MOODY'S ANALYTICS

CDS-Implied EDF™ Measures and Fair Value CDS Spreads – At a Glance

What Are CDS-Implied EDF Measures and Fair Value CDS Spreads?

CDS-Implied EDF (CDS-I-EDF) measures are physical default probabilities derived from credit default swap (CDS) spreads. For entities with both publicly traded equity and liquid CDS transactions, CDS-I-EDF measures provide an alternative assessment of default risk that can be directly compared with default probabilities (PDs) calculated by the Public Firm EDF model. For entities without publicly traded equity, CDS-I-EDF measures expand the default probability coverage of CreditEdge, Moody's Analytics' suite of industry leading credit metrics that incorporate signals from equity and credit markets. CDS-I-EDF measures are available on a daily basis, for 1,500 entities, including public and private firms, subsidiaries of public and private firms, sovereigns, state-owned and supranational entities, and municipalities. Fair Value CDS (FVS-CDS) spreads are modeled CDS spreads derived from EDF measures that can be directly compared with observed CDS spreads. FVS-CDS can be used for mark-to-market valuation and portfolio management and are published daily for 29,000 entities with EDF measures. The modeling framework for calculating CDS-I-EDF measures from CDS spreads works in reverse to calculate FVS-CDS from EDF measures.

CDS-I-EDF measures and FVS-CDS are a part of the CreditEdge™ suite of credit metrics and available through multiple channels:

- A web-based platform
- An Excel add-in
- A data file service (DFS)
- An Application Programming Interface (API)

What Differentiates the CDS-I-EDF Model?

Financial institutions, corporations, asset managers, insurance firms, and regulators include CDS-I-EDF measures and FVS-CDS in their credit risk management toolkits for the following reasons:

- Global coverage
- Forward-looking, point-in-time default probabilities
- Uniquely dynamic and granular estimation of sovereign credit risk
- Relative value trading applications
- Accurate, consistent, and transparent methodology for assessing rated and unrated public exposures
- Comprehensive documentation, regular model validation, and modeling enhancements based on extensive research

- Full support from Moody's Analytics' global team of researchers, data specialists, and product specialists
- Access to Moody's Analytics' best practices, expertise, and market leading insights
- User inputs are not required to generate entity-level default probabilities or modeled spreads

Physical Default Probabilities Versus Risk-Neutral Default Probabilities

When deriving default probabilities from CDS spreads it is important to distinguish between physical and risk-neutral default probabilities. While risk-neutral default probabilities adjust for investors' risk aversion, physical default probabilities, which can be thought of as "real world" default probabilities, do not. CDS spreads reflect expected loss – equal to the product of probability of default (PD) and loss given default (LGD) – *and* the risk premium, but oftentimes PDs extracted from CDS spreads fail to remove the risk premium. These risk-neutral PDs overstate actual default rates, especially among higher rated entities.[1] CDS-I-EDF measures are physical PDs; since they filter out the premium investors demand to compensate them for risk inherent in the CDS contract, they reflect only the risk of the underlying credit.

How Is the CDS-I-EDF Model Validated?

The CDS-I-EDF model is validated, separately, by region and rating class on several dimensions:

- Level accuracy: Is the geometric average of CDS-I-EDF measures consistent with the geometric average of EDF measures over time? Is the geometric average of FVS-CDS consistent with the geometric average of CDS spreads over time?
- Cross-sectional correlations: How correlated are FVS-CDS and CDS spreads over time?
- Sensitivity of credit returns to equity returns: How do CDS-I-EDF hedge ratios compare to empirical hedge ratios? In other words, is the sensitivity of debt to equity implied by CDS-I-EDF measures consistent with what is observed in actual bond and equity data?
- Convergence in differences between FVS-CDS and CDS spreads: Over time, do the differences between FVS-CDS and CDS spreads persist or converge? If they converge, they could have an application for asset managers in exploiting market mispricing.

