Credit Analysis

Credit Strategy | Europe
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Introduction to Lighthouse

Bank of America Merrill Lynch

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Introducing Lighthouse to our European readers

Lighthouse is a suite of data and analytical tools for single name and portfolio level credit analysis. Our web-based interface allows users to access data, reports and quantitative analysis through three main Lighthouse platforms.

Credit Option Adjusted Spread (COAS): A forward looking, issuer level model of credit risk, based on equity implied volatility, stock price and balance sheet data. The model is calibrated daily within the High Grade and High Yield universe to produce issuer level risk, sector and market aggregates for relative value comparison.

Lighthouse Portfolio Analysis: A portfolio level risk and relative value tool for analysing portfolios of cash, CDS and synthetic structured credit products across European and North American High Grade and High Yield issuers. The portfolio analytics system uses the COAS model as a starting point and overlays a correlation structure to provide a comprehensive report of both absolute and relative risk at the issuer and sector level. Our coverage universe for this analysis extends to over 5000 global issuers.

Lighthouse Data Analysis: A robust set of indicative pricings and analytics for issuers across the credit spectrum, including cash, CDS, indices. The interface is easy to use, allows for customized reports, charting functions and spreadsheet downloads.

This report provides a brief introduction to the first two tools listed above – COAS and Lighthouse Portfolio Analytics.

For further information and more in-depth publications we encourage readers to visit our website at www.bofa.com/lighthouse.

To request access to Lighthouse or schedule a demonstration, please contact your BofAML salesperson or one of the authors of this report.

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Refer to important disclosures on page 12 to 13. Link to Definitions on page 11. COAS Certification on page 11.

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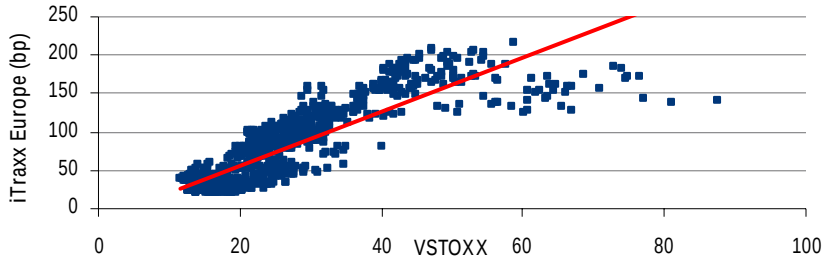
Lighthouse Credit Analysis

Corporate bond returns are asymmetrical – the magnitude of possible downside is much larger than the upside. For example, a bond trading at par has limited room for further price gain, but could lose almost all the capital risked. The latter is of course a much more unlikely event, but the extent of possible loss makes credit investors highly concerned about this 'tail risk'. Our Lighthouse suite of analytical tools including the COAS model and Lighthouse Portfolio Analysis aim to capture precisely such events, to help investors flag, manage and minimise the downside risk in corporate credit portfolios.

Credit Option Adjusted Spread (COAS) Model

Volatility is the choice indicator of tail risks as it measures the level of uncertainty in the market. The higher the volatility, the larger is the range of possible events and hence there is a higher likelihood of a 'tail event'. A company's stock price is typically negatively correlated with its volatility i.e. as the stock price falls, volatility increases and vice versa. The fall in stock price makes the company more levered as its asset value falls versus the liabilities. The rising volatility indicates the increasing risk associated with the issuer and hence is typically accompanied by rising credit spreads. This is illustrated in Chart 1, where the correlation between iTraxx Europe and VSTOXX over the entire period in (2005-2010) is a little over 87%.

Chart 1: Credit spreads tend to be highly correlated to equity volatility



Source: BofA Merrill Lynch Global Research, Bloomberg, Markit

Credit OAS uses this relationship between volatility and credit spreads to derive a forward looking measure of credit risk. Our model determines the value of the credit risk based not only on the equity market valuation and capital structure of the issuer, but also on the price of insuring the value of the equity, that is, on the price of traded options. The price of an option is quoted in terms of its "implied volatility", i.e., the amount of uncertainty the market views as likely over the future time period covered by the maturity of the option. It is in this regard that we term option-implied volatility as *forward-looking* volatility, which we distinguish significantly from volatility derived from historical stock prices, which, by definition, is backward looking.

