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MODELING METHODOLOGY

Sovereign & Size-Adjusted EDF-Implied Rating Template (for Private Firms)

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Abstract

RiskCalc™ EDF™ (Expected Default Frequency) values and agency ratings are widely used credit risk measures. RiskCalc EDF values typically measure default risk for private companies, while agency ratings are only available for rated companies. A RiskCalc EDF value measures a company's standalone credit risk based on financial statement information, while an agency rating considers additional information such as qualitative factors, external support, and country-related risks. Moody's Analytics new Sovereign & Size-Adjusted EDF-Implied Rating Template combines RiskCalc EDF values with additional factors to estimate a rating comparable to agency ratings for private companies. The new template applies to RiskCalc EDF values across numerous geographies and regulatory environments. With the new template, users can generate a rating more comparable to an agency rating than RiskCalc EDF values or EDF-implied ratings.

Analyzing data from 3,900+ companies in 60+ countries, we find that sovereign rating and total asset size, in addition to EDF value, have a statistically significant impact on an agency rating — our quantitative template incorporating these three variables reliably estimates agency ratings in a robust fashion.

Contents

1. Overview

When evaluating a company's credit risk, the RiskCalc EDF value provides a standalone, quantitative risk measure based on financial statement and industry information. Agency ratings summarize the credit risk characteristics of an obligor or an obligation. An agency rating incorporates considerations such as country-related risks and various qualitative factors, along with a standalone quantitative risk assessment. These two credit measures are both widely used, but their methodology and focus differ significantly.

The Sovereign & Size-Adjusted EDF-Implied Rating Template aims to provide a credit measure comparable to an agency rating for unrated companies. The underlying model uses financial statement information as well as sovereign rating and corporate rating data for rated companies to bridge the gap between RiskCalc EDF value and an agency rating. The template is therefore most applicable for use with larger private firms, similar in size to their agency-rated counterparts. We design the template to mimic agency rating methodologies in spirit, rather than directly replicating them.

The template combines RiskCalc EDF value, sovereign rating, and asset size to generate an estimated rating. The template shows strong and robust performance across years and geographies in the development sample, which includes 3,900+ companies in more than 60 countries, covering 1986–2017. Walk-forward testing demonstrates that the template shows strong performance out-of-sample, and that it is robust across geographies and sizes.

The rating agency rating methodologies evolve over time and, therefore, we use recent information to estimate parameters. Quantitative parameter estimation will be updated periodically.

The remainder of the paper is organized as follows:

- » Section 2 describes the data used to populate the inputs and to estimate the parameters.
- » Section 3 describes the template components.
- » Section 4 reports validation results.
- » Section 5 concludes.

2. Data Description

2.1 Financial and Rating Data

We collect global corporate and U.S. Not-for-Profit annual financial statement information using vended and Moody's financial data. We then assign each observation to one of the following RiskCalc models depending on location and sector: North America Large Firm 3.1, Europe Large Firm 4.0, Emerging Markets 3.1, China 3.1, Japan 3.2, United States 4.0 Real Estate Operators and United States 4.0 Not-for-Profit.

We also collect Moody's Investors Service (MIS) senior unsecured ratings for corporates and Long-Term Debt ratings for Not-for-Profit companies. When merging the financial statements with ratings, we look for ratings as of four months after the statement date. We assume it takes four months for rating analysts to receive and incorporate the financial information into a rating decision.

2.2 Descriptive Statistics

Our sample includes 36,000+ annual statements and 3,900+ unique rated companies. Table 1 shows the sample distribution by RiskCalc model. We aim to build a template representative of the rated population and, therefore, we use the large firm models for North America and Europe, United States sector-specific sub-models when there is a large enough sample, and the Emerging Markets, Japan, and China models.

TABLE 1

Distribution of Sample by RiskCalc Model

RISKCALC MODEL	NUMBER OF STATEMENTS	NUMBER OF UNIQUE COMPANIES
North America Large Firm 3.1	22,800+	2,000+
Europe Large Firm 4.0	5,200+	500+
Japan 3.2	2,800+	200+
Emerging Markets 3.1	1,900+	200+
China 3.1	100+	30+
United States 4.0 – Real Estate Operators	1,300+	100+
United States 4.0 – Not-for-Profit	1,800+	700+

Figure 1 presents the sample distribution by year.