Our validation exercises show the CDS-I-EDF model to produce CDS-I-EDF measures on the same average level as EDF measures and FVS-CDS on the same average level as CDS spreads, with reasonably high cross-sectional correlation. The model predicts hedge ratios consistent with empirical values, thus allowing assessment of changes in credit portfolio values using equity value changes, a useful application for illiquid credit exposures. The model also identifies differences in opinion between CDS and equity markets. The convergence of opinions over time presents an opportunity for asset managers to explore profitable trading opportunities.

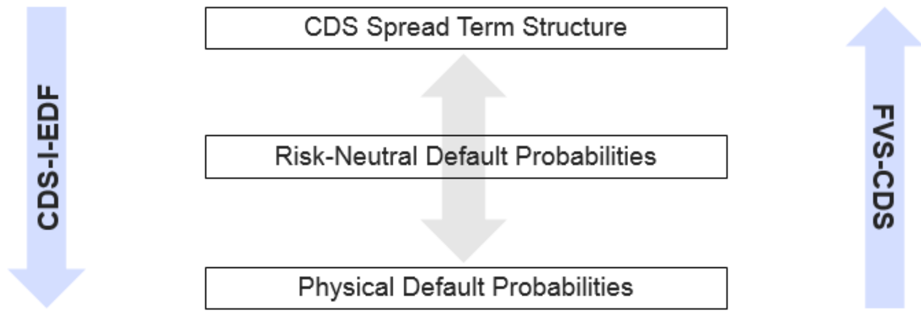
How Does the CDS-I-EDF Model Work?[2]

A CDS contract is in effect an insurance policy for default risk, whereby the buyer pays the seller a premium in exchange for a guaranteed payment in the event that the debtor defaults or experiences a specified credit event. The premium, or the CDS spread, therefore, reflects expected loss, after accounting for investors' risk aversion. The modeling framework for CDS-I-EDF translates between CDS spreads and risk-neutral PDs via a spread valuation equation built upon the observation that the cost of a CDS contract to the buyer must equal its benefit and an assumption about the risk-neutral PD term structure. The translation between risk-neutral PDs and physical PDs relies upon a structural definition of default in which a firm defaults when the market value of its assets falls below the value of its debt obligations and an assumption that the trade-off between risk and return follows the Capital Asset Pricing Model. The sequence of translations can run in either direction, yielding CDS-I-EDF measures from CDS spreads or FVS-CDS from EDF measures.

[1] J. Hull et al. "Bond Prices, Default Probabilities, and Risk Premiums". *Journal of Credit Risk*. Spring 2005.

[2] This document provides a basic overview of the CDS-I-EDF model. For those seeking a detailed description, please see: "EDF9 Updates for Bond and CDS Valuation Models", Moody's Analytics, August 2015; Nazaran et al, "EDF9 Overview", Moody's Analytics Modeling Methodology, Month Year; and Dwyer et al, "CDS-Implied EDF Credit Measures and Fair-Value Spreads", Moody's Analytics Modeling Methodology, March 2010.

Figure 1 CDS-I-EDF / FVS-CDS Model Mechanics



Model Drivers

In addition to CDS spreads, there are two key drivers in the CDS-I-EDF model. Region- and sector-specific LGDs and region- and rating class-specific market Sharpe ratios are estimated as part of the translation processes using a two-step procedure. We start with an initial assumption of 60% LGD. We then estimate market Sharpe ratios by region (North America, Europe, Japan, Rest of World) and rating class (investment grade, high-yield) using the spread valuation equation that allows us to translate CDS spreads to risk-neutral PDs. This captures the observation that, for example, Japanese companies tend to have lower CDS spreads than US companies with similar EDF levels, and investment grade companies tend to have lower CDS spreads than high yield companies with similar EDF levels. Finally, we calibrate LGDs by region and sector so that the averages of observed and EDF-implied five-year spreads are comparable. This removes lingering systematic bias in CDS-I-EDF measures for certain sectors. Market Sharpe ratios and LGDs are calculated and applied daily to produce both CDS-I-EDF measures and FVS-CDS. Figures 2, 3, and 4 show the drivers for select samples.