Very often implied volatility has provided advanced warning of credit events. There is an institutional reason why we observe closely corresponding and, in a few cases, predictive relationships between credit spreads and option implied volatility. Options markets allow investors to alter their portfolios' risk profiles with the benefit of leverage, i.e., a relatively small investment can effect a large change in the portfolio's risk exposure without having to alter the portfolio itself. Because of this feature, we often see important information in volatility markets that we would not see in the cash market stock price itself. A declining stock price is often accompanied by rising volatility and vice versa. When volatility moves independently of the stock price, though, information from the volatility markets can be of signal importance.

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Credit Option Adjusted Spread (COAS)

The 'option' in our COAS model refers to the issuer's option to put the assets of the firm back to creditors - in other words, an option to default[1]. The value of this option is calculated from the nominal benchmark spread of the issuer, adjusted for credit risk (including both mark-to-market and default risk).

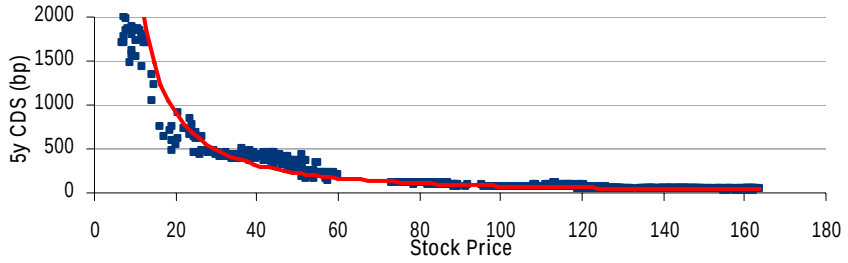
COAS = 5-year benchmark spread to LIBOR – COAS Risk

COAS Risk = Σ (Projected % Change in Bond Price * Probability of Change)

COAS Risk is the key calculation for understanding COAS. It is simply the expected 3-month holding period loss due to changes in credit spread and/or default (annualized). There are two key components to our calculation of credit risk: 1) estimation of future changes in the bond/CDS value due to changes in credit spread and 2) the probability of each credit spread change scenario. Both of these are derived using current market variables including the equity price, implied volatility, the issuer's leverage and credit spread.

To illustrate the calculation, consider DSG International as an example. Changes in the issuer's stock price can explain almost 95% of the changes in 5y CDS spread (Chart 2). For each potential outcome of stock price, the fitted line tells us the potential change in credit spread. Credit risk is this set of potential changes in spread (both wider and tighter) implied by this relationship.

Chart 2: DSG – Strong relationship between the stock price and credit spread



Source: BofA Merrill Lynch Global Research, Bloomberg, Markit

For issuers like DSG, who have had cycles of tight spreads and high equity prices as well as distressed periods, using historical data to determine potential spread movement under varying equity scenarios is possible. However, most Investment Grade issuers have not gone through the entire spectrum of ratings and credit fundamentals; and consequently, there are few observations to draw from. For this reason, we look to Merton's Model to help us derive a credit curve from just one point in time.

An Applied Merton Structural Model

COAS belongs to the class of credit risk models known as "Merton Models", named after Robert Merton following his work on valuing corporate debt by applying the Black-Scholes-Merton option pricing theory[2]. Merton's key insight is that since the corporate debt holder's payoff resembles that of a short put on the company's assets, option pricing techniques developed to price equity options could, with some modifications and assumptions, be applied to price the risk of default in corporate bonds.

[1] This is different from the OAS analysis of callable securities that investors are familiar with.

[2] See Merrton, Robert C., "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates", Journal of Fiannce, Vol. 29, No. 2, May 1974, pp. 449-470.

