

13 MARCH 2019

## RiskCalc™ at a Glance

#### Contact

Moody's Analytics Support +1-212-553-1653 MA\_support@moodys.com http://www.moodysanalytics.com/support

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RiskCalc™ at a Glance

### What is RiskCalc?

In the wake of the financial crisis, creditors turned increasingly conservative with their credit and lending decisions. When lending to public companies, creditors can rely on the market as an indicator of financial health because of the market's transparency, investor scrutiny, and public consensus. Small and medium-sized private companies are a large and integral part of the economy, but no comparable financial market indicators are available that make it easier to assess their credit risk. Recognizing the need to fill this void, Moody's Analytics created RiskCalc™, the premier model for next-generation default prediction analytics and technology, to easily and effectively assess the credit risk of private firms.

RiskCalc is the leading tool for measuring private firm probability of default. It enables greater accuracy, consistency, and efficiency when evaluating privately held firms than internal bank models or other commercially available models. RiskCalc produces a forward-looking default probability, or EDF™ (Expected Default Frequency) credit measure, by combining financial statement and equity market information into a highly predictive measurement of standalone credit risk. An EDF value is Moody's Analytics branded probability of default risk metric.

The RiskCalc solution is one of two models that comprise the RiskCalc Plus software suite, an online, web-based platform that offers advanced credit risk analytics. RiskCalc Plus consists of:

- RiskCalc, the premier private firm probability of default (PD) model.
- RiskCalc LGD™, a loss given default (LGD) model that incorporates both static and forward-looking dynamic drivers of recovery, ranging from firm-specific variables to broader factors such as geography and industry.

### What Differentiates RiskCalc?

Financial institutions, corporations, asset managers, insurance firms, and regulators globally choose the RiskCalc software as the primary solution to assess the credit risk of private companies because it:

- Derives its accuracy and predictive power from the largest and cleanest private firm financial statement and default database in the world.
- Offers an extensive global network of models with a consistent approach to measuring obligor default risk.
- Provides a transparent white box approach to modeling with extensive explanatory analytics.
- Delivers comprehensive documentation, frequent model validation, and modeling enhancements based on leading research.

- Features hosted technology that allows for simple integration with the Moody's Analytics Enterprise Risk Solutions platform or internal systems.
- Leverages Moody's Analytics market leadership and best practice expertise.

Additionally, RiskCalc enhances and simplifies credit analysis because its built-in features and functions:

- Assess risk through an entire credit cycle or at a specific point in time for improved underwriting and early warning monitoring.
- Provide one-year through five-year EDF credit measures that allow for time series charting of PD values up to five years.
- Map EDF credit measures to implied credit agency ratings or internal organizational ratings.
- Adjust for unique industry differences and market conditions.
- Display valuable ratio diagnostics including each ratio's contribution and sensitivity to risk.
- Maintain and provide financial statements for private firms in select European countries in partnership with Creditsafe.
- Offer flexibility to incorporate qualitative factors into a quantitative and systematic framework.
- Enable benchmarking against peer groups by industry and asset size buckets.

## The Power of the Credit Research Database Consortium

Comprehensive data is the foundation of a superior credit risk modeling framework. Extensive data sets create a competitive and regulatory advantage when used correctly within a credit risk model.

Regulators and internal compliance teams, however, require evidence to validate the data, methods, and results from these credit risk modeling systems. To prove that a model meets regulatory and compliance criteria, institutions must validate and calibrate models via statistical tests using data that is:

- Comprehensive and of high quality.
- Sufficiently large and of sufficient breadth across various factors such as time, size, and industry.
- From similar portfolios and concentrations.
- Regulatory-compliant for the definition of default.