Figure 2 Market Sharpe Ratios for Investment Grade Firms, by Region

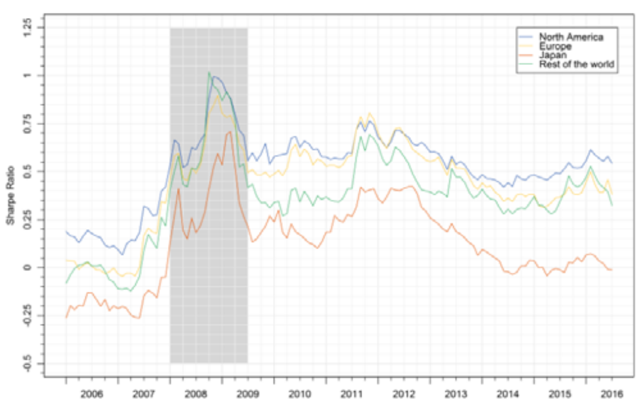


Figure 3 Market Sharpe Ratios for High Yield Firms, by Region

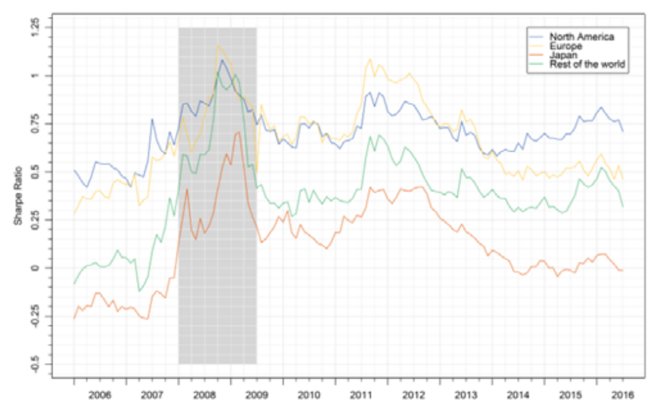
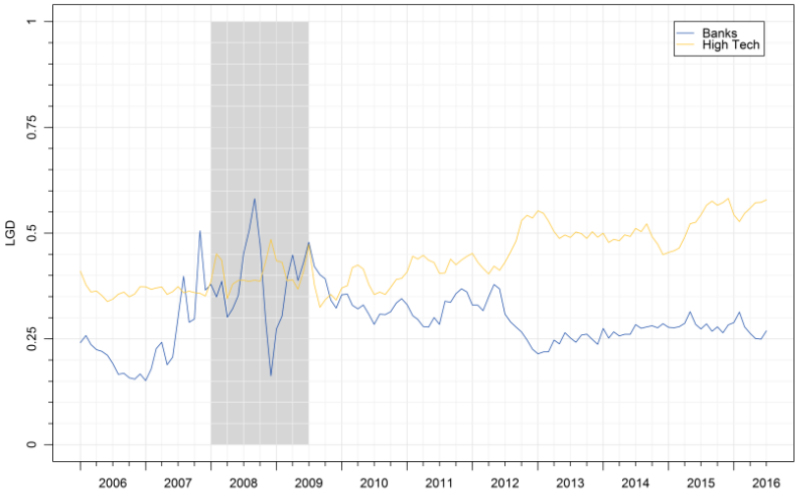


Figure 4 LGDs for North American Banks and S&Ls and North American High Tech Firms



CDS-I-EDF Term Structure

CDS-I-EDF measures are first calculated for a five-year horizon using five-year CDS spreads. The five-year CDS-I-EDF represents the probability that a firm will default within the next five years. We also produce a term structure of CDS-I-EDF measures for each entity from one to four years. A term structure of default probabilities is necessary for pricing, hedging, and risk management of long-term obligations.