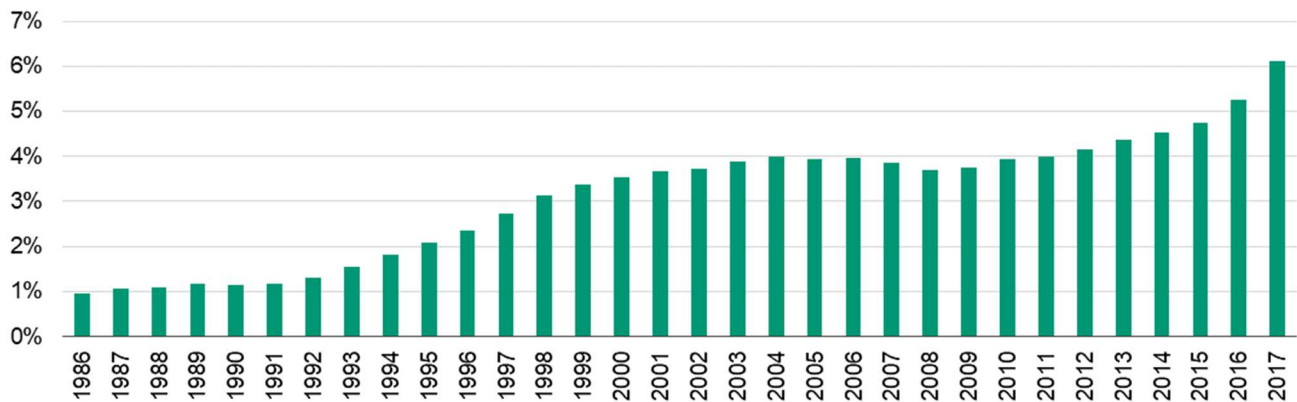**Figure 1** Distribution of statements by year.

Figure 2 presents the distribution of statements by asset size. Most statements in the sample have total assets greater than $1 billion USD.

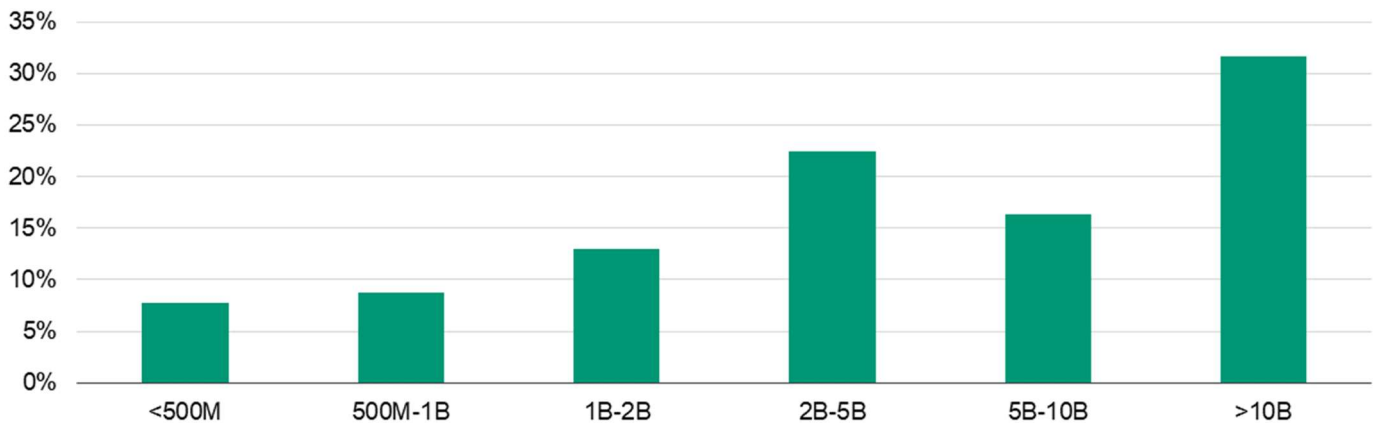**Figure 2** Distribution of statements by asset size.

