

# RELATIONSHIP BETWEEN COUNTRY CREDIT RATING AND COUNTRY PERFORMANCE: A DATA ENVELOPMENT ANALYSIS APPROACH

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## Abstract

Sovereign credit rating determines interest rate that is charged by international creditors to sovereign borrowers. Therefore, it represents a key factor in global investors' decision making and thus it is important that ratings represent appropriate riskiness of the issuers. However, rating agencies grading systems are not transparent and key determinants of the rating are undefined. Still, a bunch of studies using statistical models have been conducted in order to define the key determinants, which resulted in defining ("guessing") the wide list of ratings' key determinants. The idea of this paper is to group selected determinants of credit ratings into two subsets i.e. inputs and outputs and using Data Envelopment Analyses (DEA) technique to categorize countries regarding their efficiency. The analyses will be done for a year before last financial crisis and for a recent period. Finally, our aim is to enable policy makers to benchmark country's performance and to detect key variables that need to be improved to achieve higher credit rating.

**Key words:** sovereign credit ratings, country risk, data envelopment analysis

**JEL Code:** C44, F34, G18,

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## Introduction

Credit rating agencies (CRA) were in a center of recent global financial crisis as they were, by determining credit ratings, influencing cost of capital for securities issuers. However, their ratings, that should represent an independent and objective measure of credit quality, proved to be inaccurate and inflated before crisis. Yet, during financial crisis heavy and frequent changes have deepened crisis in several countries hampering their access to the capital market i.e. changes exacerbated a country's boom-bust cycle as shown by Schumacher (2014). Namely, results of his research provided evidence for a significant two-way interaction between the macroeconomic environment and changes in sovereigns' ratings. These ratings

that have been abruptly changed for several notches in less than a year are called failed ratings and several EU countries such as Cyprus, Greece, Ireland, Italy, Portugal and Spain have witnessed these failures. Therefore, credit rating grading system, besides being non transparent, also showed shortcomings. CRAs mistakes had serious consequences for countries and financial sector. However, investors themselves were also responsible by relying too heavily on their ratings i.e. rating of key three rating companies – Moody's, Standard and Poor's and Fitch, whose market shares were estimated to be approximately 40, 40, and 15 percent respectively. Nevertheless, credit rating agencies have been assigned considerable blame as they have failed to foresee financial problems suffered by sovereign issuers (Duan and Van Laere, 2012). Therefore, as country risk ratings assigned by CRAs is not transparent and details of assigned ratings are not publicly revealed, more transparency with regard to the quantitative parameters used in the rating process is considered necessary (Kiff et al., 2012). Assuming two-way interaction between the macroeconomic environment and changes in sovereigns' ratings, this paper attempts to make an efficiency comparison among EU countries regarding key determinants of sovereign rating. Additionally, by identifying top performance countries, analyses results should indicate variables whose performance ought to be improved for inefficient ones in order to achieve higher rating. Furthermore, the analysis was conducted for the period before financial crisis and for a recent period with the aim of identifying possible differences in policy of credit rating agencies.

The rest of the paper is organized as follows. Section 1 defines credit rating determinants. Methodology is explained in section 2, which is followed in section 3 by description of data and variables. Section 4 presents research results. Finally, last section presents our conclusions and directions for future work.

## **1 Credit rating determinants**

Researches on determinants of credit ratings have been attracting attention for many years. A large number of studies have detected a bunch of determinants depending on the characteristics of the samples, timeframe of research, economic cycle and similar. However, a few determinants have been recognized as important in more than several studies. Cantor and Packer (1996) are considered as first study regarding determinants of sovereign rating. Their analysis considers six of eight factors to be important determinant of country's rating: per capita income, GDP growth, inflation, external debt, level of economic development and default history. Bissoondoyal-Bheenick (2005) using ordered response model on 95 countries