Like the Public Firm EDF model term structure, the CDS-I-EDF term structure recognizes and accounts for three components:

» Long-run, central default tendency: Captures the observation that over the long-run, each firm's default risk converges to some level, which varies by firm size and industry.

» Aggregate factor: Captures the systematic component of default risk, which varies with the overall state of the credit cycle.

» Firm-specific factor: Captures the firm-specific component of default risk, which is a function of a firm's current EDF measure relative to its expected EDF measure given its long-run, central default tendency and the aggregate factor.

The long-run, central default tendency and aggregate factors are taken directly from the Public Firm EDF model. The firm-specific factor is disaggregated into persistent and transitory effects in the CDS-I-EDF model. These effects are estimated using maximum likelihood.

CDS-I-EDF Measures for Sovereigns

CDS-I-EDF measures provide a unique opportunity to assess the credit risk of sovereigns. Sovereigns do not have traded equity, but they often have traded CDS spreads. Market prices reflect factors – such as willingness to pay – that fundamental credit approaches may not. The interpretation of sovereign CDS spreads is similar to that of corporates.

Sovereign default is more complicated than for corporates. Sovereigns do not liquidate, and creditors cannot force liquidation. Willingness to pay is as important as ability to pay. Most defaults ultimately result in a debt restructuring.

CDS-I-EDF measures for sovereigns are estimated in exactly the same manner as for corporates. However, we make two assumptions. First, we assume LGD is always equal to 75%. Although there have been many sovereign defaults in the past several decades, very few have occurred since the advent of the CDS market, and realized recovery data for the recent past is scarce. Our assumption is supported by CDS dealer quotes, which highlight the market practice of assuming 25% recovery. Second, we assume the market price of risk is the same as for North American corporate or high yield issuers. This assumption is supported by our own research and some academic research.[3]

[3] For example, see Longstaff et al, "How Sovereign Is Sovereign Credit Risk", NBER Working Paper No. 13658.

What Are the Inputs and Outputs to the CDS-I-EDF Model ?

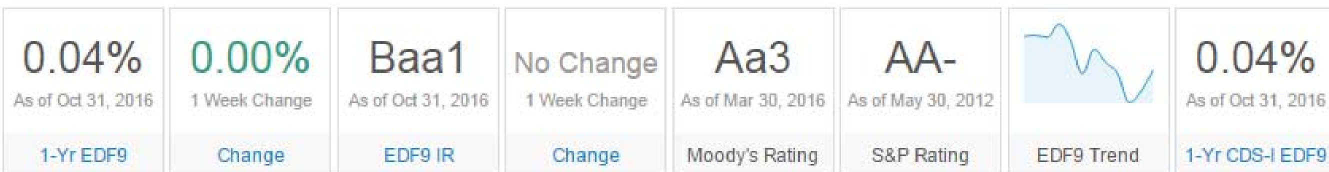
Inputs

The primary inputs to the CDS-I-EDF model are five-year CDS spreads and five-year EDF measures. Raw CDS spreads are first converted to a common DocClause and then aggregated for each entity across currencies and dealers. EDF measures are calculated in the Public Firm EDF model.[4] Extensive data quality checks ensure that pricing data is complete and based on sufficiently liquid contracts.

Outputs

The CDS-I-EDF model produces CDS-I-EDF measures for one through five year horizons and FVS-CDS spreads for a five year horizon. The key drivers to the model – market Sharpe ratios and LGDs – are also published.

Figure 5 Sample CreditEdge CDS Dashboard



How Are Customers Using CDS-I-EDF Measures?

Underwriting

Lenders use EDF and CDS-I-EDF measures to provide systematic evaluations of obligors at the time of origination. EDF and CDS-I-EDF measures and EDF-Implied ratings are also often employed in pre-qualification assessments. Additionally, the metrics are employed in internal scorecards to improve the quantitative analysis of borrowers. Finally, the metrics are used for credit approval and credit limit setting based on internal thresholds and risk appetites.