The Moody's Analytics Credit Research Database (CRD™) is a propriety database that sets stringent data quality criteria to ensure that it exceeds regulatory and compliance challenges. It is the source of the RiskCalc model's predictive power. Built in partnership with over 50 leading global financial

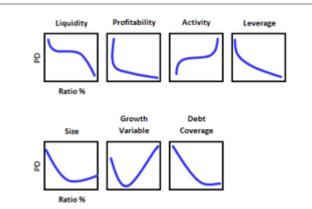
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institutions, the CRD contains 50 million financial statements from 12 million private firms and over 800,000 worldwide company defaults, providing unique insight into private firm default probability. With utmost confidentiality in mind, CRD participant data remains anonymous but is vigorously cleaned and compiled so that accurate reports and analyses can be generated. This data set is used to build new RiskCalc models as well as validate the performance of existing RiskCalc models on the latest available data.

## How Does RiskCalc Work?

The RiskCalc model incorporates financial statement data and equity information to produce EDF credit measures that reflect a forward-looking assessment of credit risk. The RiskCalc solution consists of a global network of over 29 region-specific and industry-specific models that cover most of the world's GDP. The power of RiskCalc analytics is derived from the CRD. Each model is developed and thoroughly tested on native middle-market private companies and firms.

#### RiskCalc Modelling Process



- 1. Collect financials and default data
- 2. Select relevant ratios
- 3. Compute the model output
- Calibrate the model output to actual defaults: Financial Statement Only (FSO) EDF
- Incorporate a market signal to determine the Credit Cycle Adjusted (CCA) EDF

The model identifies broad categories of ratios relevant to default including leverage, profitability, liquidity, activity, size, debt coverage, and growth variables. Numerous ratios per risk factor are evaluated but only a select few that are intuitive and demonstrate a high degree of predictive power and continuity are incorporated within each category. The inputs and ratios used in each model vary based on segment, country, and accounting standards.

## What is Required to Calculate Private Company PD?

Model inputs are based on income statement and balance sheet line items. A set of ratios are derived from the applicable financial statement inputs that we determined are most predictive of default.

Three minimum inputs are required to run a model including total assets, total liabilities, and net income. As a best practice, we recommend that you enter all the information you can. Each ratio is assigned a specific weight in the model so the more information you provide about the company, the more predictive the model is when it determines the likelihood of default. If you do not know an

input, leave the value blank. For empty values, the model uses a median ratio value based on the data set used to build the model. This ensures that no penalty is levied for missing data but the more data you supply the better the results. As a best practice you can update your internal applications or audit documentation to ensure that you capture the required RiskCalc inputs at a minimum.

#### **Expected Default Frequency Model Calculation Modes**

An EDF value is the probability of default risk metric generated by RiskCalc. The model provides EDF results in two calculation modes. The Financial Statement Only (FSO) EDF is a through-the-cycle risk measure that evaluates a company based purely on income statement, balance sheet, and industry information. The Credit Cycle Adjusted (CCA) EDF is a point in time risk measure that analyzes a company based on its financials and then incorporates an adjustment factor based on recent public market and industry changes. The RiskCalc model leverages factors from CreditEdge™, Moody's Analytics public firm credit risk model, to determine the point in time viewed and provide an early warning of credit distress.

#### Financial Statement Only EDF Mode

An FSO EDF value considers the health of the company with respect to its country and industry. Based solely on a firm's financial ratios, region, and industry, FSO mode captures the firm's long-term performance and provides a stable estimate of its default risk throughout the credit cycle. FSO mode also provides an industry adjustment factor through a dummy variable for each industry sector to ensure the model captures the difference in default rates among sectors.

#### Credit Cycle Adjusted EDF Mode

The CCA mode improves the predictive power of the FSO EDF measure. Financial statements are often backward-looking and reflect the firm's status in the past but credit quality is dynamic and credit measures need to reflect the most recent financial information available. Benefiting from forward-looking equity markets, RiskCalc uses the distance-to-default (DD) calculation from the Moody's Analytics Public Firm model to provide an early warning of credit distress. *For example*, if the DD factor for public firms in an industry indicates that a level of risk is below the historical average, the FSO EDF level is adjusted downward to arrive at the CCA EDF level. Conversely, if the risk level is higher than the historical average, the FSO EDF level is adjusted upward to arrive at the CCA EDF level.

