



Determinants of sovereign debt ratings in clusters of European countries – effects of the crisis

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Abstract

Purpose: This paper studies the determinants of the sovereign debt ratings provided by the three main rating agencies for 32 European countries. It verifies the clusters of countries existing for each of the agencies, considering regional bias, and then analyzes whether the determinants were different before and after the global financial crisis. It also aims to explain how the determinants are taken into account for rich and developing countries, using a sample for the period between 2001 and 2008 and the period between 2009 and 2016.

Design/methodology/approach: To this purpose, we perform panel data estimation using an Ordered Probit approach.

Findings: This method shows that for developing countries after the crisis, the relevant explanatory variables are the unemployment rate and the presence in the Eurozone. For rich countries, the inflation rate is pivotal after the crisis period.

Originality/value: This paper is the first to use a clustering methodology within sovereign debt rating literature, grouping the countries into cohesive clusters according to their sovereign debt ratings along the proposed time frame. Moreover, it explains which countries belong to strong or weak groups, according to the rating agencies under discussion; and, in these groups, it identifies the sovereign rating determinants.

1. Introduction

Since the emergence of the economic and financial crisis in 2007, the words “rating” and “rating agencies” have been on the agenda. However, rating agencies have been in existence for more than a century¹, and gained importance and credibility in the 1960s and 1970s, mainly because of the reduction in default cases. In fact, rating agencies have absolute supremacy in the global financial system (Ozturk *et al.*, 2016), because by publishing information on the debt capacity of companies and countries they contribute to the reduction of asymmetric information between creditors and debtors, correcting market failures resulting from this problem (Agnello *et al.*, 2021). However, before the 2007 crisis these agencies were receiving a great deal of criticism about conflicts of interest, lack of transparency, and incorrect ratings. It appears that ratings do not always reflect real economic fundamentals (Gültekin-Karakaş *et al.*, 2011). In addition, the rating agencies made mistakes and weakened their reputations; for example, in 2011 S&P changed their method of calculating the rating of commercial mortgage-backed securities, and then issued inflated ratings in order to gain the market share it had lost (Baghai and Becker, 2020).

Recent studies have shown that sovereign ratings are biased against developing countries and indebted countries (Ozturk, 2014; Tennant *et al.*, 2020), and that the ratings of the three main agencies are inflated for American companies and for governments with commercial relations with the United States of America (Yalta and Yalta, 2018). Countries with similar cultures receive similar ratings (Fuchs and Gehring, 2017), suggesting that agencies may grant ratings for groups of countries and have a regional bias. In 2011, the President of the European Commission, after a rating decline in

¹ In 1900, John Moody released Moody's Manual of Industrial and Miscellaneous Securities. In 1906 formed the Standard Statistic Bureau; in 1940 this company would be merged with the Poor's Publishing, giving rise to the Standard & Poor's. In 1913, John Knowles Fitch founded the Fitch Publishing Company.

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3 Portugal, stated that there might be some bias in the European ratings (Reuters, 2011),
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5 and the Russian Finance Minister, after a similar downgrade, noted the same bias
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7 (Reuters, 2015). The former German economy minister, Rainer Brüderle, said that
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9 American rating agencies discriminate against the Eurozone (The Guardian, 2012).
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12 It is, therefore, crucial to group together the countries with similar ratings, because
13
14 the rating determinants will be identical for these groups, given this regional bias. Hence,
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16 our study contributes to the literature in different ways. First, we study clusters of
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18 countries to understand whether the three main rating agencies show any regional bias.
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20 Then, we analyze the determinants of the ratings in pre-determined clusters of European
21
22 countries among a range of possible variables. We are also intended to understand the
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24 effects of the global financial crisis on these determinants, and we suggest that it is
25
26 possible to anticipate a new financial crisis by observing these determinants. During the
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28 proposed period (2001-2016), the European countries have faced various political
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30 challenges, such as the rise of new political parties (in Portugal and Spain) and
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32 divergences between governments (in France) (Vu *et al.*, 2017). Moreover, we study the
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34 period between 2001 to 2016, in which data are more plentiful than the data used in
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36 previous literature.
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42 To the best of our knowledge, this paper is the first in the sovereign debt rating
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44 literature to use a clustering methodology. This approach can detect a partition of
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46 countries into cohesive clusters, and then estimate the determinants of the sovereign
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48 ratings for each cluster. The main advantage of this methodology is that the countries with
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50 the most similar ratings are grouped together and, in this way, the most homogenous
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52 determinants for each of the groups are obtained, considering regional preferences.
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55 The second contribution of this study is to understand which groups of countries
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57 are regarded by the rating agencies as strong or weak and to identify the determinants of
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3 the sovereign rating in each of the groups. Using the ordered probit model, our results
4
5 show that, for rich countries, inflation is the most important variable for all agencies, and
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7 the degree of explanation increases after the crisis period. For European developing
8
9 countries, the unemployment rate and the fact of belonging to the Eurozone become
10
11 important after the crisis.
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15 The remainder of the paper is organized as follows. Section 2 presents the main
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17 theoretical principles that justify the study, and the literature review. Section 3 describes
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19 the research design. Section 4 presents and comments on the empirical results. Finally,
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21 section 5 presents our conclusions and limitations, and highlights possible avenues for
22
23 future research.
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28 29 **2. Literature review**