Figure 3 shows the evolution of corporate MIS ratings in our sample over time. The boxplot shows the 5th, 25th, 50th, 75th, and 95th percentiles of the ratings in our sample for each year. MIS rating percentiles tend to be associated with lower ratings over time. For example, in 1986, the 5th, 50th, and 95th percentiles were Aa1, Baa2, and B3, respectively, while in 2017, the 5th, 50th, and 95th percentiles were A2, Ba1, and Caa1, respectively.

Figure 3 Boxplot of MIS corporate ratings across years.
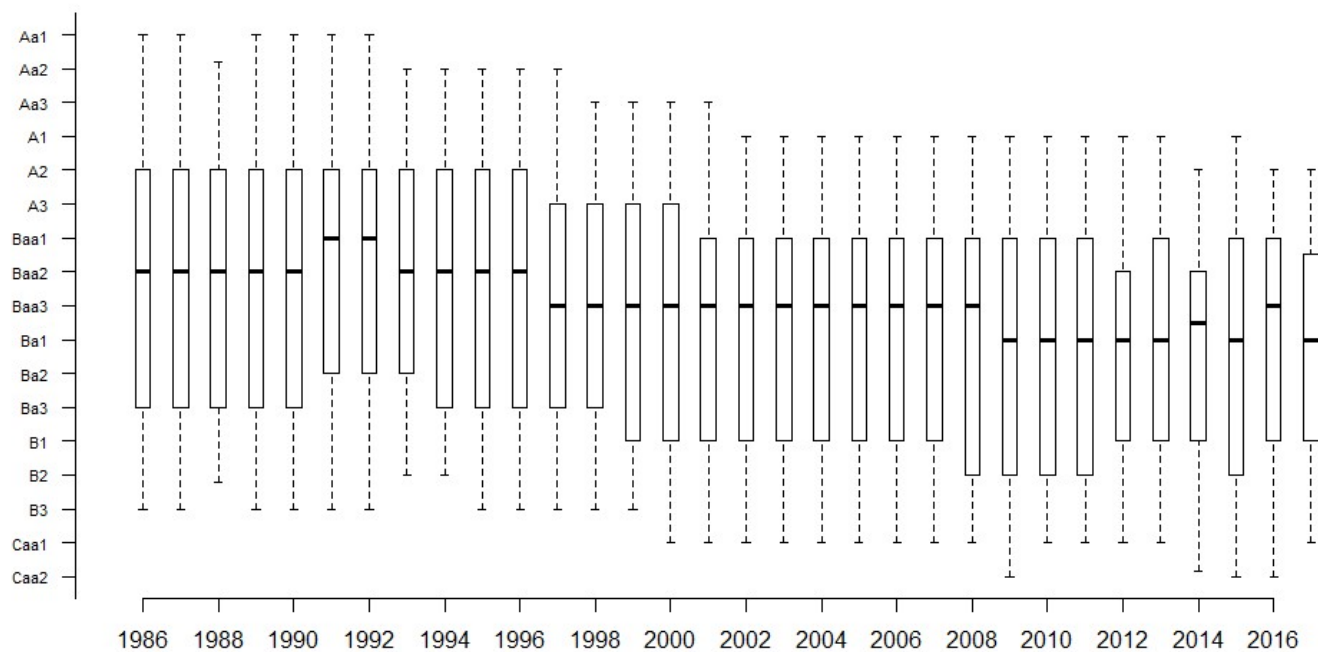
3. Quantitative Components

To obtain the Sovereign & Size-Adjusted EDF-implied ratings, we estimate a linear model using RiskCalc EDF values, Asset Size, and sovereign rating as explanatory variables, as well as variables that indicate the RiskCalc model used. The dependent variable is the MIS rating.

3.2 Overview of RiskCalc Corporate and Not-for-Profit Models

RiskCalc Models are quantitative models based on financial statement, industry, and default information. These models focus on various financial ratios, and we calibrate them to our best estimate of the true default rate in the population. We regularly validate the output EDF value, which shows robust performance for predicting defaults.

Note, RiskCalc models focus on financial profile and provide standalone risk measures. RiskCalc models do not capture qualitative factors such as external support and country-related risks.