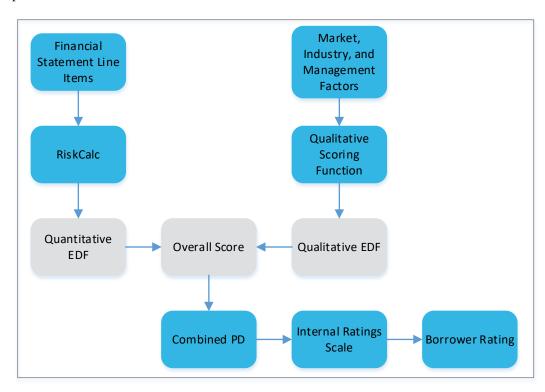
#### A Comprehensive Framework for Quantitative and Qualitative Factors

The Qualitative Overlay module is a comprehensive and global framework that incorporates subjective factors that impact the obligor's overall risk into the credit analysis. The quantitative RiskCalc EDF measure is combined with a qualitative score to provide a combined PD and overall rating. Empirical evidence reveals that this combined PD offers greater explanatory power than either an initial internal rating or the RiskCalc EDF credit measure used in isolation.

A Qualitative Overlay is populated with a set of subjective categories and questions, each of which is assigned a respective weight and score. You can customize an overlay's categories and questions, including their respective weights, to correlate with your experience of qualitative factors such as

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industry, geography, markets, and management style that affect your credit risk analysis. You can further calibrate the overlay to better reflect your unique portfolio by modifying statistical tuning parameters.



The Qualitative Overlay enables your institution to establish a stronger foundation for sound decision making through a systematic framework that offers increased transparency and consistency in credit-related actions.

## What are the RiskCalc Model Outputs and How Can You Use These Metrics?

RiskCalc strives to serve as a white box and provide transparent analytics that are well documented and supported by data. The model produces numerous outputs that include information about the income statement, balance sheet, derived ratios, and explanatory analytics. These metrics provide insight into both risk drivers and short- and long-term credit risks.

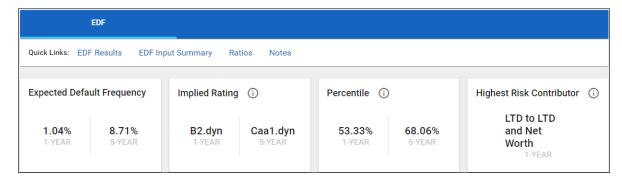
#### EDF Credit Term Structure and Implied Moody's Bond Default Ratings

The EDF measure output section in the following figure provides a high-level summary of key default statistics. It displays information such as the firm's EDF measure, implied bond default rate mapping, EDF percentile, and the entire five-year term EDF structure. EDF is a forward-looking measure of actual probability of default; it is firm specific. Therefore, the EDF measure can be used

on a stand- alone basis or it can be mapped to either a Moody's implied rating or an organizational rating to best suit your institution's needs.

If you are not familiar with quantitative probability measures you might prefer to use a discrete rating scale such as Moody's letter grades for credit risk quantification. You can choose from many different approaches to map an EDF measure to a rating category. In practice, such mappings serve different purposes but what constitutes a desirable mapping depends on how your institution intends to use it. We recommend that you use a meaningful mapping of internal ratings to rating grades with sufficient risk differentiation because it is a regulatory requirement. EDF mapping is designed to facilitate the process of an institution moving from an internal rating system where the majority of credits end up in one of two categories to a system that yields a more granular differentiation of credit risk. We map a RiskCalc EDF to a rating scale that we define as an EDF Implied Rating. The new mapping balances a number of competing objectives. The EDF Implied Ratings are intended to:

- Provide a consistent meaning across industries and different geographies throughout the world.
- Be reasonably consistent with the default rates of bond ratings as measured by Moody's Default Studies.
- Cover a reasonably large range of rating categories from Caa to A1 or even higher depending on the model.
- Prevent a cluster of too many credits into a small number of classifications.