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31 Sovereign ratings measure solvency and the ability to pay interest and loans (De Moor *et*
32
33 *al.*, 2018; Roychoudhury and Lawson, 2010). They are also a measure of a country's
34
35 development (Afonso, 2003). Essentially, they estimate the likelihood of a government
36
37 default (Pinheiro, 2020). According to Erdem and Varli (2014), sovereign credit ratings
38
39 are a signal of a country's economic, financial, and political situation, for which an
40
41 evaluation is critical when it comes to attracting capital and investment. In this way,
42
43 ratings can be used by investors, issuers, investment banks, and governments as reliable
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45 and high-quality information. In fact, investors depend on these agencies to assess a
46
47 country's credit risk (Nair, 2019), and investor portfolios can be substantially reweighted
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49 after a change in sovereign ratings (Brooks *et al.*, 2004).
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55 The rating market is an oligopoly (Eijffinger, 2012), that is, a system of imperfect
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57 competition in which a small number of companies, namely three agencies, control the
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3 market. The three agencies with this strong position are Moody's, Standard & Poor's
4 (hereafter, S&P), and Fitch (Brauers and Lepkova, 2019).
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8 The rating agencies assess the ability of public and private entities to pay their
9 debts, taking into account a range of underlying factors concerning both the entity
10 (financial capacity, composition of assets, and reputation of the issuer) and economics
11 (forecasts and macroeconomic factors, bankruptcy history, and economic cycle) (De
12 Moor *et al.*, 2018). However, the weights applied by the agencies are unknown, and their
13 interpretation may prove difficult, given the heterogeneity of the indicators used and the
14 subjective judgment used in credit ratings (Bruner and Abdelal, 2005; De Moor *et al.*,
15 2018; Rosati *et al.*, 2020).
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26 With the global financial crisis of 2007-2009, rating agencies changed the
27 sovereign ratings very frequently. Indeed, countries collapsed, and investor distrust
28 deepened each time the agencies released their rating reports. There was a significant
29 deterioration in public finances in several countries, leading to rating down-grading such
30 as those seen in the peripheral European countries (GIIPS – Greece, Ireland, Italy,
31 Portugal, and Spain) (Bartels, 2019; Boumparis *et al.*, 2017), which led to investor
32 confidence issues and unfavorable indicators (Broto and Molina, 2016). Thus, in this
33 period, these agencies were synonymous with austerity (Rosati *et al.*, 2020). However,
34 the ratings are still considered a good indicator of the quality of public debt (Pérez-
35 Balsalobre and Llano-Verduras, 2020), and the rating agencies now rely more on
36 quantitative data than they did before (Amstad and Packer, 2015).
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51 The theme of the determinants of sovereign ratings has been studied since 1996,
52 with a focus on the variables that explain the ratings. We will first review the variables
53 that have been reported as statistically significant, and then we will focus on the studies
54 that compare the determinants in different periods.
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3 Afonso (2003), Cantor and Packer (1996), and Canuto *et al.* (2012) conclude that
4 the ratings are explained by a small set of variables: gross domestic product (henceforth,
5 GDP) per capita, GDP growth, inflation, external debt, economic development, and
6 default history. Alexe *et al.* (2003) find that, besides these variables, the ratio between the
7 national credit and GDP, the public debt, political stability, and government effectiveness
8 are determinants of sovereign ratings, and Altenkirch (2005) shows that the most
9 significant variables are gross domestic savings, the current account balance, foreign
10 reserves, and political rights. All these authors use the ordinary least squares (hereafter,
11 OLS) methodology and a static estimation.
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24 Eliasson (2002) and Monfort and Mulder (2000) use a dynamic estimation to
25 determine the variables that explain the ratings of economies, and find that the ratings are
26 explained by the ratio between debt and exports, the export growth rate, the fiscal balance,
27 inflation, and GDP.
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33 To understand whether a better legal environment has a strong and positive impact
34 on sovereign ratings, Butler and Fauver (2006) introduce a new variable that measures
35 the legal environment – the legal environment index. This corresponds to the sum of the
36 following variables: the people's voice, political stability, government effectiveness,
37 regulatory quality, the rule of law, and control of corruption.
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44 Afonso *et al.* (2011) use ordered probit models and study the variables with a
45 short-term and long-term impact on the sovereign rating. GDP per capita, real GDP
46 growth, public debt, and the current account deficit have a short-term effect, and
47 government effectiveness, external debt, international reserves and dummies for
48 sovereign default only have a long-term impact.
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55 It is important to highlight that the three top rating agencies calculate ratings in
56 different ways. Hill *et al.* (2010) conclude that the three agencies disagree on sovereign
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3 [debt rating](#) more often than they agree. [Five](#) common variables are used as determinants
4
5 by the three rating agencies: GDP per capita, GDP growth rate, default history,
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7 institutional investor rating, and risk premium. Moreover, rating agencies favor their
8
9 home countries, in detriment of foreign countries (Luitel *et al.*, 2016).
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12 After analyzing the [literature on the determinants of sovereign debt ratings](#), we
13
14 now examine the literature that studies the evolution of the importance of these
15
16 determinants. Bissoondoyal-Bheenick (2005) [studies whether](#) the economic variables
17
18 have the same importance for ratings throughout the ages and [for the](#) different agencies.
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20 The author draws up three estimations — a global one, one for countries with high ratings,
21
22 and one for countries with low ratings. GDP per capita and inflation are the most
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24 significant variables. [Furthermore](#), the relevance of the variables changes depending on
25
26 the level of the country's development. For countries with high ratings, the variability
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28 between the ratings is greatly reduced. On the other hand, for countries classified with
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30 low ratings, in addition to GDP per capita and inflation, the current account balance and
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32 the level of international reserves play an important role in the determination of the
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34 sovereign rating. This leads us to believe that, for developing countries, external debt
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36 indicators and the balance of payments are relevant.
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42 Reusens and Croux (2017) find that the importance of the financial balance,
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44 economic development, [and the external](#) debt increased substantially after the European
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46 debt crisis of 2009. Moreover, GDP growth [showed a strong](#) gain in importance for
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48 countries with a large amount of debt. These authors conclude that rating agencies
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50 changed their determinants after the start of the crisis. Afonso *et al.* (2007) show that,
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52 since the Asian crisis, international reserves have taken on greater importance. [Recently](#),
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54 [Dang and Partington \(2020\)](#) have shown that culture has an impact on sovereign ratings,
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3 and Fuchs and Gehring (2017) have found that culturally familiar countries have higher
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5 and similar ratings.
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8 Another point from the rating literature is the difference between countries. For
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10 the period 1993-2013, countries in the Eurozone and North America had the highest
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12 sovereign ratings, followed by the rest of Europe, Oceania, Asia, Africa, and Latin
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14 America (Teixeira et al., 2018). In countries with lower ratings, unemployment rate,
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16 regulatory quality, and competitiveness are rating determinants; on the other hand, GDP
17
18 per capita is one of the main determinants for countries with high ratings (Boumparis *et*
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20 *al.*, 2017). Moreover, being a Eurozone member impacts negatively on the sovereign
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22 ratings during the 2007 crisis and positively after the crisis (Stawasz-Grabowska, 2020).
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26 For the sake of completeness, Table A.1 summarizes the literature, including the
27
28 explanatory variables, the rating agencies, and the methodology used in each study.
29
30 Following these studies, we intend to test economic variables, government variables, and
31
32 external variables to obtain a better understanding of the main rating determinants for
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34 European countries, and the clusters to which the countries belong. We explain in section
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36 3.2.1 the variables and their expected signs. This cluster approach finds a foundation in
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38 Fuchs and Gehring (2017) study, which shows that rating agencies group countries
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40 together and assign similar ratings to similar countries, suggesting that agencies may
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42 assign ratings by groups of countries and have a regional bias.
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49 **3. Research Design**

50 **3.1. Model**

51 **3.1.1. Clusters analyses**

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53 To classify the countries, before and after the crisis, by the three agencies, we use a non-
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55 hierarchical clustering methodology steered by a quality criterion – the *R*-squared ratio.
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This methodology was recently proposed in Martins (2017) and is known as Goal Clustering. Goal Clustering (hereafter, GC) looks for a partition of a set of elements into cohesive clusters such that the associated R -squared ratio is at least a given threshold. In what follows, we denote the R -squared ratio by R^2 and the threshold by R^2T . While in the most known k -means method, we set the number of clusters in advance (k) and then test the quality of the solution, in the GC approach, instead, the single input parameter is the threshold quality criterion R^2T . Then, it attempts to find a clustering solution with the minimum number of clusters, such that the associated R^2 ratio satisfies the threshold, that is, such that $R^2 \geq R^2T$. So, in the GC method, the number of clusters (k) is an output.