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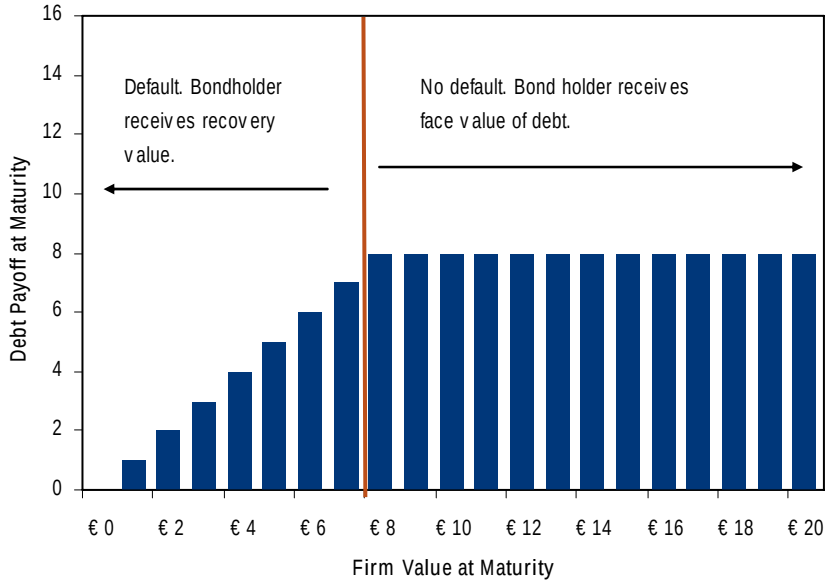
A structural model assumes that issuers have a simple two class capital structure of debt and equity. Default occurs when the value of the firm (market value of equity and debt) falls below the face value of the debt (Chart 3). Hence, the market value of the debt can be valued as the combination of risk-free debt plus a short put option on the value of the firm, where the strike price of the put is the face value of the debt. The Merton structural model uses the standard Black- Scholes-Merton formula to value this option.

Chart 3: Default occurs when the firm value at maturity falls below the face value of debt



Source: BofA Merrill Lynch Global Research

An important input in this formula is the volatility of the asset underlying the option i.e. the firm value. This is an unobservable parameter. COAS differs from standard implementations of structural models, in that rather than estimating this number in an ad hoc manner to derive the current market value of the bond, we imply the asset volatility based on the current market price of debt, to retrieve forward looking information regarding changes in credit spread. In other words, our model is 'calibrated' to current market variables.

Note that changes in credit spread are not affected by the absolute level of equity but by the change in market capitalization relative to outstanding debt. Our calibration establishes a parameterized relationship between the firm's market capitalization and credit spreads. By assuming a probability distribution for the stock price we can map changes in market capitalization to changes in credit spreads, along with corresponding probabilities, using this relationship. The changes in bond value corresponding to these credit spread changes, multiplied by the probability of each change gives us the COAS Risk. Importantly, the stock price distribution takes into account the option implied volatility and hence the uncertainty priced in the market over our time-horizon.

To get COAS, simply compare the value of the COAS Risk to the compensation received for taking the credit risk i.e. the cash or CDS spread.

In Lighthouse, we use a five-year benchmark spread to LIBOR, as we have the best coverage across both financial and industrial issuers in this tenor. It also matches the tenor of credit default swap pricing, allowing us to substitute CDS pricing for cash market pricing where necessary or desired.

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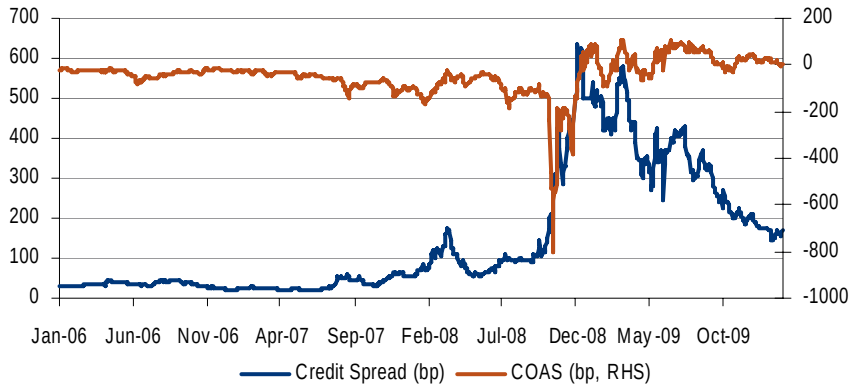
Chart 4 shows the historical COAS for Volvo AB (VLVY) as an example. A negative (positive) COAS implies that COAS Risk is higher (lower) than the compensation offered by the credit spread. A negative COAS by itself is not a signal to short the credit. Rather we are more interested in the trend of the COAS and how it compares to other market signals like equity, volatility and fundamental credit opinions.

