

Stressed EDF™ Measures – At a Glance

What Are Stressed EDF Measures?

Stressed EDF™ (Expected Default Frequency) measures are conditional, one-year default probability forecasts for public companies given a hypothetical economic scenario. They are used primarily by financial institutions to stress test their C&I (commercial and industrial) loan, corporate bond, and CLO (collateralized loan obligation) portfolios, and by portfolio managers to understand credit risk using scenario analysis. Derived from Moody's Analytics' Public Firm EDF measures¹, Stressed EDF measures can substitute seamlessly for traditional point-in-time default probabilities (PDs) whenever it is necessary to assess credit risk in alternative, future macroeconomic conditions. The Stressed EDF methodology relies on estimates of structural relationships between key macroeconomic risk factors and public firm EDF measures observed over a long history. Using a hybrid top-down and bottoms-up modelling approach, Stressed EDF measures mimic important observations about how default risk changes under stressed economic conditions – namely, that PDs rise in the aggregate, that the distribution of PDs expands, and that within the overall distribution, the relative rank-ordering of individual firms changes.

Stressed EDF measures conditioned on Moody's Analytics' economic scenarios (a baseline, one upside, and three downside) are updated each month; those conditioned on select regulatory scenarios (e.g., those published by the Federal Reserve Bank, the European Banking Authority, or the Prudential Regulation Authority) are updated in coordination with regulators' stress testing schedules. Stressed EDF measures, available at monthly and quarterly frequencies and over a five-year forecast horizon, can also be conditioned, on demand, on user-defined economic scenarios. Currently, coverage includes corporate and financial firms located in North America, Western Europe, Japan, Australia, and New Zealand.²

Stressed EDF measures 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)

¹ In this document, we use the terms "Public Firm EDF" and "EDF" interchangeably. The EDF measures discussed here and the model from which they are derived differ from RiskCalc EDF measures, Moody's Analytics' default probabilities for private firms, and the RiskCalc EDF Model.

² An additional China/Hong Kong module is due for release in the first quarter of 2015.

What Differentiates the Stressed EDF Model?

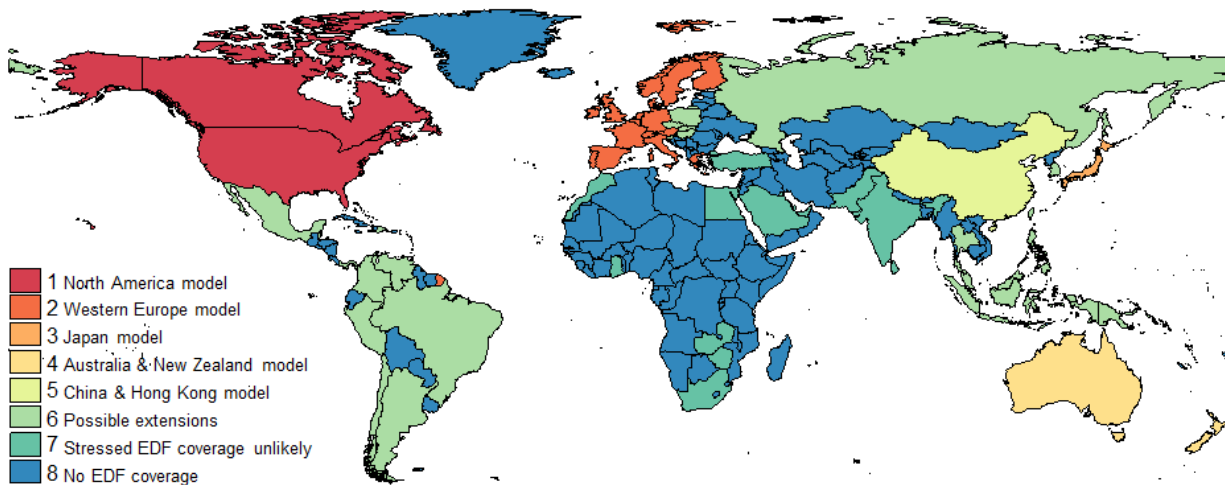
Financial institutions, corporations, asset managers, insurance firms, and regulators include Stressed EDF measures in their credit risk management toolkits for the following reasons:

- » Global network of models with a consistent approach to stressing obligor-level default risk
- » Broad geographic coverage encompassing North America, Western Europe, and Asia
- » Diverse sectoral coverage encompassing financial institutions and a broad range of nonfinancial institutions, including energy companies
- » Fully transparent modeling approach with extensive documentation and model validation support
- » Leverages a rich and globally comprehensive dataset of historical defaults, for calibration and validation purposes
- » Monthly updates for “off-the-shelf” economic scenarios defined by Moody’s Analytics and global regulators (e.g., the Federal Reserve Bank, the European Banking Authority, or the Prudential Regulation Authority)
- » Turnkey stressed PD model solution

Additionally, the Stressed EDF model can be customized in a number of ways, including:

- » Conditioning Stressed EDF measures on user-defined economic scenarios
- » Calibration for user-specific portfolio composition and/or default experiences

Global Coverage



How Does the Stressed EDF Model Work?