The R^2 ratio is a known measure to assess the quality of a partition when there is no known solution to compare with. It represents the proportion of the total variability retained between the clusters, being defined by $R^2 = SSB/SST$. So, given a set V of n elements on m attributes, with each entry represented by X_{it} ($i=1, \dots, n$ and $t=1, \dots, m$), and a partition of V into k clusters, represented by $V = Q^1 \cup Q^2 \cup \dots \cup Q^k$, with $Q^a \cap Q^b = \emptyset$ for all $a, b = 1, \dots, k$ and $Q^a \neq \emptyset$ for all $a = 1, \dots, k$, the R^2 is the ratio of the between-groups variability (henceforth, SSB) of the partition over the total variability (hereafter, SST) of V .

The between-groups variability of the partition is defined by

$$SSB = \sum_{t=1}^m \sum_{q=1}^k |Q^q| \cdot (\bar{X}_t^q - \bar{X}_t)^2$$

and the total variability of V is represented by

$$SST = \sum_{t=1}^m \sum_{i=1}^n (X_{it} - \bar{X}_t)^2.$$

The term \bar{X}_t^q denotes the average value of attribute t among all elements in cluster Q^q , and \bar{X}_t denotes the average value of attribute t among all elements in V .

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3 Concerning the dataset under discussion, the elements represent the countries,
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5 with $n = 32$, and the time stream of the years represents the attributes. For the period
6
7 before the crisis, the set of attributes ranges from 2001 to 2008, while, for the period after
8
9 the crisis, the set of attributes goes from 2009 to 2016. Hence, $m = 8$ in both cases. Setting
10
11 the threshold quality criteria to $R^2T = 0.9$, then the solutions returned by the GC method
12
13 for each of the three rating agencies (Moody's, Fitch and S&P) for the two periods (before
14
15 and after the crisis) are obtained as highlighted in the next three tables.
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22 [Insert table 1 about here]

23 [Insert table 2 about here]

24 [Insert table 3 about here]

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31 Considering the same threshold ratio $R^2T = 0.9$, all the before crisis solutions
32
33 involve 3 clusters, and all the after crisis partitions require 4 clusters. In a broad sense, all
34
35 agencies detach a group of richer countries, being more restrictive after the crisis period.
36
37 Then, in the before crisis period, Moody's and S&P create two additional clusters,
38
39 grouping most countries entering the EU in 2004 and putting in the other group the
40
41 countries entering the EU after 2007, besides Ukraine and the Russian Federation. This
42
43 separation is rather different from the before crisis partition provided by Fitch, which
44
45 divides the countries into the old U.S.S.R allies and the remaining European countries,
46
47 besides those in the richer group, and apart from a few exceptions (Slovenia and Estonia).
48
49

50
51 The three agencies' solutions are more stable after the crisis period. Once again,
52
53 Moody's and S&P are very similar, with a small difference in placing Italy and Ireland,
54
55 while Fitch places Belgium in the richer group and puts Portugal in the lower emerging
56
57 countries' cluster. In all after crisis solutions, Greece is placed together with Ukraine in a
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3 single separated cluster, reflecting the [poor](#) sovereign indicators revealed by Greece. In
4
5 table 4 we present the average ratings for each cluster, and we conclude that rich countries
6
7 have the highest ratings.
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10 [Insert table 4 about here]
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15 Other values for the threshold have been tried in preliminary tests. Higher values
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17 for R^2T may conduct to overfitting, with many clusters (including singletons – many
18
19 isolated countries), while lower values for R^2T determine partitions with few clusters,
20
21 putting rather different countries in the same group. In fact, the best choice for the
22
23 threshold is not a matter of consensus, depending on the particular [issue](#) being tested.
24
25 However, we should stress that the highest the threshold, the better the homogeneity
26
27 within groups, so our choice for $R^2T = 0.9$ was in line with these assumptions and the
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29 preliminary tests not reported [here](#) (but available upon request).
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35 36 **3.1.2. Ordered Probit**

37 Ordered Probit is the appropriate methodology for the research problem [under analysis](#)
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39 because the rating is a discrete variable and reflects the probability of default. According
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41 to Afonso *et al.* (2007) and Reusens and Croux (2017), we have an unobserved latent
42
43 variable Rating (R^*), which means a continuous evaluation of a country's
44
45 creditworthiness:
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47

$$48 \quad R_{it}^* = \beta_i X_{it} + \mu_i + \varepsilon_{it},$$

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50 where X_{it} is a vector of explanatory variables that vary over time (macroeconomic
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52 variables, government variables, and external variables). The index i (for $i = 1, \dots, n$)
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54 indicates the country, the index t (for $t = 1, \dots, T$) [specifies](#) the period, β_i is a vector of
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unknown parameters at time t , μ_i is an error term *that is*, by definition, uncorrelated with the regressors, and ε_{it} are independent errors across countries and over time.

There is a *limited* number of rating categories, and the agencies have cut-off points to establish the limits of each rating category (R_{it} are the quantitative country ratings). In our case, the rating is given by:

$$R_{it} = \begin{cases} \text{AAA(Aaa), if } R_{it}^* > c_{16} \\ \text{AA + (Aa1), if } c_{16} > R_{it}^* > c_{15} \\ \text{AA (Aa2), if } c_{15} > R_{it}^* > c_{14} \\ \text{AA - (Aa3), if } c_{14} > R_{it}^* > c_{13} \\ \text{A + (A1), if } c_{13} > R_{it}^* > c_{12} \\ \text{A (A2), if } c_{12} > R_{it}^* > c_{11} \\ \text{A - (A3), if } c_{11} > R_{it}^* > c_{10} \\ \text{BBB + (Baa1), if } c_{10} > R_{it}^* > c_9 \\ \text{BBB (Baa2), if } c_9 > R_{it}^* > c_8 \\ \text{BBB - (Baa3), if } c_8 > R_{it}^* > c_7 \\ \text{BB + (Ba1), if } c_7 > R_{it}^* > c_6 \\ \text{BB (Ba2), if } c_6 > R_{it}^* > c_5 \\ \text{BB - (Ba3), if } c_5 > R_{it}^* > c_4 \\ \text{B + (B1), if } c_4 > R_{it}^* > c_3 \\ \text{B (B2), if } c_3 > R_{it}^* > c_2 \\ \text{B - (B3), if } c_2 > R_{it}^* > c_1 \\ < \text{CCC + (Caa1), if } c_1 > R_{it}^* \end{cases}$$

The parameters β , δ , λ and the cut-off points c_1 to c_{16} are obtained through the likelihood maximum. In this methodology, the ratings have a linear transformation of 1 to 17, as shown in [Table A.2](#). The model estimation assumes an error term correlated across countries, and the error term is assumed to be normally distributed (Sehgal et al., 2018). This methodology has shown better results than linear models (e.g., Afonso *et al.*, 2011; Bissoondoyal-Bheenick, 2005; Mora, 2006) whenever there are few rating

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2
3 categories and the classifications accumulate at the extremes of the ratings (Reusens and
4
5 Croux, 2017). It should be noted that in an ordered probit model the estimated coefficients
6
7 differ by a scale factor, and, therefore, it is not possible to interpret the magnitude of the
8
9 coefficients; the only direct conclusion we can draw is the sign (positive or negative) of
10
11 the influence of the independent variable on the dependent variable (Wooldridge, 2016).
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13 We estimate the models using the Gretl software version 2020a (Gnu Regression,
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15 Econometrics, and Time-series Library).
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21 **3.2. Variables**