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The outputs in the following figure illustrate how a firm's fundamentals compare with its peers. The ratio or level number is the raw value of the ratio, calculated from the financial statements that were used as inputs to the analysis. The percentile shows where the firm's ratio ranks compared with those of firms in the model sample.

	Percentile	Ratios Or Levels
Current Liabilities / Sales	45.31 %	14.18
Inventory / Sales	98.19 %	38.65
Change in WC Over Sales	16.73 %	-5.89
EBITDA / Interest Expense	58.39 %	530.86
Sales Growth	13.49 %	-14.84
Change in ROA	36.15 %	-2.12
Retained Earnings / Current Liabilities	32.46 %	30.95
LTD to LTD and Net Worth	96.00 %	100.00
Cash / Assets	71.19 %	10.76
ROA	92.14 %	26.40
Size	87.97 %	26,606.47

#### **Relative Contribution**

Relative Contribution identifies the specific ratios that drive the firm's risk. Each ratio's effect on EDF is categorized as either positive or negative. A positive risk contribution value means that a particular ratio increases the firm's EDF value because it pulls the firm's EDF value up from the average default rate observed in the sample data set. Conversely, a negative value means that the ratio reduces the firm's EDF value because it pulls the firm's EDF value down from the average default rate. It is helpful to know not only the direction of the ratio's effect on the firm's EDF value but also the magnitude, or size, of its contribution relative to other ratios. Magnitude is evaluated across ratios but only within a single financial statement. It quantifies how much stronger or weaker the impact of one ratio is when compared to another ratio.

#### **Relative Sensitivity**

Relative Sensitivity serves as a what-if analysis; it identifies the ratios that can be changed to obtain the optimal mix to improve a firm's EDF measure. This analysis quantifies the impact of a change to a single ratio while all other ratios remain constant. A positive value means that an increase in the ratio would increase the EDF value while a negative value indicates that an increase in the ratio would decrease the EDF value.

#### Visualizing Analytics for Model Transparency and Insight

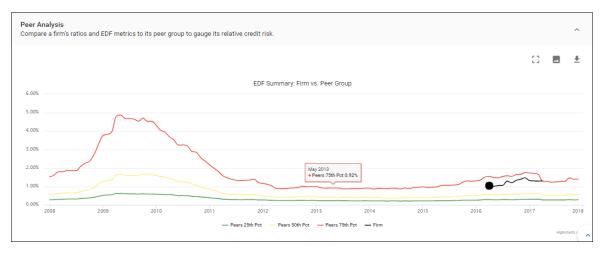
Results are translated into graphs and charts that are easy to understand with a quick glance.

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## **Additional Features**

#### Peer Analysis for Additional Transparency and Insight



The Peer Analysis module allows you to compare credit risk information for a particular customer against a specific group of peers. Peer groups are defined either by industry or by asset size. After a peer group is selected and customer information is provided, a report is generated that outlines credit risk trends for the borrower and the peer group. The trends depicted include RiskCalc CCA and FSO EDF percentiles over time, as well as ratio values for up to six years. Output includes comparison graphs that show the EDF driver ratios, EDF percentiles, and EDF values over time.

#### Stress Testing Models to Meet Regulatory Requirements

As a result of the financial crisis, bank regulators adopted new rules for stress testing and capital adequacy for regulated institutions. Regulators now expect banks to set aside enough capital in case of default and to demonstrate that they can continue lending even under adverse economic conditions. RiskCalc can help your institution meet this requirement because it can generate the stressed EDF measures and loss estimation metrics needed for this regulatory exercise. As a best practice, we encourage you to use stress testing as a method to manage your portfolio so you can analyze best and worst case scenarios based on changes to macroeconomic factors such as GDP, unemployment, inflation, and other similar variables.