Pricing, Reserves & Limit Setting

EDF and CDS-I-EDF measures enhance risk-based pricing of loans and vendor contracts. As a key input to expected loss calculations, EDF measures are a key input to many banks' processes for setting reserves, and they inform the process by which banks set credit limits for different segments of their portfolios.

Counterparty Assessment

EDF and CDS-I-EDF measures helps users assess the credit risk of their suppliers and service providers based on default probabilities and implied ratings. The CreditEdge platform provides continuous monitoring of counterparties, so that users can quickly identify potential changes in vendor creditworthiness. This allows them to get ahead of possible credit deterioration, and thus manage their business continuity risk.

Early Warning & Portfolio Monitoring

Moody's Analytics has developed an EDF early warning toolkit, a set of metrics we recommend users employ to effectively and efficiently monitor their portfolios.[5] An accompanying Excel template that leverage the CreditEdge Excel Add-In provides a turnkey solution for putting the toolkit into practice. The CreditEdge website has a number of features (e.g., alerts) that allow users to monitor changes in obligor credit quality and apply the toolkit's approach for identifying at-risk names. As forward-looking probability of default metrics, EDF measures have helped risk managers allocate resources more effectively. Prior research has

[4] For more details, please see "Public Firm Expected Default (EDF) Measures – At a Glance", Moody's Analytics.

[5] See Ferry, Baron, and Hamilton, "Using EDF Measures to Identify At-Risk Names – A Monitoring & Early Warning Toolkit", Moody's Analytics Viewpoints, April 2016.

shown that taking the worst of EDF and CDS-I-EDF measures yields a more accurate credit measure than taking either of the two individually.[6]

Pre-Screen Investments & Perform Relative Value Analysis

Asset managers, particularly investors in corporate bonds, use EDF and CDS-I-EDF measures in a number of ways. They are employed to increase the efficiency of portfolio surveillance; to find undervalued assets; and as inputs into a variety of quantitative security and portfolio construction and valuation models. Our research shows that EDF measures can be used to construct portfolios of bonds that minimize default risk while maintaining a target yield. Such strategies result in superior risk-adjusted (i.e., higher Sharpe ratios) as well.

Inputs to Internal Risk Rating Systems

Internal rating systems are the foundation of many business decisions within financial institutions. They typically combine quantitative and qualitative factors at both the market/industry-level and firm-level. Since EDF and CDS-I-EDF measures are based on large amounts of data and rigorous statistical methods, they are often used as quantitative inputs to internal risk rating systems.

Benchmarking & Calibrating Internal Risk Rating Systems

EDF and CDS-I-EDF measures reflect the experience learned from the large number of defaults in our database, as well as other credit-related inputs. They are therefore well-suited for benchmarking and calibrating internal risk systems. Many institutions do not possess enough internal data for this purpose, so using external data sources such as EDF and CDS-I-EDF measures improves model accuracy.

Input to Bank Regulatory Capital Calculations

Probabilities of default associated with internal ratings play a central role in the calculation of capital requirements in the Basel framework. Many banks use EDF, CDS-I-EDF, or Through-the-Cycle (TTC) EDF measures as part of their internal ratings, either for regulatory capital calculations or for benchmarking and calibrating their internal models to fulfill regulatory requirements.

Input to Required Economic Capital Calculation

EDF and CDS-I-EDF measures provides the probability of default input needed in portfolio models to calculate expected loss (EL), unexpected loss (UL), and thus subsequently to set economic capital (EC). Many institutions leverage EDF measures in this capacity.

Loss Provisioning

EDF and CDS-I-EDF measures are used to estimate the likelihood of borrowers defaulting on their loans, information vital to determine appropriate levels of loan loss provisions. Borrowers can use firms' EDF term structures to establish loss provisions for long-dated exposures.

For More Information

To learn more about the CDS-I-EDF model and its applications, please contact our experts at clientservices@moodys.com.

[6] Dwyer et al, "CDS-Implied EDF Credit Measures and Fair-Value Spreads", Moody's Analytics Modeling Methodology, March 2010.