for period 1995 - 1999 concluded that the GNP per capita and inflation are the key economic indicators in determining the credit ratings. Avendano et al. (2009) in their paper focused on remittances as important factor for credit rating for less developed countries. As control variables GDP per capita, GDP growth, inflation rate, external debt over exports, external debt service over GDP and economic development were included as determinants of sovereign ratings. Afonso et al. (2007) using panel estimation and random effects ordered probit model for the period of 1995-2005 for 78 countries defined a set of core variables as determinants of credit rating: GDP per capita, GDP real growth rate, government debt, government effectiveness, external debt, external reserves and sovereign default indicators. Additional research by Afonso et al. (2011) using linear and ordered response models for the period 1995–2005 on sample of 66 countries concluded that changes in GDP per capita, GDP growth, government debt and government balance have a short-run impact on a country's credit rating, while government effectiveness, external debt, foreign reserves and default history are important long-run determinants. Similarly, Miricescu et al. (2016) have identified the determinants of the sovereign rating of 25 European Union countries for period 2005-2012. They found that short run variation in inflation, unemployment and public debt to GDP ratio negatively affect credit ratings, while real growth rate, GDP per capita and control of corruption have positive impact. All variables were proven as robust determinants of sovereign debt rating. They also found that these key indicators differ regarding the countries' development i.e. real GDP growth rate, inflation, public debt ratio and control of corruption are emphasized more when credit ratings of CEE countries are analyzed. Besides, they concluded that it seems that indicators such as real GDP growth rate and public debt to GDP are given more importance during the post-crisis period. The study by Reusens and Croux (2017) examined determinants applying composite marginal likelihood approach using a multi-year ordered probit model for a sample of 90 countries for period 2002–2015. GDP growth proved to be statistically significant for highly indebted sovereigns, while government debt proved important for countries with a low GDP growth rate. Moreover, financial balance, the economic development and the external debt also proved to be important after the start of the European debt crisis in 2009. Besides traditional macroeconomic variables, new researches are expanding set of variables that are considered as significant in improving credit rating. Montes et al. (2017) for example tested the importance of new institutional and governance variables such as monetary strategy i.e. adoption of inflation targeting, financial

openness, democracy, law and order, and corruption. Based on a sample of 40 countries for the period 1994 - 2013 they have found abovementioned variables as significant.

This research will focus on following macroeconomic variables, which have been proved statistically significant in most research: GDP per capita, GDP real growth rate, inflation and government debt, government balance and external balance. After defining key credit ratings determinants, to apply DEA as proposed by Oral (2009), input and output variables were identified within the context of country risk rating. Government balance and government debt were considered as inputs, while GDP per capita, GDP growth, inflation and external balance were considered as outputs. The methodology is similar to those applied by Hsu et al. (2008), who made efficiency comparison between the developed countries and the less developed countries regarding the level of country competitiveness.

## 2 Methodology

DEA is a non-parametric technique for measuring and analyzing the efficiency of different economic subjects. There are several reasons to use DEA for efficiency evaluation. DEA assumes that not all decision making units (DMUs) are efficient. It allows multiple inputs and outputs in linear programming model, which develops a single score of efficiency for each DMU. DEA identifies the optimal ways of efficiency rather than the average. This means that it identifies ways to improve performance for the DMUs which are not relatively efficient.

The first step in applying the DEA approach is to select a model for assessing the efficiency. Types of DEA models can be chosen based on scale and orientation of the model. CCR (Charnes-Cooper-Rhodes) model assume constant returns to scale, while BCC (Banker-Charnes-Cooper) model assume variable returns to scale. Efficiency is defined as the ratio of output(s) over input(s). Hence, if the emphasis is on reduction of inputs to improve efficiency, input orientation model must be use. Otherwise, output orientation model define efficiency on the basis of maximization of the output.