22 **3.2.1. Explanatory variables**

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24 According to the literature review, the variables that can affect the sovereign ratings are
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26 divided into four groups: macroeconomic variables, government variables, external
27
28 variables, and other variables. Following Afonso *et al.* (2011), Boumparis *et al.* (2017),
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30 and Reusens and Croux (2017) and the available data, we consider: as our macroeconomic
31
32 variables, the GDP per capita, unemployment, and inflation; as our government variable,
33
34 the government effectiveness; as our external variables, the reserves and current account
35
36 balance; and, finally, as our other variables, we consider two dummy variables that
37
38 indicate if a specific country belongs to the Eurozone or if it is a European Union country.
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44 The expected signs are explained as follows:

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46 1) GDP per capita (+): Countries with higher GDP per capita have more stable
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48 institutions because they can avoid excessive government borrowing, are less vulnerable
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50 to exogenous shocks, and, consequently, have a higher rating, because the probability of
51
52 default is smaller (Boumparis *et al.*, 2017; Reusens and Croux, 2017).
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55
56 2) Unemployment rate (-): The more flexible labor markets are in countries that
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58 have lower unemployment rates and so have a lighter tax burden from unemployment and
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3 social benefits, with more money available for the payment of state obligations, thus
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5 leading to a negative relationship between unemployment and sovereign ratings (Afonso
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7 *et al.*, 2011; Boumparis *et al.*, 2017).

8
9
10 3) Inflation rate (+/-): On the one hand, with high inflation, a country has bigger
11
12 resources to pay foreign debt obligations, as inflation reduces the real stock of
13
14 government debt in the national currency (Afonso *et al.*, 2011). On the other hand, high
15
16 inflation can originate problems at the macroeconomic level (Reusens and Croux, 2017).

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18
19 4) Government effectiveness (+): a high quality of public service provision,
20
21 competence in bureaucracy, and low levels of corruption should improve a government's
22
23 ability to meet its debt obligations (Afonso *et al.*, 2011). This variable is measured by the
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25 World Bank Governance Government Effectiveness indicator, which ranges from -2.5
26
27 (poor government effectiveness) to 2.5 (strong effectiveness).

28
29
30 5) Reserves (+): high reserves must assist a government in fulfilling its
31
32 obligations; hence, the higher they are, the higher the rating. The literature uses foreign
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34 reserves, which are not available for European countries in the World Bank database.

35
36
37 6) Current account balance (+/-): On the one hand, a higher current account deficit
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39 can damage sustainability in the long run, because it can imply overconsumption. On the
40
41 other hand, it can mean growth and long-term sustainability through investment
42
43 accumulation (Afonso *et al.*, 2011; Boumparis *et al.*, 2017).

44
45
46 The variables are obtained using the World Bank (Economic Policy & Public Debt
47
48 and Worldwide Governance Indicator) and the International Monetary Fund (World
49
50 Economic Outlook) databases. The specification of the variables, the expected signs, and
51
52 the sources are explained in the table presented below.

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58 [Insert table 5 about here]

3.2.2. Dependent variable

In this paper, we study the sovereign debt ratings for foreign currency for the three agencies (S&P, Moody's, and Fitch), because this type of rating is used in intercountry comparisons. These variables are obtained from Bloomberg, and we consider the end-of-year sovereign credit ratings, following Reusens and Croux (2017).

The notations that are the object of this study are the long-term ratings, ranging from D, meaning "in default", to A, indicating "with no risk of failure". It is possible to observe that each of the agencies has its own taxonomy, and it is therefore difficult to draw comparisons.

As the scales of the ratings are qualitative information, we need to transform them into quantitative scales using linear transformations so that they are mathematically workable. Table A.2, in Appendix A, shows the assignment of a number for each rating that lies in the range 1 to 17; this is a linear transformation and was also used by Boumparis *et al.* (2019), Canuto *et al.* (2012), and Reusens and Croux (2017).

3.3. Data

The analysis focuses on the periods 2001 to 2008 and 2009 to 2016, using annual data. The year 2008 is the yearly cut, following Neves *et al.* (2015) and Reusens and Croux (2017). The countries under study are the following European countries: Spain, the Netherlands, Sweden, Finland, Ireland, Switzerland, Norway, Germany, Denmark, France, the United Kingdom, Austria, Hungary, Poland, the Czech Republic, Ukraine, Latvia, Slovakia, Croatia, Russia, Lithuania, Bulgaria, Romania, Luxembourg, Iceland, Slovenia, Italy, Portugal, Belgium, Malta, Greece, and Estonia. We have 27 of the 28 countries of the European Union, three countries outside the European Union that have

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3 free trade agreements (Iceland, Norway, and Switzerland), and the largest European
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5 country (Russia) with one of its European neighboring countries outside EU (Ukraine).
6
7

8 Table 6 presents the descriptive statistics of the variables used in the study. We
9
10 point out that the country ratings are higher at Moody's and lower at Standard & Poor's
11
12 in the global and pre-crisis period. Following the crisis, Moody's assigns the lowest
13
14 ratings to the countries in the study and Fitch assigns the highest ratings. We highlight
15
16 that average GDP, unemployment, reserves, and current account increase in the second
17
18 period under study, while the average value of the inflation rate and government
19
20 effectiveness decreases.
21
22

23
24 [Insert table 6 about here]
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26
27

28 **4. Empirical Analysis**

29
30 The next three subsections analyze the global panel results for the two periods, i.e., 2001
31
32 to 2008 and 2009 to 2016, and then compare them with the results obtained from the
33
34 clustering methodology. This explicit comparison between global panel and clustering
35
36 results will allow us to better emphasize the contribution of the clustering methodology
37
38 in these applications.
39
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42
43

44 **4.1. Moody's**

45 **4.1.1. Global Panel**

46
47 Inspection of table 7 reveals that the obtained signs are the expected ones for all the
48
49 variables in the pre- and post-crisis periods. In terms of statistical significance, all
50
51 variables, except the current account balance, are statistically significant before the crisis,
52
53 with a significance level of at least 10%. Lane (2012) shows that before the crisis there
54
55 was an increase in the dispersion and persistence of current account imbalances across
56
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3 the euro area, which may indicate that this variable was not taken into account when the
4
5 Moody's ratings were calculated. After the crisis, the inflation rate is no longer
6
7 statistically significant.
8
9

10 Regarding the variables that could have a positive or a negative impact, we show
11
12 that inflation has a negative impact before the crisis, current account balance has a
13
14 positive effect after the crisis, and being a country in the Eurozone and the European
15
16 Union has a positive impact in both periods. Moreover, the degree of explanation
17
18 decreases in the post-crisis period. With respect to the stability between the pre- and post-
19
20 crisis periods, we observe that there is no stability for Moody's. This can be documented
21
22 by the changes in the statistical significance of the variables under study, which indicate
23
24 a structural change between the two periods, caused by the crisis.
25
26
27
28
29