3.3 Independent Variables

We reference the MIS rating process when identifying candidate variables. MIS uses a particular methodology depending on the industry, combining quantitative factors such as scale, leverage, liquidity and/or coverage, and qualitative factors such as business profile, financial policy, management, and country-related risks. Taking these factors into account, as well as the data described in Section 2.1, we include as candidate variables the RiskCalc EDF value in Financial Statement Only (FSO) mode[1], several financial ratios considered in MIS rating processes, sovereign rating, asset size, and proxies for some of the qualitative factors considered by MIS. We then perform a forward-variable selection process: 1) begin with the RiskCalc EDF value; 2) add the variable with the best added explanatory power; 3) repeat Step 2 until the additional variable no longer adds material performance gain.

The final selected variables in our template include the RiskCalc one-year FSO EDF, sovereign rating, and total asset size in USD. The template also includes indicator variables associated with the RiskCalc model used. The remainder of this section discusses each variable used.

RiskCalc EDF
We score the financial statements using a RiskCalc model, depending on the location and sector, and obtain the one-year FSO EDF values. We transform the EDF value by taking the normal inverse of it. While the EDF credit measure distribution is highly skewed, the distribution of $N^{-1}(EDF)$ is approximately a normal distribution.

Sovereign Rating
The MIS rating methodologies consider country-related risks in addition to a company's financial profile. The sovereign rating contains rich information regarding a country's overall economic situation and the government's financial healthiness. A country's deteriorating economic situation creates systemic risk and negatively affects the operating environment for all companies in the country. Therefore, the final template includes sovereign rating.

Asset Size
One component of MIS rating methodology is company size. Despite the fact that size is already a variable in the RiskCalc EDF, we find that it plays a larger role in determining a company's agency-comparable rating, given the larger horizon of the rating agencies and their emphasis on stability. Large companies boast some benefits, such as greater power with vendors, ability to influence business trends and pricing, ability to support a stable market position, more resilience to changes, and greater capital market access. Asset Size is also a proxy for likelihood of support from the parent company or the government. Therefore, the largest companies usually have better ratings.

The underlying model has the following functional form:

$$Rating \; = \; \beta_0 + \beta_1 EDF + \beta_2 Sovereign\ Rating + \beta_3 Size + \sum_{j=1}^{K} \gamma_j\, I_j$$

Where β and γ are estimated coefficients,

EDF is the normal inverse of the one-year FSO EDF,

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[1] The Financial Statement Only (FSO) mode delivers a firm's default risk based only on financial statements and sector information. In this mode, the risk assessments produced by the model tend to be relatively stable over time.

Sovereign Rating is the MIS Sovereign Rating of the country where the company is located on a 1 to 19 scale corresponding to Aaa to Caa3/C,

Size is the log of total assets of the company in USD thousands.[2]

$I_1,...I_K$ are indicator variables for each of the RiskCalc models used.

3.4 Template Weights

We determine relative weights in the template by estimating a regression on the data. We estimate the parameters periodically, because agency ratings show a downward trend over time, as in Figure 3. Estimating on the entire sample overlooks this effect. Table 5 reports the relative weights of the three main components, and Figure 6 visualizes the weight evolution over the years.

TABLE 5

Template Weights Across Time

TEMPLATE WEIGHTS

	SOVEREIGN RATING	EDF	ASSET SIZE
1988-1990	1%	52%	48%
1991-1993	2%	46%	53%
1994-1996	19%	34%	47%
1997-1999	16%	38%	47%
2000-2002	12%	46%	42%
2003-2005	13%	43%	44%
2006-2008	14%	39%	48%
2009-2011	10%	40%	50%
2012-2014	9%	42%	49%
2015-2017	11%	36%	53%