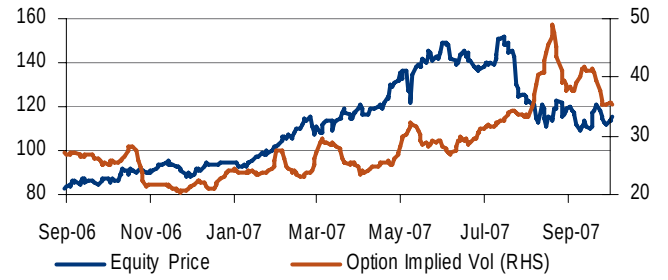
Chart 4: Historical COAS versus Credit Spread for Volvo AB



Source: BofA Merrill Lynch Global Research

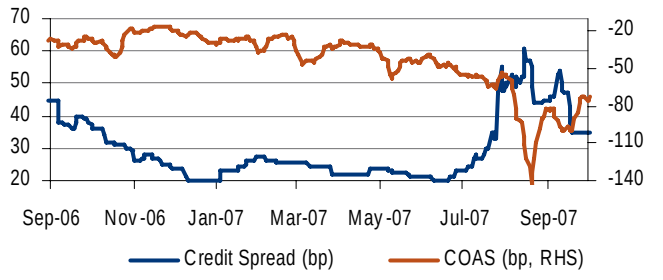
To illustrate this, consider the same credit between 2006 and 2007 (Chart 5 & Chart 6). We see that between Nov 2006 and Jul 2007 the equity price gained over 65% in value. At the same time, the volatility *increased* by 12 vol. points (a 57% rise). This rising risk was captured by the steadily decreasing (becoming more negative) COAS, which went from -16 to -56 in spite of the stellar stock performance. While the credit spread remained steady over the period, it eventually saw a dramatic rise in July 2007. This is a good example of the COAS model picking up signals from the options market where the cash equity is still to reflect the risk.

Chart 5: Implied vol increased in spite of rising equity...



Source: BofA Merrill Lynch Global Research

Chart 6: ...reflected in a steadily more negative COAS



Source: BofA Merrill Lynch Global Research

For more details on the COAS model and its practical applications please see 'Introduction to Lighthouse', 26 Jan 2009, available at www.bofa.com/coas

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Lighthouse Portfolio Analytics

The COAS model is a good tool for analysts trying to identify relative value and trends at the issuer level. In Lighthouse we go a step further by using this issuer level information to build a bottom-up portfolio model that can provide invaluable assistance to portfolio managers in their risk management.

Because the best case return to a creditor is return of principal and the worst case is default, credit returns are asymmetric and skewed toward the downside. Assuming symmetry for the sake of simplicity, leads to a drastic overstatement of credit diversification and larger sensitivity to the assumed correlation structure. By capturing the large downside risk in credit assets, spurious credit diversification can be avoided, and the resulting diversification value attributed to each credit is much less sensitive to the assumed correlation.

Lighthouse expresses the risk and relative value of a credit portfolio incorporating a forward-looking risk model for the underlying credits that accurately captures the tail risk of the portfolio. Lighthouse can analyze portfolios containing High Grade and High Yield cash bonds as well as portfolios that contain CDS, Single Tranche CDOs, First-to-Default baskets and Index Products in both long and short credit exposures. Lighthouse users employ the tool as an overall risk management system, as a relative value tool or to perform scenario and what-if analysis.

The "3 Cs" of Lighthouse Portfolio Analysis

Lighthouse portfolio analytics are built from the bottom up and contain three main inputs—what we call the "Three Cs": COAS Risk, Concentration and Correlation. Starting with the exposure information (concentration), we employ the Credit OAS model to characterize the credit risk for each issuer. Finally, we add in a model of correlation to determine the credit risk at the portfolio level, along with risk disaggregation at the issuer and issue level.

COAS Risk

Lighthouse characterizes issuer risk using the COAS model, where each issuer's implied option volatility, capital structure and equity are used to create forward-looking credit return distributions. Additionally, by treating cash and synthetic instruments differently, we also capture basis risk. Figure 1 below looks at the COAS inputs and outputs for issuers in iTraxx Europe S12.