Banks and regulators can use RiskCalc to measure capital adequacy through periods of stressed economic conditions with two different approaches. In the ratio-based approach, RiskCalc analyzes an individual company and links its financial ratios to various macro-economic conditions. It models the impact of the macroeconomic shock on the income statement and balance sheet to generate projected financial statements and ratios over the next two years. RiskCalc also produces annualized and quarterly stressed EDF term structures under this approach. The second method involves the PD and LGD modeling approach. This approach allows you to aggregate similar borrowers and tackle stress testing from a portfolio level. With minimal borrower and loan inputs, the model generates loss estimation metrics such as stressed PD values, stressed LGD values, expected losses,

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allowance for loan and lease losses (ALLL), charge-offs, and provisions needed for regulatory purposes. The following table compares the features offered by both approaches.

#### Ratio-based Modeling

- Stress EDF values at an individual firm level
- Benefit from the RiskCalc United States 4.0 Corporate Model income statement and balance sheet inputs
- Utilize the CRD private company data
- Project financials and nine quarters of stressed EDF values
- Stress scenarios including CCAR supervisory scenarios, Moody's Analytics economic scenarios, and organization-specific scenarios

#### PD and LGD Modeling

- Stress EDF, LGD, and expected loss at an aggregate or firm level
- Utilize the CRD of private firm financials, defaults, and Default Risk Database data
- Forecast losses, net charge-offs, ALLL, exposure at default, and provisions for 20 quarters
- Stress scenarios including CCAR supervisory scenarios, Moody's Analytics economic scenarios, and organizationspecific scenarios

#### Financial Statement Pre-population to Expedite Credit Analysis

RiskCalc decreases the time you spend spreading or importing European private firm financial statements and increases time you spend on credit analysis. In partnership with data provider Creditsafe, RiskCalc currently provides private firm income statement and balance sheet data for the following models:

 United Kingdom 4.0, France 4.0, Germany 3.2, Sweden 3.1, Italy 3.1, Norway 3.1, and Europe Large Firm 4.0 (incorporates data from the United Kingdom, Germany, Sweden, Ireland, Italy, France, Luxembourg, and Norway). In the future, pre-population coverage will expand with additional countries.

You can search for and select a private firm from one of these designated European models as shown in the following figure. RiskCalc then automatically populates financial statement data for that applicable firm.



#### Save and Retrieve Model Inputs and Financial Statements to Better Manage Data

RiskCalc enables you to save and retrieve model inputs and financial statement data including prepopulated income statements and balance sheets from relevant models. Stored inputs and financial statements are retrieved through a central portal called the Firm Library.

The Firm Library displays key attributes associated with each company stored in RiskCalc including the applicable model, the RiskCalc industry sector, the applicable Qualitative Overlay, a date and time stamp reflecting the most recent change made to model inputs or financial statements and the user name of the individual who made the applicable change.

Hyperlinks in the Model and Qualitative Overlay columns of the Firm Library, as shown in the following figure, allow you to navigate to the Calculation Input and Qualitative Overlay pages, respectively, where corresponding financial statements and responses to the most recently saved overlay questions are displayed.

Firm	Firm Library ADD NEW FIRM					
View, cr	View, create and access firm and model data.					
Searc	ch Q					■ View Legend
	Firm Name	Model/Scorecard	Country	Industry	Modified Date (GMT)	Modified By
	* AUTOCOLONNA SOCIETA' A RESP.	ITA 4.0	ITA	Business_Services	Wednesday, May 23, 2018	dwilliams
	1232	FIRM SCRD			Friday, April 20, 2018	yingchan
	1234	LFE 4.0 FIRM SCRD	AUT	Construction	Friday, May 11, 2018	akalenteridi
	34610917	USA 4.0	USA	Consumer_Products	Thursday, May 3, 2018	ziyisun