Assuming variable returns to scale, this study was conducted using the BCC model. Since EU countries, in order to access European Monetary Union, have to meet the Maastricht criteria, the input-oriented model was used. The efficiency scores ( $\theta_0$ ) for the group of peer DMUs ( $j=1,\dots,n$ ) are computed for the selected outputs ( $y_{rj}$   $r=1,\dots,s$ ) and inputs ( $x_{ij}$ ,  $i=1,\dots,m$ ). The BCC input-oriented model formulation is listed below (Ozcan, 2016):

$$\begin{aligned}
 & \text{Minimize } \theta - \varepsilon \left( \sum_{i=1}^m s_i^- + \sum_{r=1}^s s_r^+ \right) \\
 & \sum_{j=1}^n \lambda_j x_{ij} + s_i^- = \theta x_{i0}, i = 1, \dots, m \\
 & \sum_{j=1}^n \lambda_j y_{rj} - s_r^+ = y_{r0}, r = 1, \dots, s \\
 & \sum_{j=1}^n \lambda_j = 1, j = 1, \dots, n \\
 & \lambda_j \geq 0, j = 1, \dots, n
 \end{aligned} \tag{1}$$

In the second step of the study, correlation between efficiency score and credit rating was carried out. Namely, assuming two-way interaction between the macroeconomic environment and changes in sovereigns' ratings, policy makers can assess country's performance, identify top performance and get information how to improve their efficiency i.e. credit rating.

### 3 Data and variables

As mention in Section 1, data set for measuring efficiency of EU 28 countries consist of two input and four output variables (Table 1).

**Tab. 1: Definition and source of variables included in the DEA model**

Variable	Role	Description	Data source	Standardization
Government balance	input	General government deficit/surplus, % of GDP	Eurostat	Equation (2)
Government debt	input	General government gross debt, % of GDP	Eurostat	Equation (3)
GDP per capita	output	Gross domestic product at market price, current price, euro per capita	Eurostat	/
GDP growth	output	Real GDP growth rate (volume), percentage change on previous year	Eurostat	Equation (2)
Inflation	output	Annual percentage at the end of period, consumer prices are year-on-year changes	IMF	Equation (4)
External	output	Measured using current account balance (%)	IMF	Equation (2)

balance		of GDP)		
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Source: Compiled by authors.

One of the requirements of DEA is for all the variables to be positive (nonnegative). Therefore, the first step was the normalization of the data:

$$x_{i,NOR} = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}} \quad (2)$$

where  $x_{i,NOR}$  is normalized value,  $x_i$  is original value of variable,  $x_{\min}$  is the lowest value of the variable within the sample and  $x_{\max}$  is the highest value of the variable within the sample.

As DEA interprets positive changes favorably, in order to fulfill this requirement, we needed to recalculate values for government debt. Therefore, the final value for the government debt  $x_{i,FIN}$  is calculated as:

$$x_{i,FIN} = 100 - x_{i,NOR} \quad (3)$$

Furthermore, taking 2% inflation target, the inflation values which are included in DEA calculation are defined as:

$$x_{i,FIN} = 100 - |x_i - 2| \quad (4)$$

The data on input and output variables as well as on credit ratings (credit rating data refers to the ratings assigned by the Moody's agency that were valid on the last day of observed year) refer to 2006 and 2015 in order to compare credit rating agencies policy before financial crisis and recently.

## 4 Results

In the first part of the analysis, efficiency scores were calculated through BCC input-oriented model (Table 2). The efficiency analysis was conducted using computer software Frontier Analyst Banxia Software.

**Tab. 2: Efficiency score of EU 28 countries (%)**

Country	Year		Country	Year	
	2006	2015		2006	2015
Austria	1	1	Italy	1	1
Belgium	1	1	Latvia	1	0,31

Bulgaria	0,37	0,14	Lithuania	0,57	0,13
Croatia	0,58	0,80	Luxembourg	1	1
Cyprus	1	0,17	Malta	0,67	1
Czech Republic	1	0,37	Netherlands	1	1
Denmark	1	1	Poland	0,98	0,19
Estonia	1	0,29	Portugal	0,60	1
Finland	0,58	0,62	Romania	0,70	0,18
France	1	0,82	Slovakia	1	0,33
Germany	1	0,86	Slovenia	0,84	0,67
Greece	1	1	Spain	0,30	1
Hungary	1	0,51	Sweden	1	0,87
Ireland	1	1	United Kingdom	1	1

Source: Compiled by authors.