Figure 1: COAS Risk

Issuers by sector: All

Issuer Summary					COAS Model Input						COAS Model Output			
Ticker	Issuer	Mdy/S&P/Fit	Outlook	Sector	Price	Shares (mil)	Debt (mil)	Vol (%)	Sprd (bps)	Beta	DTMC (%)	Risk (bps)	COAS (bps)	3M Avg (bps)
ZURN VX[C	Zurich Finl Svcs AG	A2/A+/N/A	NA/NA	Insurance - P&C	242.90	147	13,034	24	80	1.00	26.68	70	10	
XTA LN[CD	Xstrata PLC	Baa2/BBB/NA	NEG/NEG	Basic Industries	10.30	2,939	18,233	63	159	1.00	37.58	367	-208	
WPP LN[CD	WPP Grp PLC	Baa3/BBB/BB	STABLE/STABLE	Media	5.93	1,254	1,919	28	135	1.00	20.51	96	38	
WKL NA[CI	Wolters Kluwer NV	Baa1/BBB+/B	STABLE/STABLE	Media	14.96	293	2,597	25	55	1.00	37.23	69	-14	
VOLVB SS	Volvo AB	A3/NA/N/A	STABLE/NEG	Autos&Autoparts	63.65	2,128	74,885	39	184	1.00	35.60	176	8	
VOW GR[C	Volkswagen AG	A3/A-/BBB+	STABLE/STABLE	Autos&Autoparts	62.90	400	5,279	34	107	1.00	17.33	116	-9	
VOD LN[CD	Vodafone Grp PLC	Baa1/A-/A-	STABLE/STABLE	Telecom - European+	1.38	52,616	19,296	23	70	1.00	21.00	58	12	

Source: BofA Merrill Lynch Global Research

The three major input parameters to our Credit OAS model: debt to market cap (DTMC as calculated from equity price, shares outstanding and debt), option implied volatility (Vol) and credit spread[3] (Sprd), can all be edited by the user. Risk is the annualized expected mark to market loss over the next three months, while COAS is the difference between credit spread and COAS Risk. The latter is a measure of the degree to which investors are compensated for the "expected" risk they are taking.

[3] Credit spread refers to either Cash or CDS spread, typically to a 5y maturity.

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Concentration

With a unique risk statistic for every issuer in our universe (approximately 5,000 names, or 99% of the High Grade and 95% of the High Yield universe by market value), the next input needed by Lighthouse is exposure. To capture the risk differential of different maturities, we characterize exposure based on contribution to duration (CTD) weighting. Figure 2 below is a sample of the input file a client would have to supply in order for Lighthouse to calculate market value and contribution to duration for a CDS portfolio. For a cash portfolio, Lighthouse simply needs a CUSIP or ISIN and par amount.

Figure 2: Sample Upload File

Snapshot Home — Total Par:125,000,000

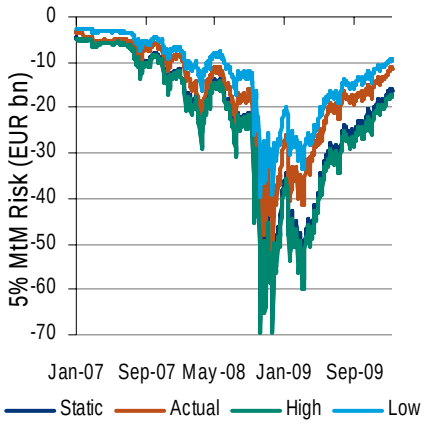
Delete	Cusip/ISIN/Name	Type	Par	Sub	Maturity	BookSpread	Upfront(%)	Attach
☐	EDF	CDS	1,000,000	SrUn	20-Dec-2014			
☐	EDP - ENERGIAS DE PORTUG	CDS	1,000,000	SrUn	20-Dec-2014			
☐	EDISON SPA	CDS	1,000,000	SrUn	20-Dec-2014			
☐	EON AG	CDS	1,000,000	SrUn	20-Dec-2014			
☐	DIAGEO PLC	CDS	1,000,000	SrUn	20-Dec-2014			
☐	DEUTSCHE TELEKOM AG	CDS	1,000,000	SrUn	20-Dec-2014			

Source: BofA Merrill Lynch Global Research

Correlation

In Lighthouse, since we model the mark-to-market risk of the portfolio, correlation is well defined as the correlation of spread changes. In the Lighthouse model we have four correlation options that users can choose from. By default, portfolios will run using a two-tier correlation matrix that relates issuers to their sectors and sectors to sectors created in 2002, called 'static' correlation. 2002 represented one of the highest periods of spread correlation, thereby making the Lighthouse risk output conservative. We also provide correlation matrices dubbed, high, low and actual. These correlations represent, on a monthly basis, the highest and lowest 6-month correlation dating back to 2002, and the most recent 6-month period of correlation, respectively. Finally, users can input their own correlation assumptions, thereby providing not only the ability to be aggressive or conservative, but also allowing for scenario analysis.