## What is RiskCalc LGD?

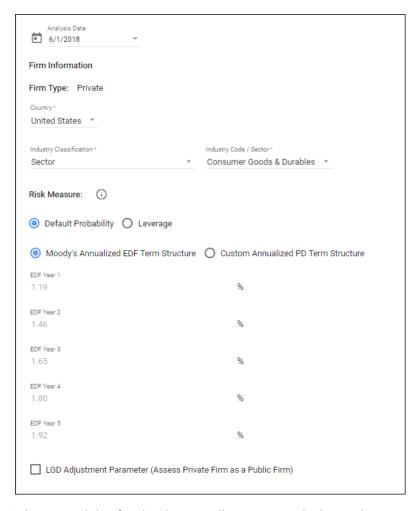
Formerly known as LossCalc™, the new RiskCalc LGD model is now two integrated modules within the RiskCalc solution that determine LGD credit measures and expected losses (EL) for private firms. The model is premised on LossCalc 4.0, the upgraded version of Moody's Analytics loss methodology. Both modules are predicated on detailed market and security level recovery data from Moody's Analytics Default and Recovery Database (DRD) that was compiled over the last 30 years with more than 5,500 defaulted instruments of rated and unrated public and private firms. To provide an even more complete recovery picture for senior issues, RiskCalc LGD also leverages data from Moody's Ultimate Recovery Database (URD).

RiskCalc LGD enables you to more efficiently calculate LGD and EL by passing and using RiskCalc EDF values as RiskCalc LGD inputs. It maintains flexibility by allowing you to supply your own PD values. In addition to private firms, you can also use the model to calculate LGD and EL measures for loans, bonds (including municipals and sovereigns), and public companies using the following drivers:

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- Firm-specific EDF
- Debt Type
- Industry
- Seniority
- Geography
- Bailout
- Bankruptcy

The following figure illustrates the benefits of RiskCalc EDF and LGD integration as well as the flexibility the LGD model provides.



The EL module of RiskCalc LGD allows you to calculate and view results for EL and cumulative EL alongside PD and LGD inputs. You can calculate EL using a combination of Moody's Analytics EDF

values, user-defined PD values and LGD values, and user-defined exposure at default (EAD) values. The EL module provides a unified view of default and recovery risk for both private and public firms.

**Note** You must be a subscriber to CreditEdge, the public EDF model, to receive the public EDF data feed through the RiskCalc LGD model.

## How is RiskCalc and RiskCalc LGD Used Today?

#### Underwriting

RiskCalc and RiskCalc LGD offer the ability to systematically screen obligors at origination. You can use the EDF values, ratings, and LGD values in pre-qualification assessments and in internal scorecards that evaluate the borrower from a comprehensive perspective based on both quantitative and qualitative factors. You can also use the EDF values, ratings, and LGD values for credit approval and to set credit limits based on internal thresholds and risk appetite.

#### **Risk-based Pricing**

RiskCalc and RiskCalc LGD price credit risk consistently based on a systematic approach. You can use EDF and EL measures mapped to implied ratings to establish risk-based pricing whereby you differentiate prices charged to customers based on counterparty risk. Each transaction priced for risk can help your company maximize shareholder value.

A risk-based approach to pricing also enables your organization to set limits and cut-offs according to institutional thresholds and risk appetite.

#### **Counterparty Assessment**

RiskCalc is a valuable driver of any underwriting process, particularly for pre-qualification. It provides your organization with a market advantage because you can choose suppliers and servicers with high credit quality based on EDF and implied rating levels. It also allows you to continually monitor counterparties to identify potential changes in vendor financial credit worthiness that might create business continuity risk for your business and impact your business' revenue.

#### **Transfer Pricing**

RiskCalc and RiskCalc LGD serve as a global framework that provides a consistent approach to determine both the credit standing of subsidiaries and the arm length credit terms related to them. You can use RiskCalc and RiskCalc LGD to determine a fair interest rate charge based on EDF and EL measures mapped to an implied rating. You can then apply that rate to inter-company transactions.

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#### **Early Warning and Portfolio Monitoring**

RiskCalc and RiskCalc LGD help to monitor changes in obligor credit quality. EDF and LGD measures are objective and forward-looking indicators that can help you monitor your counterparties to detect and warn you of changes in their credit profiles. Besides early warnings about credit deterioration, RiskCalc and RiskCalc LGD can help you to allocate resources more effectively to better assess and mitigate risk.

You can also use RiskCalc and RiskCalc LGD to identify both outliers and key trends for insights into your portfolio and to set limits to minimize concentration risk.

