



Modelling sovereign credit ratings: The accuracy of models in a heterogeneous sample



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ABSTRACT

The accuracy of sovereign credit ratings renewed interest toward sovereign credit ratings in the aftermath of the 2008 financial crisis. The controversy over the accuracies encouraged internal credit scoring systems to reduce reliance on sovereign credit ratings. By employing classification and regression trees (CART), multilayer perceptron (MLP), support vector machines (SVM), Bayes Net, and Naïve Bayes; we explore the prediction performance of several artificial intelligence (AI) techniques in predicting sovereign credit ratings in a heterogeneous sample. The results suggest that AI classifiers outperform the conventional statistical technique in terms of accurate prediction. According to *within one notch and two notches accurate prediction* measure, the prediction performances of the AI classifiers exceed 90% accuracy whereas the performance of the conventional statistical method is around 70%. The results further reveal that the prediction performance of the models declines around the threshold rating that is located between investment grade and speculative grade which is not necessarily the result of inadequacy of the models. Rather, this is potentially due to CRAs' cautious behaviour toward those countries around threshold rating which can be interpreted as the certification price of upgrading to investment grade.

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1. Introduction

Credit ratings assigned by rating agencies to countries (sovereign credit ratings) have undeniable supremacy in the global financial system. Although they constitute a small portion of the rating industry, the impact of sovereign credit ratings in the global financial markets is remarkable. Apart from around USD 50 trillion outstanding sovereign debt instruments rated by a number of credit rating agencies (CRAs), a huge volume of corporate and financial debt is benchmarked to sovereign credit ratings (Masciandaro, 2013).

Since sovereign credit ratings form a benchmark indicator for the credit risk assessment of many other assets, the breadth and volume of assets affected by sovereign credit ratings are massively high. Beyond their direct influence on corporate and financial ratings, the national collateral arrangements are mainly based on sovereign credit ratings that make the entire national financial systems over-reliant on agency ratings. This is especially destructive when a sovereign credit rating is downgraded to below investment grade since this downgrade prompts liquidation and deep price falls (cliff effects) (Eijffinger, 2012; Deb et al., 2011). Further problems arise due to spillovers across the markets (Alsakka and Gwilym, 2013; Narayan et al., 2014; Narayan, 2015). A

sovereign credit rating change has a potential to affect the interest rates of the assets in another country due to economic and financial linkages between these countries. Therefore, sovereign credit ratings have multidimensional impact both within country and across countries (Amstad and Packer, 2015; Alsakka and Gwilym, 2013; Deb et al., 2011).

Notwithstanding they are such important measures, the majority of sovereign credit ratings are assigned by Fitch, Moody's and Standard & Poor's – The Big Three – which situates the rating industry into an oligopolistic structure. The limited number of agencies frequently raises concerns over the accuracy of ratings. Whilst significant progress has been achieved after the 2008 financial crisis to lessen their power, the rating process remains still opaque to regulators, investors and even countries.

The opaqueness of rating process is primarily driven by the design of qualitative and quantitative analyses. As clear enough, the final rating decision is given by a committee where the majority of the members are expected to sign-off on the final rating (Amstad and Packer, 2015). The rating committee considers the analytical output provided by rating analysts yet to what extent analytical output is indicative for the final rating is unknown. It is also ambiguous how rating process varies from country to country. For instance during the 2009–2011 period, Eurozone countries were deeply downgraded in several steps as these countries' rating committees repeatedly overlooked their deteriorating fiscal, economic and financial outlook (Eijffinger, 2012). On the other

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hand, many emerging market countries were scaled back with high caution for an upgrade (Gültekin-Karakaş et al., 2011; Bartels and Weder di Mauro, 2013).

Since the beginning of the financial crisis there has been a vivid dispute on the procedures and methodologies of rating process. In relation to sovereign credit ratings, Eijffinger (2012) argues that the disagreement among CRAs on sovereign credit risk (split ratings) is one of the severe shortcomings of the agency ratings. Potentially due to the lack of adequate transparency and regulation, CRAs' methodology on sovereign credit ratings can be significantly different (S&P, 2010; Moody's, 2010; Fitch, 2011). Discrepancies in clarity, length and quantitative content of the rating methodologies, as Eijffinger (2012) argues, are the significant indicators that these agencies have huge power on their assessments.

On the market power of the CRAs and limited transparency of the rating process, queries suggest that CRAs should be forced to substantially increase transparency, including publishing a separate breakdown of the objective and subjective components of credit ratings (Partnoy, 1999, 2001). The debates focus on the allegations that CRAs' self-fulfilling regulatory power leads to inaccuracies and thus severe capital misallocations in the global financial markets. There is now a widespread consensus that regulation and supervision on the transparency issue would automatically enhance rating standards and improve the accuracy of ratings.