30 [Insert table 7 about here]
31
32
33

34 35 **4.1.2. Clustering** 36

37 The next table shows the results for Moody's.
38
39
40
41

42 [Insert table 8 about here]
43
44
45

46 Before the crisis, cluster 1 contains Portugal, Italy, Greece, and Spain (the PIGS
47
48 cluster) and the eastern countries, cluster 2 the "rich" area of Europe (western, central,
49
50 and northern Europe) and cluster 3 Russia and its close geographic partners (eastern
51
52 countries and eastern Europe). However, after the economic crisis, cluster 3 has the "rich"
53
54 area of Europe (western, central, and northern Europe), excepting the Ireland, Iceland and
55
56
57
58
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1
2
3 **Belgium cases.** These results are in line with the average ratings obtained in each of the
4
5 clusters in the different periods (table 4).
6

7
8 The degree of explanation in clusters 1 and 2 decreases after the crisis. However,
9
10 it increases for the rich countries, which means that after the crisis the inflation rate is a
11
12 crucial variable to keep the richest **countries having a high rating.** Boumparis *et al.* (2017)
13
14 conclude that when uncertainty is low, the inflation rate has a stronger economic impact
15
16 on credit rating decisions. Moreover, for these countries, the sign **for belonging to the**
17
18 Eurozone is positive before the crisis and negative after the crisis, **which corroborates the**
19
20 **findings** of Reusens and Croux (2017).
21
22

23
24 After the crisis, clusters 1 and 2 do not make much sense separately, because in
25
26 both eastern Europe and the European countries **there were** noises of rescue or news
27
28 shocks from the crisis (in cluster 1, Spain, Italy, and Belgium, and in cluster 2 Portugal
29
30 and Ireland). Our results show that the unemployment rate (cluster 2) becomes important
31
32 after **the** crisis for the less developed European countries, which corroborates **the results**
33
34 of Boumparis *et al.* (2017). Moreover, the inflation rate, current account balance, and
35
36 belonging to **the** Eurozone become statistically significant. Reusens and Croux (2017)
37
38 conclude that after 2009 the financial balance and the effect of Eurozone membership are
39
40 determinants of the Eurozone countries' sovereign ratings.
41
42
43
44
45

46 47 **4.2. Fitch**

48 49 **4.2.1. Global Panel**

50
51 As for Moody's global panel, the signs obtained are the ones expected for all the variables
52
53 in the pre- and post-crisis periods, analyzing the table 9. In terms of statistical
54
55 significance, after the crisis, the rate of inflation and the current account are no longer
56
57 significant. This result is in line with Lane (2012), as mentioned above in the comment
58
59
60

1
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3 to Moody's global panel. It should be noted that belonging to the Eurozone does not lose
4 statistical significance, as it is the case with Moody's and Fitch, being in line with
5 Altdörfer *et al.* (2019) that find in the Eurozone sovereign debt crisis Fitch assigned
6 higher ratings to European countries compared to S&P and Moody's.
7
8
9

10
11
12 The degree of explanation decreases in the post-crisis period, but Fitch appears to
13 be the most moderate one, compared to Moody's, given that the standard error of R^2 is
14 lower. Regarding the stability between the pre- and post-crisis periods, for Fitch, it
15 appears that the model is stable. This result is consistent with the conclusions taken by
16 Altdörfer *et al.* (2019). These authors concluded that in the post-crisis period Fitch was
17 more favorable than its peers for European countries' sovereign debt ratings and should
18 be considered the most "European" rating agency.
19
20
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29

30 [Insert table 9 about here]

31 32 33 **4.2.2. Clustering**

34 The next table reveals the results for Fitch.
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36
37
38
39

40 [Insert table 10 about here]

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42
43
44 Fitch is the agency that has the most distinct groupings of countries before the
45 crisis. It joins Portugal, Italy, and Greece (PIG) in one cluster (cluster 3) and Spain and
46 Ireland (IS) in another (cluster 1). Spain and Ireland are in the cluster of rich European
47 countries.
48
49
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53
54 After the crisis, Fitch puts together Portugal, Italy, Ireland, and Spain (PIIS) in
55 cluster 1, because Greece no longer counts. In cluster 3 we have the rich European
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1
2
3 countries. Note that cluster 2 has non-euro countries such as Romania, Bulgaria, Croatia,
4
5 Iceland, and Hungary (Lithuania is the only one belonging to the Eurozone).
6

7
8 In the same way as for Moody's, the degree of explanation in clusters 1 and 2
9
10 decreases after the crisis. However, it increases for the rich countries, which means that
11
12 inflation, government effectiveness, reserves, and current account balance are crucial
13
14 variables after the crisis to keep the richest countries having a high rating. For countries
15
16 with financial problems after the crisis, GDP becomes important to their credit ratings;
17
18 this is consistent with the observations of Reusens and Croux (2017) and Bissoondoyal-
19
20 Bheenick (2005).
21
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26 4.3. S&P

27 4.3.1. Global Panel

28
29 The results for the global panel for S&P (table 11) are in line with those of Moody's set
30
31 out in section 4.1.1.
32
33

34
35 [Insert table 11 about here]
36
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38
39

40 4.3.2. Clustering

41
42 The next table reports the results for S&P.
43
44
45

46
47 [Insert table 12 about here]
48
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51
52 Similarly to the observations made for the case of Fitch, before the crisis S&P
53
54 places Portugal, Italy, and Greece in cluster 2, with this cluster containing the less
55
56 developed European countries. Moreover, as highlighted for the Moody's case, after the
57
58 crisis, clusters 1 and 2 do not make much sense separately, because it seems that both
59
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1
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3 eastern European and European countries have noises of rescue or news shocks from the
4
5 crisis (in cluster 1, Spain, Ireland, and Belgium and in cluster 2 Portugal and Italy). Thus,
6
7 the unemployment rate and belonging to the Eurozone continue to be important to the
8
9 credit rating of these countries, as Boumparis *et al.* (2017) found.
10
11

12 The degree of explanation increases for the rich countries, which means inflation
13
14 is a crucial variable after the crisis to keep the richest countries having a high rating.
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19 **4.4. General comments**

20
21 Analyzing the results for the global panel we conclude that the degree of explanation
22
23 decreases after the crisis, so after the market crash the rating agencies used other variables
24
25 to explain their ratings. When the analysis of determinants is divided by clusters, we find
26
27 that the explanatory variables vary from cluster to cluster, and, for this reason, our results
28
29 show that rating agencies group countries into clusters with similar ratings, assigning
30
31 essentially the same ratings to similar countries, as noted by Fuchs and Gehring (2017).
32
33 Indeed, we find that for rich countries, the inflation rate is the most important variable in
34
35 the sovereign rating, and for developing European countries the unemployment rate and
36
37 belonging to the Eurozone become important after the crisis. We verify the regional bias
38
39 through our clusters that aggregate economically similar countries (rich vs. poor
40
41 countries).
42
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49 **5. Conclusion**