Chart 7: ER00 Tail risk at different correlations



Source: BofA Merrill Lynch Global Research, Tail risk = MtM at 95% confidence level that will not be exceeded on the downside.

The asymmetry in credit returns makes the effect of correlation less important than in equity portfolios. Chart 7 shows the 5% tail risk of the BofA-ML ER00 index portfolio over time. Even though the magnitude of tail risk is different at different levels of correlation, the four time-series in the chart are almost perfectly correlated and in fact, each exhibits a very high level of correlation with the level of market volatility (we use VSTOXX as a proxy). This indicates that it is volatility, not correlation that drives the direction of tail-risk.

Disaggregating Portfolio Risk

Because of the issues we discussed above, it's notoriously difficult to build credit portfolio models that incorporate the skewness in returns (i.e., more downside than upside in credit). The main difficulty is the lack of efficient ways of adding up a large number of asymmetric distributions and then calculating the "true partial derivative" of each individual component that is allocating the total portfolio risk to each contributing portfolio element. The application of Saddle Point methodologies to portfolio credit risk presents a solution to this problem.

The key idea of this approach is to focus on one particular tail point of the loss distribution (instead of the entire distribution). Once we pick the particular tail point, the tail risk of the portfolio can be approximated with a closed form formula built up from moment generating functions of individual issuer's loss distribution. The advantage of this approach is that not only does it quickly produce portfolio

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risk at a certain tail point; it also generates issuer-level contributions to the portfolio's tail risk with no incremental computation time. The latter, of course, is a critical piece of information that makes it possible to evaluate a credit's relative value within a portfolio context.

From Issuer to Issue level risk

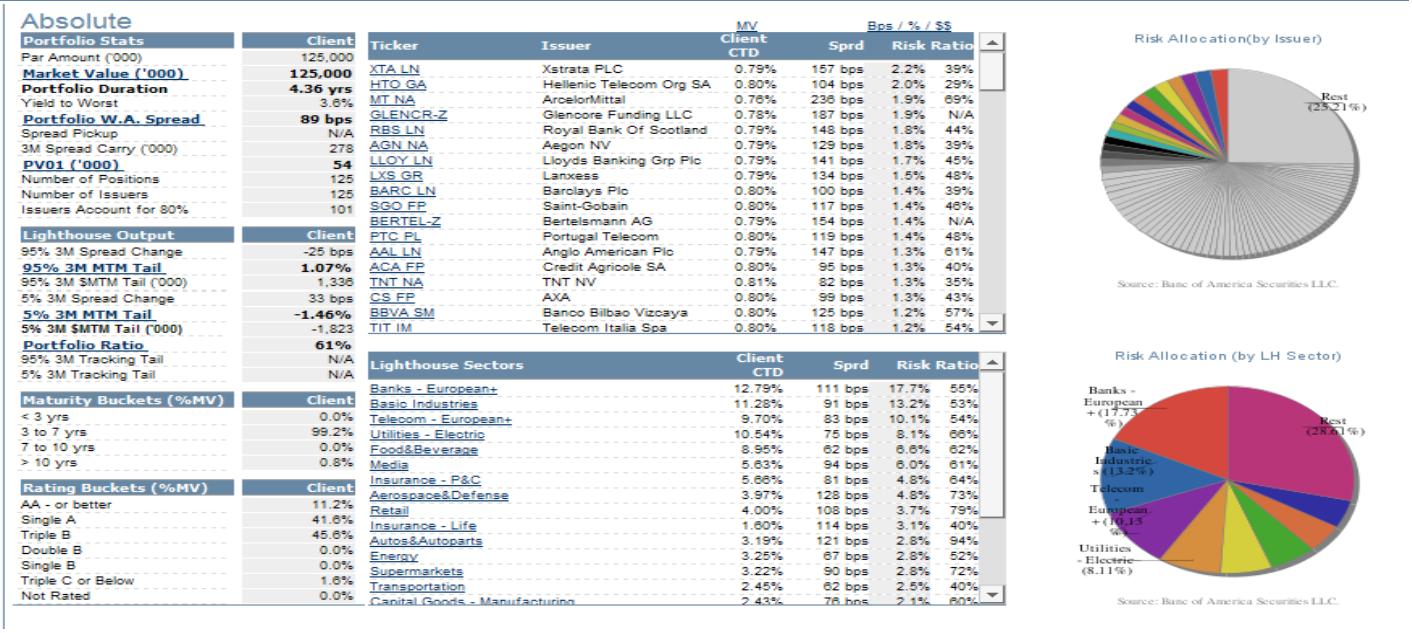
COAS Risk is an issuer level metric, calculated for a benchmark 5y tenor. The model to calculate COAS risk is calibrated to either the benchmark bond or CDS spread. For our portfolio analysis, this risk has to be transferred to the issue level, which may be different than the instrument used in the calibration or have a different maturity.