Figure 4 Evolution of variable relative weights.
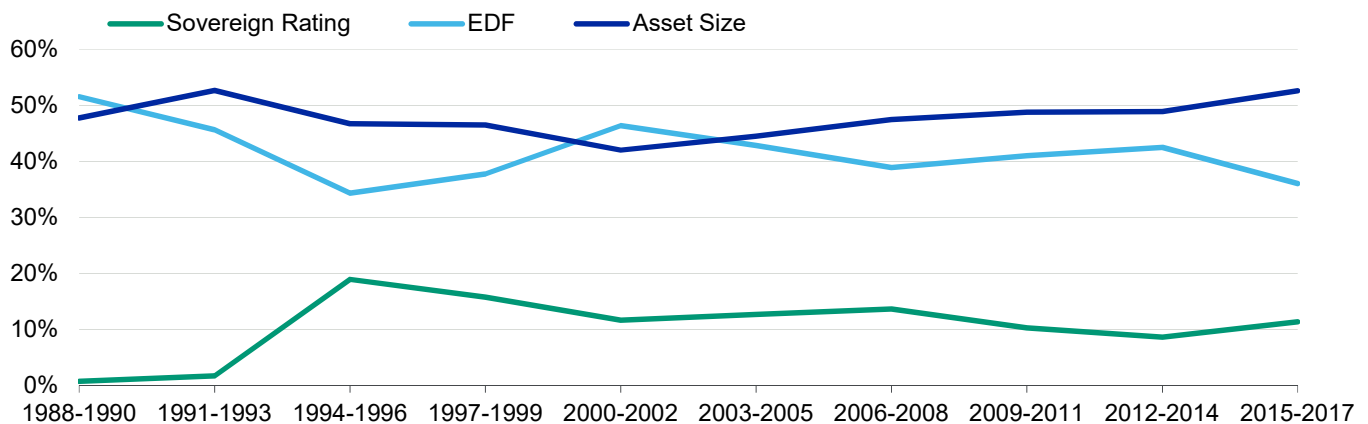
As Figure 4 shows, Total Assets and EDF value play a larger role when compared to sovereign rating in the Sovereign & Size-Adjusted EDF-Implied Rating Template. RiskCalc EDF takes a purely quantitative approach and provides a standalone risk measure, while the rating agencies consider quantitative and qualitative factors as well as the operating environment; during this process, analyst knowledge and experience contribute to the rating.

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[2] The template includes a cap and floor on the size effect, defined based on the size of the companies from the development sample.

4. Quantitative Validation

This section presents validation results for the template's rating performance. The template is intended to be robust across years, so we show its performance on various cuts, both in-sample and out-of-sample. Results show that the final template effectively links EDF values to the corresponding agency ratings.

4.1 In-Sample Performance

Figure 5 shows the accumulative percentages of the sample that have their estimated ratings within zero to five notches of their agency rating. Results show an improvement over time. For recent years, the estimated ratings have an approximately 90% chance to be within a three-notch error of the true agency ratings.

Figure 5 In-sample notch differences across years.
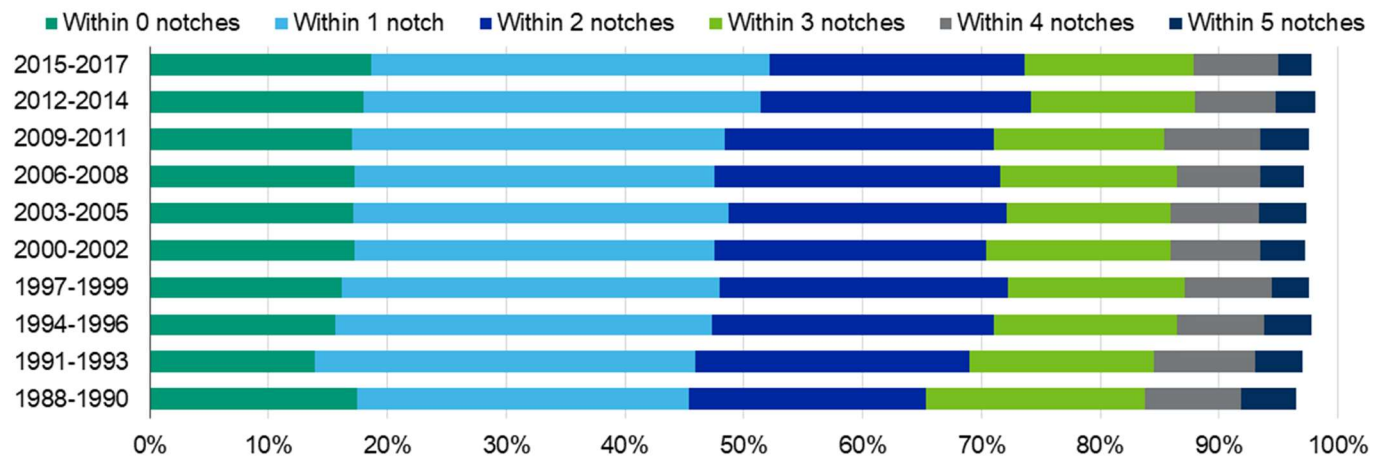
Table 6 and Table 7 present the accumulative percentages of the sample that have their estimated ratings within zero to five notches of their agency rating across models and asset size, for the estimation between 2015 and 2017.