The dispute over the accuracy of ratings is not solely an academic phenomenon. The rising unrest also finds its place in the political and regulatory agenda as well. The 'Report on Credit Rating Agencies: Future Perspectives' adopted in March 2011 by the ECON Committee of the European Parliament discusses several issues related to CRAs, such as over-reliance on ratings in banking regulations, the degree of competition and entry barriers in the rating sector and the creation of a European Credit Rating Foundation (EP, 2010). It also asks the Commission to assess alternative risk measurement systems in order to reduce reliance on agency ratings. These developments reveal the tension regarding the role of CRAs and their regulation in Europe. From a regulatory perspective, the alternative measurement of credit risk is highly encouraged by international financial organizations or joint regulatory initiatives. For instance, the recommendations of the Financial Stability Board (FSB) centred on individual credit scoring systems (FSB, 2010). Among the policy recommendations of the FSB, the idea of individual credit scoring was overwhelmingly underlined as an alternative for agency ratings (FSB, 2010).

The candid intentions to prevail individual credit scoring after the 2008 crisis led to solid progress. Many large investment funds have developed their own models to estimate creditworthiness of entities and corresponding loss given default. Just like CRAs, these funds incorporate both quantitative and qualitative analysis in their assessments. Interestingly, they make use of market-based indicators such as credit spreads and prices of credit default swaps (CDS) in their analysis. Additionally, many central banks have expanded their own credit risk assessment capabilities and are using multiple indicators for determining creditworthiness. These developments however do not propose an ultimate solution to credit risk assessment woes. It is not hard to anticipate that devising individual credit scoring systems will be among the top priorities of financial institutions who were hit by the rumours of using flawed ratings.

Accurate measurement of credit risk is a difficult task, since an attempt to measure it suffers from the weaknesses of measurement tools and wrong value judgements. A number of governmental and international organizations embolden the efforts of internal credit scoring, although there is not a compromise on which methodologies to employ. In this study, we explore the methods that predict the sovereign credit ratings the best. We examine various AI models in the prediction of credit ratings through a comparison with a conventional statistical model. We also unravel the prediction performance across different rating scales. This allows us to uncover CRAs' behaviour toward different risk clusters.

There is no overall best AI technique in predicting sovereign credit ratings. The artificial techniques, especially machine learners, decision trees and kernel based techniques are the widely used tools in pattern recognition. In our analyses, we employ five different techniques that have not been employed in the prediction of sovereign credit ratings so far, to the best of our knowledge. These techniques are classification and regression trees (CART), multilayer perceptron (MLP), support vector machines (SVM), Bayes Net, and Naïve Bayes. Based on the findings, we compare the predictive power of these techniques with statistical models in predicting sovereign credit ratings. We also check the robustness of our analyses with additional techniques to reach a more complete conclusion.

The dataset of this study encompasses 1022 country-year observation of 92 countries for the period of 1999–2010. The results suggest that AI techniques outperform the conventional statistical technique in predicting sovereign credit ratings even controlling for cross country heterogeneity. The exact correct prediction rate is around 60% in all the techniques. Bearing in mind that, CRAs can make systematic errors on the ratings, the one and two notch deviations from the actual ratings could be tolerated as a success in the prediction of sovereign credit ratings. When we tolerate one and two notch deviations as correct predictions, the methods exceed 90% accuracy. We arrive at more conclusive results when we disentangle prediction success across rating scales. The results reveal that the prediction performance declines around the threshold rating between investment grade and junk grade which is not necessarily due to weaknesses of the models. We interpret this result as the vigilant stance toward those countries on the edge of threshold rating. Although a country deserves an investment grade rating, CRAs opt to see further achievements for an upgrade which can be assessed as the certification price of upgrading to an investment grade rating. The certification of investment grade ratings brings significant opportunities to countries.

The remainder of the paper is organized as follows: the next section will briefly provide the debate over the reliance on sovereign credit ratings. The third section will briefly introduce the data. The fourth section will discuss the estimation techniques. The fifth section will present the results. The last section will conclude.

2. Reliance on credit ratings

Credit ratings represent the probability of debt repayment and the creditworthiness of borrowers. The role of credit ratings is to provide up-to-date information to markets on the likelihood that a borrower may renege on its commitments. While this can be viewed as an important role to lessen information asymmetry between borrower and debtor, the role attached to credit ratings has expanded over time which made CRAs an indispensable part of the global financial system. Credit ratings are heavily included in financial contracts, investment processes, and the regulatory framework that renders markets reliant on CRAs. The reliance on credit ratings is accepted by many as one of the reasons behind the 2008 crisis since the purported flaws in credit ratings might have created huge misallocation of financial resources.¹ CRAs have therefore come under close scrutiny in recent years and many legislative initiatives have been designed to resolve rating related issues.

Sovereign credit ratings are the smallest constituent of the rating industry. Although their size is small, their impact on financial markets is disproportionately huge. According to Kunczik (2000), rating a country is very much like taking a picture of a country at a specific time with respect to its financial, economic, and political conditions. Sovereign credit ratings constitute an alpha-numeric representation of the probability

¹ Inaccuracies may arise from intentional and unintentional reasons. CRAs deficiencies in their rating methodologies might be the unintentional reason behind the rating inaccuracies. Many CRAs have demonstrated considerable progress in their methodologies and their disclosure. The conflict of interest arising from issuer-pays model and rating shopping seems not to vanish yet since CRAs still collect huge profits from rating business.

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