In the first case, where the COAS Risk is calculated using CDS Spread while the portfolio has a bond from the same issuer (or vice versa), we calculate a beta between the CDS and bond and apply this for the issue level mark-to-market risk. To adjust for maturity, our approach is to apply what we call a "volatility scalar" to the durations of the issues within a portfolio. To calculate the scalar, we take the ratio of standard deviations using three-month spread data for the 'N' year tenor and 5 year. Once we calculate the scalars we apply them to the durations and calculate a scaled contribution-to-duration (CTD) for each issue. Using this CTD, we can then calculate each position's weight within the issuer and apply that weight to the issuer risk.

Lighthouse Portfolio Reporting

Lighthouse takes the issuer level Credit OAS model to the portfolio level and allows the user to view the results and manipulate the inputs using an online application. Figure 3 is a snapshot of the Lighthouse online Risk Report for iTraxx Europe S12 (as of 11 Feb 2010), which we use as an example in the following articles.

Figure 3: Lighthouse Risk Report for iTraxx12



Source: BofA Merrill Lynch Global Research

The above risk report is broken into six main quadrants. The first shows basic portfolio statistics like the portfolio Par Amount, Market Value, Duration and Weighted Average Spread. The second quadrant shows the main proprietary risk output of the model. There are three numbers that should stand out here: 95%

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3M MTM Tail, 5% 3M MTM Tail and Portfolio Ratio. Because Lighthouse calculates a distribution of potential outcomes, the system provides points both on the downside as well as on the upside. We note the difference between these outcomes by calling the downside the 5% 3M MTM Tail and the upside the 95% 3M MTM Tail. Both events have a 5% chance of happening (so, a 95% confidence interval) over a three-month horizon. The user has the ability to change both the confidence interval as well as the time horizon, depending on the investor's objective. For e.g. a 0.1% tail risk measure over a 1-year horizon may be appropriate for calculating certain capital requirements, while some users may prefer a 1 week horizon for their trading books.

Additionally, these risk numbers can be considered "total credit risk" (interest rate risk is assumed to be hedged with Treasuries, though we can incorporate it as a bespoke exercise). Although Lighthouse does not specifically factor default rates when computing tail risk, we do capture default risk through the mark-to-market risk. Because Lighthouse is a large scenario engine, simulating potential spread movements for each underlying credit within a portfolio, a spread change consistent with hitting an exogenously determined recovery value indicates a default event.

In the above example of iTraxx12, we see that the Index has a 5% chance, over the next three months, to lose more than 1.46%. We translate this mark-to-market risk into potential spread widening (33 bps) as well as a potential cash loss (€1823M). Similarly, the portfolio stands to make more than 1.07% (i.e., tighten by more than 25 bps or increase by more than €1336M in value). One of the key points to these numbers is the asymmetry mentioned earlier - notice the larger downside potential than upside.

In addition to the mark-to-market risk of the portfolio, we also see the relative value of the portfolio itself. By looking at the Portfolio Ratio (the weighted average spread divided by the 5% 3M MTM) the user can get an idea of the "efficiency" of the portfolio. This becomes important when comparing two portfolios against one another.

