- a more accurate splitting of higher moments in skewness and kurtosis,
- an analysis of the index in different time span to figure out the time "bucket" where risks are growing up,
- an analysis of the correlation through time of the risks drivers to study the tails of the distribution of the index and of its single risk components,
- an assessment on the impact on a "dollar basis" of the crisis.

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