TABLE 6

In-Sample Notch Differences Across Models 2015–2017

DIFFERENCE BETWEEN RATING TEMPLATE AND AGENCY RATING

MODEL	WITHIN 0 NOTCHES	WITHIN 1 NOTCH	WITHIN 2 NOTCHES	WITHIN 3 NOTCHES	WITHIN 4 NOTCHES	WITHIN 5 NOTCHES
China 3.1	17.8%	54.8%	74.0%	89.0%	97.3%	100%
Emerging Markets 3.1	18.0%	58.4%	75.4%	88.4%	93.4%	96.3%
Japan 3.2	11.0%	49.5%	74.3%	87.2%	87.2%	89.9%
Europe Large Firm 4.0	18.6%	52.5%	72.3%	88.0%	95.6%	97.5%
North America Large Firm 3.1	17.9%	49.4%	70.3%	85.7%	94.3%	97.7%
U.S. Not-for-Profit 4.0	21.2%	55.9%	79.8%	91.6%	97.0%	98.8%
U.S. Real Estate Operators 4.0	16.3%	48.3%	76.6%	88.5%	94.3%	98.6%

In Table 6, we see that, for all models, more than 85% of the sample is within a three-notch difference with respect to the true agency rating.

TABLE 7

In-Sample Notch Differences Across Asset Sizes 2015–2017

DIFFERENCE BETWEEN RATING TEMPLATE AND AGENCY RATING

TOTAL ASSETS	WITHIN 0 NOTCHES	WITHIN 1 NOTCH	WITHIN 2 NOTCHES	WITHIN 3 NOTCHES	WITHIN 4 NOTCHES	WITHIN 5 NOTCHES
<500M	20.03%	48.58%	73.09%	89.39%	96.11%	98.21%
500M-1B	25.64%	65.36%	82.19%	94.13%	98.04%	99.02%
1B-2B	18.89%	56.14%	78.73%	91.94%	96.83%	99.08%
2B-5B	14.97%	44.42%	70.47%	85.86%	95.70%	98.43%
5B-10B	16.13%	47.97%	68.70%	82.80%	92.20%	96.90%
>10B	19.77%	55.31%	73.89%	87.81%	93.99%	96.70%

Table 7 shows that, for all asset size cuts, more than 80% of the sample is within a three-notch difference with respect to the true agency rating.

4.2 Out-of-Sample Testing

The out-of-sample validation is implemented as a walk-forward test, which uses the template estimated on the previous three years' data to estimate the rating during the next three years. Figure 6 shows the accumulative percentages of the sample that have their estimated ratings within zero to five notches of their agency ratings for the walk-forward test. The out-of-sample performance is stable across years and, more importantly, it falls in-line with the in-sample performance. This result indicates that the template is robust under the walk-forward test.