Risk Disaggregation

After using the Saddle Point methodology to calculate the negative 1.46% downside, Lighthouse then attributes the tail risk to each underlying issuer. In iTraxx12, we see that Xstrata Plc contributes the largest amount of tail risk. As a matter of fact, it contributes 2.2% of the total downside tail (-1.46%). The issuer table comprises six columns, the first two being the ticker and issuer description. The Client column is the contribution to duration (CTD) weighting for each issuer while the Spread column is the weighted average spread of the positions held for that name. The Risk column is the percentage contribution of issuer tail risk out of the total portfolio tail risk. The key drivers of an issuer's tail risk contribution are: (1) its standalone credit risk, (2) its portfolio weighting and (3) its correlation with the rest of the portfolio. In the case of Xstrata, the main driver of risk is its standalone COAS Risk.

Tail risk over time

The Ratio column in the issuers section highlights the relative value aspect to Lighthouse. Like the Portfolio Ratio, this number is a reflection of efficiency and answers the question: *How many units of spread am I being paid for each unit of risk that I am taking (by having a particular position in a name)?* The actual calculation of this number is (Issuer MV% x Issuer Spread) / (Issuer Risk% x Portfolio Risk in bps). We suggest that clients use a two-tier approach when analyzing the issuer ratio. First, they should look at the ratio relative to the issuer's own history. Chart 8 shows the efficiency ratio for Hellenic Telecom (the second largest risk contributor in our iTraxx12 example), which has fallen significantly over the last month. This indicates that the spread tightening for this issuer has been overdone relative to its risk.

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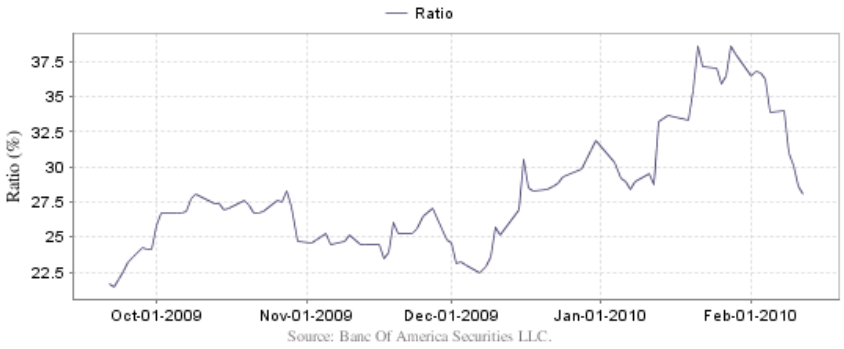
Chart 8: Spread to Risk Efficiency Ratio for Hellenic Telecom in iTraxx S12



Source: BofA Merrill Lynch Global Research

Second, in addition to looking at the ratio relative to each issuer's own history, we encourage the user to look at each issuer's ratio relative to its sector's average. In the sector quadrant of the risk we see that the average ratio among Telecoms is 54%. This suggests that Hellenic Telecom (@29%) is earning a lower spread per unit of risk compared to its peers within the Index.

One thing to keep in mind is that these results are very specific to this portfolio at this date. The same issuer in another portfolio could look completely different.

Beyond Absolute Risk Reports

In addition to the portfolio risk analysis discussed above, there is much more that Lighthouse can accomplish.

- **Scenarios Analysis:** Portfolio and issuer risk changes due to volatility, spread shocks, etc.
- **What-if Analysis:** Risk changes by switching in/out of issuers, implementing macro hedges, including structured trades, etc.
- **Risk relative to a benchmark:** Calculate tracking tail and risk relative to a benchmark portfolio (from the BofAML index family or any customized index/portfolio provided by the user).
- **Portfolio Optimization:** Optimize notional weights within a given universe of securities, to maximise spread-to-risk efficiency with other constraints.

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Link to Definitions

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Click here for definitions of commonly used terms.

COAS Certification

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BofAML Credit Opinion Key

Recommendation	Investor Action Points (Cash and/or CDS)	Primary Investment Return Driver
Overweight-100%	Up to 100% Overweight of investor's guidelines	Compelling spread tightening potential
Overweight-70%	Up to 70% Overweight of investor's guidelines	Carry, plus some spread tightening expected
Overweight-30%	Up to 30% Overweight of investor's guidelines	Good carry, but little spread tightening expected
Underweight-30%	Down to 30% Underweight of investor's guidelines	Unattractive carry, but spreads unlikely to widen
Underweight-70%	Down to 70% Underweight of investor's guidelines	Expected spread underperformance
Underweight-100%	Down to 100% Underweight of investor's guidelines	Material spread widening expected

Time horizon – our recommendations have a 3 month trade horizon.

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