50
51 This paper aimed to study the determinants of sovereign debt ratings from the three top
52
53 rating agencies in 32 European countries. It verified whether there was any change in the
54
55 determinants before and after the global financial crisis, and if credit rating agencies had
56
57 a regional bias. The analysis focused on the periods 2001 to 2008 and 2009 to 2016.
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59
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3 For the global panel, comprising all countries, we concluded that the signs for all
4 the variables were as expected. The degree of explanation decreased in the post-crisis
5 period and the inflation variable became less important after the crisis in this model.
6
7

8
9
10 However, with the clustering methodology, we observed that for the rich countries
11 the inflation rate was the most important variable for setting the credit rating, and the
12 degree of explanation increased after the crisis. For developing European countries, the
13 unemployment rate and belonging to the Eurozone became important after the crisis. Our
14 results show that rating agencies group countries together and assign equivalent ratings
15 to similar countries, as noted by Fuchs and Gehring (2017). These results are important
16 to investors, as, when using ratings in their analysis, they need to note the factors that
17 could cause rating downgrades or increases in the clusters of countries.
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28 In summary, we conclude that the rating agencies have a crucial role in the global
29 financial markets, especially in banking and securities, given the use of their ratings by
30 investors, issuers, borrowers, and states. The ratings are used in decision-making and can
31 lead to herd behavior. The methods of setting the ratings are not known and, for this
32 reason, we cannot reach a conclusion on how rigorous they are, which is the main
33 limitation of the paper. However, our results highlight new knowledge about the variables
34 and the country clusters used by these agencies, and, consequently, the regional bias.
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44 In future studies, it would be interesting to analyze the implications of the outlooks
45 of sovereign ratings in the market, to test the use of dynamic models, to consider the
46 importance, and the form of regulation in this sector as well as the existence of cartels in
47 the context of competition law, to study the impacts of the creation of a European rating
48 agency, and, in an ambitious logic, to create a rating index that could assemble all the
49 existing ratings of the companies in a country.
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Tables

Table 1: Clusters to Moody's

Panel A: Before the crisis (2001-2008)	Panel B: After the crisis (2009-2016)
Cluster 1	Cluster 1
Czech Republic	Belgium
Estonia	Czech Republic
Greece	Estonia
Hungary	Italy
Italy	Malta
Latvia	Poland
Lithuania	Slovakia
Malta	Slovenia
Poland	Spain
Portugal	Cluster 2
Slovakia	Bulgaria
Slovenia	Croatia
Cluster 2	Hungary
Austria	Iceland
Belgium	Ireland
Denmark	Latvia
Finland	Lithuania
France	Portugal
Germany	Romania
Iceland	Russia
Ireland	Cluster 3
Luxembourg	Austria
Netherlands	Denmark
Norway	Finland
Spain	France
Sweden	Germany
Switzerland	Luxembourg
United Kingdom	Netherlands
Cluster 3	Norway
Bulgaria	Sweden
Croatia	Switzerland
Romania	United Kingdom
Russia	Cluster 4
Ukraine	Greece
	Ukraine

Table 2: Clusters to Fitch

Panel A: Before the crisis (2001-2008)	Panel B: After the crisis (2009-2016)
Cluster 1	Cluster 1
Austria	Czech Republic
Denmark	Estonia
Finland	Ireland
France	Italy
Germany	Malta
Ireland	Poland
Luxembourg	Portugal
Netherlands	Slovakia
Norway	Slovenia
Spain	Spain
Sweden	Cluster 2
Switzerland	Bulgaria
United Kingdom	Croatia
Cluster 2	Hungary
Bulgaria	Iceland
Croatia	Latvia
Czech Republic	Lithuania
Hungary	Romania
Latvia	Russia
Lithuania	Cluster 3
Poland	Austria
Romania	Belgium
Russia	Denmark
Slovakia	Finland
Ukraine	France
Cluster 3	Germany
Greece	Luxembourg
Belgium	Netherlands
Estonia	Norway
Iceland	Sweden
Italy	Switzerland
Malta	United Kingdom
Portugal	Cluster 4
Slovenia	Greece
	Ukraine

Table 3: Clusters to S&P

Panel A: Before the crisis (2001-2008)	Panel B: After the crisis (2009-2016)
Cluster 1	Cluster 1
Austria	Belgium
Belgium	Czech Republic
Denmark	Estonia
Finland	Ireland
France	Malta
Germany	Poland
Ireland	Slovenia
Luxembourg	Spain
Netherlands	Slovakia
Norway	Cluster 2
Spain	Bulgaria
Sweden	Croatia
Switzerland	Hungary
United Kingdom	Iceland
Cluster 2	Italy
Czech Republic	Latvia
Estonia	Lithuania
Greece	Portugal
Hungary	Romania
Iceland	Russia
Italy	Cluster 3
Latvia	Austria
Lithuania	Denmark
Malta	Finland
Poland	France
Portugal	Germany
Slovakia	Luxembourg
Slovenia	Netherlands
Cluster 3	Norway
Bulgaria	Sweden
Croatia	Switzerland
Romania	United Kingdom
Russia	Cluster 4
Ukraine	Greece
	Ukraine

Table 4: Ratings means for each cluster

	2001-2008			2009-2016			
	Cluster 1	Cluster 2	Cluster 3	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Moody's	12.66	16.84	6.4	12.08	8.66	16.85	2.5
Fitch	16.92	8.8	12.34	11.71	8.35	16.69	7.12
S&P	16.86	11.82	6.9	12.48	8.33	16.76	2.93

Notes: The values shown in the table represent the average ratings after applying the linear transformation from 1 to 17 explained in Annex A1 (the AAA/Aaa rating is equivalent to 17; and the CCC + / Caa1 rating is equivalent to 1).

Table 5: Explanatory variables, expected signs, source, and notes

Explanatory variables		Expected Signal	Source	Notes
Macroeconomic variables				
GDP per capita	GDP	+	World Bank (WB) - Economic Policy & Public Debt	USD, 2005 constant prices
Unemployment	UNEM	-	World Bank - Labor & Social Protectio	% workforce
Inflation	CPI	+/-	World Bank - Economic Policy & Public Debt	Calculated by Laspeyres formulas (Vide Armknecht e Silver (2012)).
Government variables				
Government effectiveness	EFFEC	+	World Bank Governance	-2,5 (bad government effectiveness) to 2,5 (strong government effectiveness).
External variables				
Reserves	RESER	+	International Monetary Fund - World Economic Outlook	USD, constant prices, log
Current account balance	CURREN	+/-	International Monetary Fund - World Economic Outlook	-----
Other variables				
European Union	EU	-/+	-----	Dummy variable: 1 if country belongs to the European Union; 0 if not
Euro Zone	EZ	-/+	-----	Dummy variable: 1 if country belongs to the Euro Zone; 0 if not