Figure 6 Out-of-sample notch differences across years.
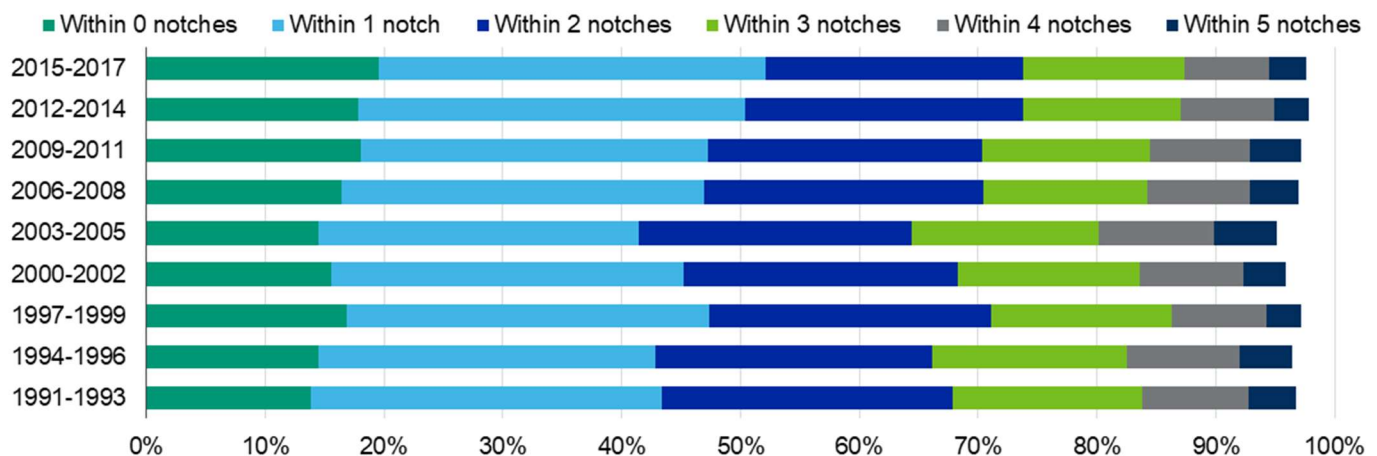
Similar to the in-sample performance, the out-of-sample performance by regions and asset sizes is robust. Table 8 and Table 9 present the difference between estimated and agency ratings across models and asset sizes, for the estimation using 2012–2014 data and applied to 2015–2017 data.

TABLE 8

Out-of-Sample Notch Differences Across Models 2015–2017

DIFFERENCE BETWEEN RATING TEMPLATE AND AGENCY RATING

MODEL	WITHIN 0 NOTCHES	WITHIN 1 NOTCH	WITHIN 2 NOTCHES	WITHIN 3 NOTCHES	WITHIN 4 NOTCHES	WITHIN 5 NOTCHES
China 3.1	21.9%	50.7%	72.6%	90.4%	98.6%	98.6%
Emerging Markets 3.1	20.0%	58.9%	75.1%	87.4%	93.1%	96.1%
Japan 3.2	11.9%	45.9%	78.9%	87.2%	87.2%	89.9%
Europe Large Firm 4.0	21.0%	52.3%	74.0%	88.0%	94.6%	97.1%
North America Large Firm 3.1	18.8%	49.2%	70.7%	85.9%	94.2%	97.7%
U.S. Not-for-Profit 4.0	20.7%	56.5%	78.3%	89.7%	95.9%	98.6%
U.S. Real Estate Operators 4.0	17.2%	50.7%	77.0%	87.1%	94.3%	98.6%

TABLE 9

Out-of-Sample Notch Differences Across Asset Sizes 2015–2017

DIFFERENCE BETWEEN RATING TEMPLATE AND AGENCY RATING

TOTAL ASSETS	WITHIN 0 NOTCHES	WITHIN 1 NOTCH	WITHIN 2 NOTCHES	WITHIN 3 NOTCHES	WITHIN 4 NOTCHES	WITHIN 5 NOTCHES
<500M	19.28%	49.63%	70.10%	85.50%	94.02%	97.91%
500M-1B	26.03%	64.77%	82.78%	92.56%	98.04%	99.41%
1B-2B	20.34%	56.27%	78.07%	92.07%	96.83%	98.55%
2B-5B	16.54%	45.82%	71.46%	86.27%	94.87%	98.18%
5B-10B	17.95%	47.65%	69.55%	82.59%	92.09%	96.69%
>10B	20.31%	54.33%	74.49%	87.92%	93.82%	96.59%

Overall, the walk-forward test results are consistent with the in-sample performance. This finding indicates that our template performance is stable and robust, both in-sample and out-of-sample.

5. Summary

Although RiskCalc EDF as a standalone risk measure differs in nature from an agency rating, the Sovereign & Size-Adjusted EDF-Implied Rating Template links these two well-respected credit measures. We achieve this joining by basing our model on three main inputs: the RiskCalc one-year FSO EDF value, sovereign rating, and asset size. Validation results shows strong and robust performance in estimating agency ratings across years, geographies, and asset size groups. Walk-forward test results also show that estimation power out-of-sample is as good as the estimation power in-sample.