#### Inputs to Internal Risk Rating Systems

Many business decisions undertaken by financial institutions rely on internal risk rating systems that typically combine quantitative and qualitative factors at both the firm level and the market or industry level. You can employ RiskCalc EDF credit measures as the quantitative inputs to your internal risk rating systems.

#### Benchmarking and Calibrating Internal Risk Rating Systems

RiskCalc EDF values are developed from actual defaults and comprehensive credit data, making these credit measures well-suited for benchmarking and calibrating internal risk rating systems. The same concept also applies to LGD values generated in RiskCalc LGD. Many institutions lack sufficient internal data to benchmark and calibrate their systems. In such cases, these institutions can benefit from an external, third-party model to perform this exercise. Your institution can use RiskCalc and RiskCalc LGD to benchmark and calibrate its internal rating risk system to validate its results and ensure that its quantitative credit assessments remain accurate.

#### Input to Regulatory Compliance

Under the Basel II framework, the PD associated with an internal rating is a critical variable when determining regulatory capital requirements. Many banks use external PD models as part of their internal ratings, either for regulatory capital calculations or for benchmarking and calibrating their own internal models to meet regulatory requirements. Your bank can use RiskCalc to fulfill either of those designated purposes.

#### **Stress Testing**

RiskCalc offers the unique ability to provide both detailed and aggregate views for stress testing exercises. It incorporates sound assumptions and validation results and can serve as the primary, benchmark, or challenger model when stress testing credit portfolios. You can use RiskCalc to generate credible outcomes under different stress scenarios, including CCAR supervisory scenarios, other broad economic scenarios, and organization-specific scenarios. RiskCalc produces baseline and stressed outputs including the loss estimation analytics your organization needs to support regulatory requirements.

#### Input to Required Economic Capital Calculation

Many financial institutions use economic capital (EC) to assess and measure their portfolio risk. EC represents the amount of capital that must be held to ensure that the portfolio can withstand losses during a defined time horizon and consistent with a given solvency probability. Portfolio models generally build a distribution of credit losses through Monte Carlo simulation and use a PD value as an input to determine EC. EDF values and EL values generated in RiskCalc and RiskCalc LGD, respectively, can help your organization determine EC on its portfolio.

#### Loss Provisioning and Reserve Setting

Loan loss provisions are expenses to allow for bad loans that are charged to a bank's earnings. RiskCalc incorporates forward-looking EDF values based on changes in the credit cycle and when combined with RiskCalc LGD can help you to produce accurate estimates of credit losses. You can use both RiskCalc and RiskCalc LGD to help determine your organization's loan loss provisions and ensure that you are prepared to meet regulatory requirements.

The application also enables you to determine sufficient reserves that your institution needs to set aside based on risk and predetermined expected losses.

# How Can RiskCalc and RiskCalc LGD Benefit Users in Your Organization?

Credit risk professionals within your organization can benefit from RiskCalc and RiskCalc LGD in many ways:

- Underwriters can assess borrowers in real time for pre-qualification and on-the-spot credit assessment.
- Credit Analysts can monitor emerging changes in credit risk by using advanced default probabilities and LGD values for private companies based on real-time market data.
- Risk Managers can detect credit deterioration early and focus their analyses on the riskiest
  exposures. Risk Managers can conduct a scenario analysis to determine whether future default risk
  will affect an institution's ability to pass regulatory requirements.
- Corporate Treasurers can forecast default risk to assess the impact of possible future events and business strategies on a customer's or supplier's financial condition. Corporate Treasurers can also employ RiskCalc for intra-company loan transfer pricing transactions.
- Portfolio Managers can better examine and understand risks in their portfolios whether they view a single borrower's performance or the performance of specific groups.
- Chief Financial Officers can analyze potential acquisition targets and benchmark their
  organization against its peers based on financial data adjusted for comparability across regions and
  industries.

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## For More Information

To learn more about RiskCalc and other Moody's Analytics solutions, contact our experts at clientservices@moodys.com.