Table 6: Descriptive statistics

Variable	Global Panel					2001-2008					2009-2016				
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
RATMO	512	12.850	4.294	1	17	256	13.645	3.919	1	17	256	12.055	4.508	1	17
RATFI	512	12.723	4.183	1	17	256	12.988	4.296	1	17	256	12.457	4.057	1	17
RATSP	512	12.662	4.203	1	17	256	13.262	3.872	3	17	256	12.063	4.437	1	17
GDP	512	33 511	23 915	2 005	111 968	256	32 616	23 807	2 005	111 968	256	34 406	24 036	2 829	111 001
UNEM	512	8.437	4.300	1.805	27.466	256	7.612	3.733	1.805	19.921	256	9.261	4.665	3.103	27.466
CPI	512	3.091	4.188	-4.480	48.724	256	4.129	4.168	-1.146	34.468	256	2.053	3.952	-4.480	48.724
EFFEC	512	1.114	0.745	-0.808	2.359	256	1.137	0.789	-0.765	2.359	256	1.091	0.698	-0.808	2.260
RESER	512	4.95E+10	9.14E+10	1.27E+08	6.79E+11	256	3.03E+10	5.09E+10	1.27E+08	4.79E+11	256	6.87E+10	1.16E+11	2.07E+08	6.79E+11
CURREN	512	-0.055	6.467	-23.904	16.232	256	-1.347	7.490	-23.904	16.232	256	1.236	4.936	-12.345	14.854

Table 7: Ordered Probit results to Moody's

Dependent variable: Moody's rating	2001-2008	2009-2016
GDP	6.10E-05 ***	1.37E-05 **
UNEM	-0.043 *	-0.141 ***
CPI	-0.054 **	-0.006
EFFEC	2.427 ***	1.428 ***
CURREN	-0.009	0.031 *
EU	0.569 **	0.788 ***
EZ	0.605 **	0.332 *
RESER	0.388 ***	0.281 ***
McFadden R²	0.514	0.288
Chow Test (p-value)	4,9281e-005	

Notes: *: p-value <0.10; **: p-value <0.05; ***: p-value <0.01; Instability (Chow test) between the two periods is detected if the p-value is less than 0.05.

Check Table 5 for description of variables.

Table 8: Ordered Probit results to Moody's

Dependent variable: Moody's rating	Panel A: Before the crisis, 2001-2008			Panel B: After the crisis, 2009-2016		
	Cluster 1	Cluster 2	Cluster 3	Cluster 1	Cluster 2	Cluster 3
GDP	9.63E-05 ***	6.16E-05	0.000557 ***	1.94E-04 ***	-3.38E-06	-4.28E-07
UNEM	-0.055	-0.052	-0.147	-0.006	-0.134 ***	0.036
CPI	-0.021	-0.510 ***	-0.080 **	-0.245 **	-0.032	1.624 **
EFFEC	1.980 ***	-0.276	-0.632	-0.314	-0.875 *	11.124
CURREN	0.360 ***	0.308		-0.472 ***	0.004	0.832
EU	-0.022	-0.099	0.031		-0.367	
EZ	0.481	-1.441	1.323	-3.040 ***	0.507	-0.553
RESER	0.268	-0.030		-0.763 ***	-0.490 ***	0.803
McFadden R²	0.293	0.230	0.357	0.243	0.065	0.650

Notes: *: p-value <0.10; **: p-value <0.05; ***: p-value <0.01.
Check Table 5 for description of variables.

Table 9: Ordered Probit results to Fitch

Dependent variable: Fitch rating	2001-2008	2009-2016
GDP	2.66E-05 ***	3.19E-05 ***
UNEM	-0.060 **	-0.074 ***
CPI	-0.036 *	-0.029
EFFEC	1.552 ***	1.131 ***
CURREN	0.026 *	0.018
EU	0.310	0.981 ***
EZ	0.594 ***	0.687 ***
RESER	0.312 ***	0.248 ***
McFadden R²	0.344	0.299
Chow Test (p-value)	0.257	

Notes: *: p-value <0.10; **: p-value <0.05; ***: p-value <0.01; Instability (Chow test) between the two periods is detected if the p-value is less than 0.05.

Check Table 5 for description of variables.

Table 10: Ordered Probit results to Fitch

Dependent variable: Fitch rating	Panel A: Before the crisis, 2001-2008			Panel B: After the crisis, 2009-2016		
	Cluster 1	Cluster 2	Cluster 3	Cluster 1	Cluster 2	Cluster 3
GDP	6.23E-05	-7.04E-05	-5.38E-05 **	2.90E-05 *	-0.00013 ***	4.05E-05
UNEM	0.064	-0.088 **	-0.262 ***	-0.039	-0.298 ***	0.124
CPI	-0.458 *	-0.071 ***	-0.206 **	-0.106	0.107 *	0.355 *
EFFEC	-3.132 **	3.730 ***	1.963 ***	-1.819 **	1.694 **	5.607 ***
CURREN	-0.038	-0.003	0.063 *	-0.178 ***	0.088 **	0.487 *
EU	-2.706	0.910 **	0.698 *		-0.653	-14.261
EZ		1.876 ***	0.411	-0.728	0.797	-1.422
RESER	-0.174	0.746 ***	0.666 ***	-0.388 ***	-0.493 *	0.729 *
McFadden R²	0.204	0.383	0.242	0.108	0.180	0.457

Notes: *: p-value <0.10; **: p-value <0.05; ***: p-value <0.01.
Check Table 5 for description of variables.

Table 11: Ordered Probit results to S&P

Dependent variable: SP rating	2001-2008	2009-2016
GDP	5.89E-05 ***	1.87E-05 ***
UNEM	-0.074 ***	-0.144 ***
CPI	-0.126 ***	0.003
EFFEC	2.016 ***	1.682 ***
CURREN	-0.009	0.030 *
EU	0.957 ***	0.921 ***
EZ	1.177 ***	0.338 *
RESER	0.319 ***	0.236 ***
McFadden R²	0.515	0.314
Chow Test (p-value)	0.0002	

Notes: *: p-value <0.10; **: p-value <0.05; ***: p-value <0.01; Instability (Chow test) between the two periods is detected if the p-value is less than 0.05.

Check Table 5 for description of variables.

Table 12: Ordered Probit results to S&P

Dependent variable: S&P rating	Panel A: Before the crisis, 2001-2008			Panel B: After the crisis, 2009-2016		
	Cluster 1	Cluster 2	Cluster 3	Cluster 1	Cluster 2	Cluster 3
GDP	2.08E-04 ***	-5.48E-06	-1.81E-04	-2.29E-06	1.41E-05	5.66E-05 *
UNEM	-0.014	-0.138 ***	-0.026	-0.154 ***	-0.126 ***	-0.117
CPI	-0.439 *	-0.170 ***	-0.124 **	-0.021	-0.009	0.366 *
EFFEC	-0.357	1.658 ***	7.081 ***	0.956	-0.599	2.848 **
CURREN	-0.253 **	0.111 ***	-0.128 ***	-0.136 ***	-0.052	0.045
EU		1.430 ***	-0.580		-0.045	-3.069
EZ		1.916 ***		1.437 ***	1.074 ***	-0.845
RESER	0.730 **	-0.059	2.433 ***	0.206 *	-0.215	0.424
McFadden R²	0.361	0.339	0.508	0.122	0.089	0.392

Notes: *: p-value <0.10; **: p-value <0.05; ***: p-value <0.01.
Check Table 5 for description of variables.