The Stressed EDF methodology is grounded in the observation that during an economic recession PDs rise in the aggregate, that the distribution of PDs expands, and that within the overall distribution, the relative rank-ordering of individual firms changes. Stressed EDF measures reflect estimates of structural relationships between key macroeconomic risk factors and public firm EDF measures observed over a long history. By grouping firms that share common economic experiences and business practices, the model recognizes that these structural relationships are unique to each region. Within region, grouping by 16 sector classifications further tailors Stressed EDF measures to the credit dynamics of each firm’s primary market characteristics.³

The model parameters capture empirical relationships between select macroeconomic and financial market risk factors and credit risk. They vary by region and sector. However, Stressed EDF measures for firms in a given region and sector are not identical –

³ The 16 sectors are: consumer discretionary, defense, agriculture, consumer staples, transportation, financial services, media, materials, business products, capital goods, IT, consumer services, health care, energy, utilities, and “unclassified”.

rather, they are firm-specific – because the model also takes into account each firm's recent EDF momentum. Table 1 shows the macroeconomic risk factors included in the Stressed EDF model, by region. Those marked by a bold X are the most influential macroeconomic risk factors at the portfolio level. When assessing portfolio-level average Stressed EDF measures, it is instructive to also understand the scenario paths of these key risk factors. Firm-level or sub-portfolio-level Stressed EDF measures can usually be understood in this context as well, but the risk factors marked by a non-bold X may also need to be examined (e.g., oil prices have a singular impact on energy firms).

Table 1 Macroeconomic Risk Factors Included in the Stressed EDF Model^{4,5}

| MACROECONOMIC RISK FACTOR | NORTH AMERICA | WESTERN EUROPE | JAPAN | AUSTRALIA & NEW ZEALAND |
|----------------------------------|---------------|----------------|----------|-------------------------|
| Real GDP, YoY % chg | | | | X |
| Real consumption YoY % chg | | | | X |
| Real investment, YoY % chg | X | X | | X |
| Real exports YoY % chg | | | X | X |
| Retail sales, YoY % chg | X | | | X |
| Unemployment rate, YoY chg | X | X | X | X |
| Consumer price index , YoY % chg | X | X | X | X |
| Producer price index , YoY % chg | X | X | | |
| Oil price, YoY % chg | X | X | X | X |
| US farm price index, YoY % chg | X | X | NA | NA |
| Stock index, YoY % chg | X | X | X | X |
| Corporate profits, YoY % chg | X | NA | NA | NA |
| Yield curve, % | X | X | X | |
| US Baa spread, bps | X | X | X | X |
| US Ted spread, bps | X | X | X | X |
| S&P 500 volatility, % | X | X | X | X |

The model parameters were estimated over as many business cycles as possible so that a wide range of credit experiences informs them. These estimation periods are shown in Table 2.