Selected countries having efficiency score equal to 1 are efficient and form the efficiency frontier. As many as 18 countries are considered to be efficient before financial crises. Those 35% countries having efficient score lower than 1 are inefficient in relation to the countries on the frontier. The average efficiency score of countries has gained 86% in 2006. Bulgaria, Croatia, Finland, Lithuania, Malta, Portugal, Romania, Slovenia and Spain attained the efficiency score lower than the average efficiency score. Further, 12 countries are considered to be relatively efficient in 2015, while the average efficiency score of countries has gained 69%. As many as 12 relatively inefficient countries attained the efficiency score lower than the average efficiency score (Bulgaria, Cyprus, Czech Republic, Estonia, Finland, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia). In the next step correlation between obtained results and credit ratings was examined (Table 3).

**Tab. 3: Correlation matrix**

Country	Year 2006	Year 2015
Spearman's rho	0,366	0,252
p-value	0,28	0,097
N	28	28

Source: Compiled by authors.

Table 3 shows that correlation is positive for both 2006 and 2016 at the level of 0,05 and 0,10 respectively. However, it seems to be weak. The potential explanation is a possible non-linear relationship between the variables, whereas correlation assumes a linear relationship between the observed variables.

In order to find out which determinants of credit rating a country should improve to increase its efficiency, Table 4 presents the sources of relative inefficiency. Namely, the DEA allows setting the inputs and outputs targets, which inefficient countries need to achieve in order to become relatively efficient. For example, in order to reach efficient countries Lithuania should reduce the government deficit by 89,5% and government debt by 87,1%.

**Tab. 4: Target values of input and output variables for three most inefficient countries**

Country	Year 2006					
	Government balance	Government debt	GDP per capita	GDP growth	Inflation	External balance
Bulgaria	28,79 (-62,9%)	30,88 (-62,9%)	14922,29 (314,5%)	51,46 (0%)	97,78 (3,4%)	25,77 (45%)
Lithuania	35,86 (-43%)	49,63 (-43%)	12634,99 (70,7)	56,31 (0%)	98,24 (0%)	41,44 (24,1)
Spain	24,27 (-69,8%)	19,68 (-69,8%)	22700 (0%)	35,29 (39,8%)	98,58 (0,1%)	40,92 (6,3%)
	Year 2015					
Bulgaria	8,6 (-86,3%)	8,81 (-90,3%)	21441,53 (240,3%)	14,34 (%)	97,05 (0,1%)	39,69 (38,9%)
Cyprus	7,11 (-89%)	7,21 (-82,7%)	20800 (0%)	7,17 (0%)	97 (0,6%)	35,42 (275,5%)
Lithuania	8,17 (-89,5%)	10,35 (-87,1%)	18508,35 (43,5%)	7,55 (0%)	97,32 (0%)	33,92 (152,8%)

Source: Compiled by authors.

Also, GDP p/c should be increased up to 18.508 euro and current account balance improved for 152,8%. Analogue explanations can be applied to the rest of the country.

## Conclusion



In this paper we have tried to confirm the thesis of a relationship between the macroeconomic environment and changes in sovereigns' ratings in order to offer a tool for policy makers to measure their relative efficiency. Therefore, using DEA technique, we have categorized countries regarding their relative efficiency. Additionally, we have detected key variables that need to be improved in order a country to be assigned higher credit rating. This information could be taken as the basis for future policy decisions. However, due to weak correlation between credit rating and efficiency score, given results should be taken with caution. In order to improve correlation, the future work should be oriented to incorporation of credit default swap (CDS) as an indicator of credit risk. Namely, CDS as well as macroeconomic determinants change more frequently and with more variation than the credit rating. Besides, a non-linear relationship between the variables needs to be examined as well. Regarding the period before crisis and recent period, our results reveal that CRA have recently become more conservative considering rating assignment. Possible explanation is that credit rating agencies have improved their rating systems and that some variables are considered more careful and with more thoughtfulness today than they were before the crisis.

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