Appendix A

Table A.1: Literature, explanatory variables, ratings agencies and methodology

Reference	Data	Explanatory variables	Most relevant variables	Rating agencies	Methodology
Cantor e Packer (1996)	Cross-section 1995 45 countries	GDP per capita, GDP growth, Inflation, External debt, Fiscal Balance, External Balance, Economic development, Default history	GDP per capita, GDP growth, Inflation, External debt, Economic development, Default history	Standard & Poor's Moody's	Linear transformation OLS
Monfort e Mulder (2000)	Panel 20 emerging economies 1995-1999	Debt, Reserves, Current account, Real exchange rate, Exports, the ratio between exports price and imports price, Inflation rate, Credit, GDP growth, Fiscal Balance, Savings, Investment, GDP per capita, the ratio between debt and exports, default history (only in static), Export growth rate, Spread, Asiatic country dummy, Latin-American country dummy, Treasury bills	The ratio between debt and exports, default history (only in static), Export growth rate, Inflation rate, GDP growth	Standard & Poor's Moody's Institutional Investors	Pooled OLS, Fixed effects First Differences
(Eliasson, 2002)	Panel 1990-1999 38 emerging economies	GDP per capita, GDP growth, Inflation, External debt, Fiscal Balance, Ratio between external debt and GDP, Export growth rate, interest rate spread	Fixed effects: External debt, Fiscal Balance, GDP growth, Inflation	Standard & Poor's	Linear transformation OLS, Fixed effects, random effects Static Model Dynamic Model
(Afonso, 2003)	Cross-section 2001 81 countries	GDP per capita, External debt, Economic development level, Default history, Inflation, Real growth rate, Fiscal Balance as GDP percentage	GDP per capita, External debt, Economic development level, Default history, Inflation and Real growth rate	Standard & Poor's Moody's	Linear, logistic and exponential transformation OLS
(Alexe et al., 2003)	Cross-section 1998 68 countries	GDP per capita, Inflation, Balance of trade, Export growth rate, External reserves, Fiscal balance, Public debt, Exchange rate, ratio between government debt and GDP, Government effectiveness, Corruption, Political stability	Political stability, ratio between the national debt and GDP, GDP per capita, Government effectiveness.	Standard & Poor's	Linear Transformation OLS
Canuto, Dos santos, e De Sá Porto (2004)	Cross-section and Panel Average between 1998 and 2002 66 countries	Inflation, GDP per capita, Real GDP growth, Nominal result of Central Government, Gross Government Debt, Degree of openness, Total net external debt, Economic development dummy, Default history dummy	GDP per capita, Total net external debt, Gross Government Debt	Standard & Poor's Moody's Fitch	Pooled OLS, Fixed effects First differences
(Bissoondoyal -Bheenick, 2005)	Panel 1995 - 1999 95 countries	GDP per capita, Inflation, Ratio between Financial balance and GDP, Ratio between Government debt and GDP, Real exchange rate, External reserves, Ratio between net exports and GDP, Unemployment rate, Unit labour cost, Ratio between current account and GDP, Ratio between external debt and GDP.	GDP per capita, Inflation	Standard & Poor's Moody's	Ordered probit using scales 1-21 e 1-9
Butler e Fauver (2006)	Cross-section 2004 86 countries	GDP per capita, Legal environment index, Inflation, Subdevelopment index, Default history dummy, Emerging economy dummy, Ratio between external debt and GDP, Common law dummy, 10 bond yield	GDP per capita, Legal environment index, Inflation, Subdevelopment index, Default history dummy	Institutional Investor ¹	OLS
Afonso, Gomes, e Rother (2007)	Panel 1970-2005 98 countries to Fitch and Moody's; 110 countries to S&P	GDP per capita, Unemployment rate, Inflation, Real GDP growth, Government debt, Fiscal Balance, Government effectiveness, External Debt, External reserves, current account, Default history, European Union dummy, Regional dummies	GDP per capita, Unemployment rate, Government effectiveness, External Debt, Real GDP growth, Government debt, External reserves, Default history	Standard & Poor's Moody's Fitch	OLS, Fixed effects, random effects Ordered probit.

Table A.1: Literature, explanatory variables, ratings agencies and methodology (cont.)

¹Numeric rating ranging between zero and 100

Hill, Brooks, e Faff (2010)	Panel 1990-2006 129 countries	GDP per capita, Real GDP growth, Inflation, Current account, Fiscal Balance, External Debt, Default history, Institutional Investor rating, Market risk premium.	GDP per capita, Real GDP growth, Default history, Institutional Investor rating, Market risk premium.	Standard & Poor's Moody's Fitch	Ordered Probit Hazard Model
Afonso, Gomes, e Rother (2011)	Panel 1995-2005 66 countries to Moody's, 65 countries to S&P 58 countries to Fitch	GDP per capita, GDP growth, Unemployment rate, Inflation, Public debt, Fiscal balance, Government effectiveness, External debt, External reserves, Current account, Default history, European Union dummy, Regional dummies.	Short-term impact: GDP per capita, Real GDP growth, Public debt and the Current Account deficit. Long-term impact: Government effectiveness, External debt, International reserves and default history.	Standard & Poor's Moody's Fitch	OLS, Fixed effects, random effects <i>Ordered probit.</i>
Boumparis et al. (2017)	Panel 2002-2015 Eurozone countries	GDP per capita, Government debt, Current account, Unemployment rate, Inflation, Regulatory quality	Low rated countries: Regulatory quality and competitiveness High rated countries: GDP per capita	Standard & Poor's Moody's Fitch	Quantile regression
Reusens & Croux (2017)	Panel 2002-2015 90: Advanced and emerging countries	GDP per capita, GDP growth, Government debt, Eurozone membership, Financial balance, Economic development, External debt, Current account, Inflation, Default history.	After crisis: financial balance, economic development, external debt, GDP growth.	Standard & Poor's Moody's Fitch	The multi-year ordered probit regression model Consider

Table A.2: S&P, Moody's and Fitch Ratings Systems and linear transformations

Classification	Ratings			Linear Transformation
	Fitch	S&P's	Moody's	
Highest quality	AAA	AAA	Aaa	17
High quality	AA+	AA+	Aa1	16
	AA	AA	Aa2	15
	AA-	AA-	Aa3	14
Strong payment capacity	A+	A+	A1	13
	A	A	A2	12
	A-	A-	A3	11
Adequate payment capacity	BBB+	BBB+	Baa1	10
	BBB	BBB	Baa2	9
	BBB-	BBB-	Baa2	8
Likely to fulfill obligations, ongoing uncertainty	BB+	BB+	Ba1	7
	BB	BB	Ba2	6
	BB-	BB-	Ba3	5
High credit risk	B+	B+	B1	4
	B	B	B2	3
	B-	B-	B3	2
Very high credit risk	CCC+	CCC+	Caa1	1
	CCC	CCC	Caa2	
	CCC-	CCC-	Caa3	
Non default with possibility of recovery	CC	CC	Ca	
	C			
Default	DDD	SD	C	
	DD	D		
	D			

Source: Afonso et al. (2007); Boumparis, Milas and Panagiotidis (2019)