Table 2 Estimation Period For Stressed EDF Model

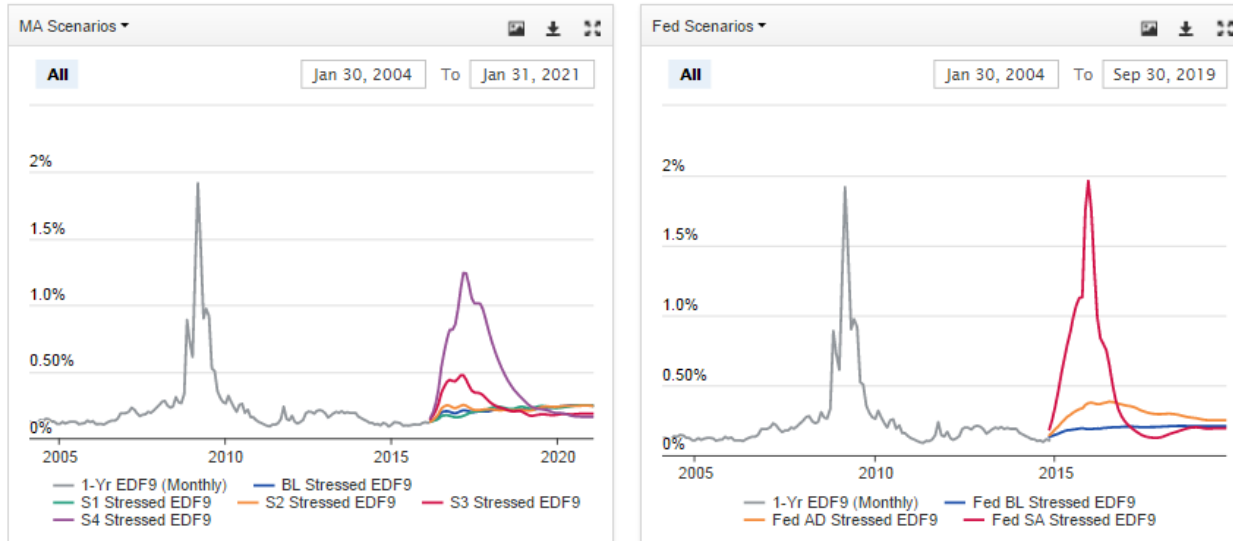
| REGION | BEGINNING PERIOD | ENDING PERIOD |
|-------------------------------|------------------|---------------|
| North America | January 1980 | June 2014 |
| Western Europe (GIIPS & ROWE) | January 2000 | June 2014 |
| Japan | January 1999 | June 2014 |
| Australia & New Zealand | January 1999 | June 2014 |
| China & Hong Kong | January 1995 | March 2015 |

Stressed EDF measures are calculated by applying the estimated model parameters – which measure the average sensitivity of credit risk to country-specific macroeconomic risk factors and to firm-specific EDF momentum – to forward-looking macroeconomic scenario data and recent EDF data. Therefore, Stressed EDF measures represent future one-year default probabilities conditioned on the economic scenario being considered.

⁴ Growth rates and changes are year-on-year. The yield curve is defined as the difference between long- and short-term sovereign bond rates. The Baa spread is defined as the Moody's Baa corporate yield less the 10-year US Treasury rate. The Ted spread is defined as 3-month LIBOR less the 3-month US Treasury rate.

⁵ Unless otherwise noted, all macroeconomic variables are country-specific and matched to firms according to country of incorporation.

Caterpillar, Inc.



What Are the Inputs to the Stressed EDF Model?

Stressed EDF measures can be calculated for any publicly listed firm provided the following inputs are available:

- » Country-specific macroeconomic data describing an economic scenario (provided by MA or the user)
- » Two years of firm-level data including EDF, country of incorporation, and primary sector (provided by MA)

"Off-the-Shelf" Macroeconomic Scenarios

Each month, Moody's Analytics updates and publishes Stressed EDF measures based on five standard economic scenarios developed by Moody's Analytics' Economic and Consumer Credit Analytics (ECCA) team. ECCA's team of more than 80 economists produce, on a monthly basis, quarterly forecasts for core economic measures for 54 countries. The economic scenarios are developed using a structural large-scale macro modeling approach grounded in Keynesian-style, demand-side economic theory. The Stressed EDF model utilizes ECCA's baseline (BL), one upside (S1), and three downside (S2, S3, S4) scenarios. The S4 scenario broadly resembles the experience of the 2008-09 financial crisis and has to date been consistent with the Federal Reserve Bank's CCAR (Comprehensive Capital Analysis and Review) "Severely Adverse" scenario.

Stressed EDF measures are also updated and published for regulatory-driven bank stress tests, such as those of the Federal Reserve Bank, the European Banking Authority, or the Prudential Regulation Authority. These updates are not monthly, but rather follow the release of regulators' economic scenarios.

Regulators typically define their stress test scenarios using a limited set of macroeconomic variables which do not fully overlap with the inputs required by the Stressed EDF model. ECCA's economists expand the scenarios to include a wider set of macroeconomic variables while preserving the key characteristics of each scenario.

| Moody's Analytics | Regulatory Driven | | |
|--------------------------------------|--------------------------------|------------------------|------------------------|
| BL Baseline | FB FRB Baseline | EB EBA Baseline | PB PRA Baseline |
| S1 Stronger Near-Term Rebound | FA FRB Adverse | ES EBA Adverse | PS PRA Stress |
| S2 Mild Second Recession | FS FRB Severely Adverse | | |
| S3 Deeper Second Recession | | | |
| S4 Protracted Slump | | | |

User-Specified Macroeconomic Scenarios

In addition, users can condition Stressed EDF measures on custom scenarios, at any time. It is necessary only that the user specify economic scenario forecasts for at least one macroeconomic variable input to the Stressed EDF model. This accommodates the possibility that users do not have forecasts for all of the variables (across all countries) employed by the Stressed EDF model. Moody's Multi-Country Macroeconomic Scenario Accelerator (MCMESA) is employed to complete partially filled input templates, while ensuring that the macroeconomic time series are mutually consistent.⁶ For example, if a user specifies forecasts for German GDP growth, unemployment, and consumer inflation, MCMESA will calculate forecasts for German consumption, investment, exports, retail sales, etc. (as well as forecasts for all other countries) that are internally consistent with the user's forecasts from a macroeconomic modeling standpoint.

Firm-Level Data

Stressed EDF measures depend not only on macroeconomic scenario data but also on each firm's recent EDF momentum, its country of incorporation, and its primary sector. Two years of EDF history are required to calculate Stressed EDF measures. Country of incorporation and primary sector are used to assign the correct set of model parameters, which vary by region and sector.

What Are the Outputs of the Stressed EDF Model?

Stressed EDF measures are firm-level, conditional one-year PDs with a monthly frequency and horizon of five years, for "off-the-shelf" scenarios, or a corresponding horizon when a custom scenario is provided. For ease of use in stress testing applications, PD outputs based on custom scenarios are also provided with a quarterly frequency and converted from one-year, annualized measures to cumulative PDs. There are occasions when obligors are not covered in the Stressed EDF universe, but their stressed credit risk can be reasonably proxied using representative aggregates drawn from the Stressed EDF output. In these cases, we recommend using median Stressed EDF measures aggregated by country or region, sector, and current PD or risk rating. A standard set of aggregates are available for Stressed EDF measures based on both "off-the-shelf" and custom scenarios.

The model outputs are summarized below:

- » Firm-level data
 - » One-year Stressed EDF, monthly and quarterly frequency
 - » Cumulative Stressed EDF, monthly and quarterly frequency
- » Aggregated data – by region, sector, and starting PD quantile
 - » One-year Stressed EDF, monthly and quarterly frequency
 - » Cumulative Stressed EDF, monthly and quarterly frequency
 - » Starting PD quantile definitions

How Are Customers Using Stressed EDF Measures?

Capital Adequacy

PDs are a key input to expected loss calculations, and loan loss provisions are a major component in the computation of capital ratios. Customers use Stressed EDF measures to estimate loan loss provisions, ALLL (allowances for loan and lease losses) and, ultimately, capital adequacy under stress scenarios – to satisfy their regulators, Board of Directors, or Chief Risk Officer. Stressed EDF measures are also used as an input to stress testing models of CLOs and direct obligation corporate bonds held in investment portfolios.

Credit Portfolio Management

When setting limits and managing concentrations, credit portfolio managers need to assess potential losses at the pool and portfolio levels. Expectations for potential losses are generally based on a combination of economic projections, historical loss

⁶ For a more complete description, please see "MCMESA – At a Glance".

ranges, expert judgment, and stress testing results. Stressed EDF measures allow portfolio managers to compute expected losses under hypothetical economic scenarios of interest and can also provide a window into the sensitivity of concentrations to various scenarios. Names and pools requiring greater scrutiny are typically identified using a size threshold and a series of credit risk benchmarks. The surveillance process can be further bolstered by considering credit risk triggers under different economic scenarios.

Risk-Based Pricing & Counterparty Risk Assessment

When embedded in a systematic approach, PDs and credit risk ratings are powerful tools for assessing borrowers at origination, pricing deals to maximize returns on capital, and monitoring the credit worthiness of counterparties and vendors. However, these measures are most informative when the status quo is expected to continue. Stressed EDF measures can help identify names, sectors, and geographic concentrations vulnerable to specific plausible, "what-if" scenarios. Examples include:

- » The impact on loan originations and borrower concentrations under a scenario in which growth benefits accrue to the Japanese economy following a new trade deal
- » Potential disruption in the distribution network of a manufacturer under a scenario in which geopolitical unrest leads to a sharp rise in oil prices and lower profitability among trucking companies
- » The credit worthiness of a Greek bank that is counterparty to a CDS contract under a scenario in which Greece exits the euro zone

For More Information

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