

# Influence of World Governance Indicators on the determination of Sovereign Ratings in Latin American countries

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*Abstract:* - The credit risk of governments worldwide has been evaluated by expert international agencies that disclose their ratings. However, the weightings of the variables that determine these ratings are still not as transparent as they should be. This study has the purpose of assessing the influence of worldwide governance indicator measures on the determination of long-term sovereign credit ratings in Latin American countries, using ordinal regression as the analytical tool. The results of this study show that the government effectiveness and regulation quality are two of the factors that can influence the perception of sovereign risk. The contributions of this study include the expansion of knowledge on this subject and the search for empirical evidence regarding the determination of ratings. Information regarding the effects of governance indicators on the determination of sovereign risk can be useful for researchers, governments, and agents of the financial market, aiding them in decision making and risk management.

*Key-words:* - Economy; Finance; Sovereign risk; Ratings; Indicators.

## 1 Introduction

Governments issue annuity certificates as a way to raise funds and finance their budgets. Given that these annuities are currently the main form of public debt financing, it is essential to reduce their cost, which is measured by the country's interest rates. In order to attain this goal, governments try to convey a low risk position to the market. At the same time, investors and creditors seek information about the governments that issue these annuities in order to build their investment portfolios with the lowest possible risk. This dynamic produces demand for information about the risk of these annuities/bonds.

According to [1-3], to address the costs and asymmetry of information, economic entities seek to obtain information about governments using risk classification categories produced by specialized international agencies. These agencies analyze countries' economic status, as well as the legal and political factors influencing the management and probability of non-compliance with obligations, and state their opinions about the risk of default. The risk of default in this context is also widely known as sovereign risk [4-6].

Historically, the profile of public debt in several countries has undergone changes, evolving from a narrow basis of creditors to a wider basis, provoking an increase in the number of investors and creditors. Consequently, the demand for risk information provided by international agencies has also increased. After study and assessment, the agencies publicly disclose their opinions on the sovereign risk through risk classification categories, or sovereign ratings. These ratings are widely used by economic entities; however, the evaluation and classification process used by these international agencies is somewhat subjective and lacks transparency [1,3,7-11].

According to [3], sovereign ratings' influence on countries' financing cost and the low transparency of the specialized agencies are aspects that have sparked the interest of researchers in analyzing the determinants of sovereign risk [12,13]. Research has been carried out to investigate the risk agencies' ability to foresee financial crisis, as well as the factors that influence the construction of ratings. [1] Showed that the countries with the highest ratings, meaning those with the lowest risk, obtained financing with better conditions than the countries at more risk. [2] analyzed the agencies' assessment methods and the influence of ratings on the risk

premium of market titles. [3] Mentioned the lack of explicit disclosure of the variables used to determine sovereign ratings, as well as the weighting structure of these variables.

In this context, the goal of this work is to measure the influence of worldwide governance indicator measures on the determination of the long-term sovereign credit ratings of Latin American countries. To grasp the influence of both governance and non-governance aspects, and measure their influence on the determination of sovereign ratings, we hereby suggest the use of worldwide governance indicators created through an initiative of the World Bank. These worldwide governance indicators have been studied, tested, and criticized during recent years by several researchers [14-18]. This study intends to investigate the influence of these indicators, given their importance for governments and economic entities as an instrument to measure and determine sovereign risk. The contributions of this study include: (i) expansion of the base of knowledge regarding this subject, providing a basis for new research, both theoretical and empirical; (ii) use of statistical models to measure the influence of political aspects in rating determination; and (iii) providing a basis from which to deepen the discussion of the use of political and public governance indicators as a way of measuring countries' governance and performance.

This study is organized into the following sections: First, the main terms, concepts, and definitions that will frame the theoretical arguments are presented. This is followed by presentation of the worldwide governance indicators and their analysis dimensions. Next, the data collected to investigate the determination of sovereign ratings and the influence of worldwide governance indicators are analyzed. This analysis will involve the use of ordinal logistic regression techniques. Finally, the final considerations, limitations of this study, and recommendations are offered.

## 2 Empirical Theoretical

In order to achieve a theoretical reflection of a subject, it is important to define or delimit the terms and concepts, and to present some terms commonly accepted by researchers the international financial market.

### 2.1 Sovereign risk

Sovereign risk is the credit risk associated with the credit operations conceded to countries, meaning to sovereign states [2]. This concept is different from that of country risk, which has a completely different meaning. Country risk is related to all the financial assets of the country, meaning it is related to the default risk of all creditors of the country. Sovereign risk, the subject of this article, is a specific type of credit risk, related to the government's ability to meet its commitment to paying its debt within the agreed terms and dates. [1] Sets sovereign risk as the assessment of the probability of a government not meeting its obligations. This definition is widely cited in literature and is used in this article.

### 2.2 Risk classification agencies

Risk classification agencies are private international companies committed to providing information that aids in investment decision making. This information is provided in the form of credit ratings, indexes, research, assessment, and solutions for risk management. Currently, the main international agencies are Standard & Poor's, Moody's, and Fitch Ratings [19, 20].

For sovereign risk, the economic function of these risk classification agencies is to provide guidance for investors and creditors about the credibility of a country, addressing the lack of information or the difficulty in obtaining it [13, 21-22]. These agencies collect and process information, but do not interfere with contracts and negotiations. [23] Showed that during the 1980s, the information provided by the risk classification agencies was relevant for the international financial market. The number of assessed companies grew substantially, from an average of 10 countries in 1980 to more than 100 countries in 1999. Currently, some agencies evaluate approximately 140 countries.

[3] Mentioned some criticisms and some possible problems related to risk classification agencies, among them the high concentration of the market in only three agencies, the relative independence of the agencies, and the lack of transparency regarding aspects of the evaluation process. Despite these criticisms, the research, assessment, and disclosure of agency information is becoming fundamental for the international financial market. The cost to evaluate sovereign risk and the difficulty of obtaining information are both high, and therefore the agencies supply the information demand. The disclosure of risk reports and classification on the agencies' allows investors

to carry out several analyses, and it widens the potential basis of government creditors.

Despite criticism, the ratings disclosed by classification agencies have some level of reliability. [2] Performed a temporal analysis on the history of default in comparison with the reports disclosed by the agencies, and they observed that the countries with the highest ratings had a lower frequency of default than did countries with lower rating scores. This analysis shows that the ratings disclosed by the agencies have a level of importance for the worldwide economy.

### 2.3 Structure and process of risk classification of the agencies

The classifications of sovereign risk refer to the ability and disposition of the government to honor its debts to creditors. The risk classification agencies evaluate this ability and governments' disposition of payment and synthesize the results of this evaluation in risk classifications. These classifications of risk are estimates of the probability that a government will suspend interest and principal payments or restructure its debt without the agreement or consent of the creditors [2].

The nomenclature used by the agencies is formed by scales using the letters A, B, C, and D. The higher ratings start at the letter A, and get lower until they reach the letter D. In the Standard & Poor's and Fitch Ratings scales, the highest classification is indicated by the letters "AAA," and the worst classification is indicated by the letter "D." Moody's uses a variation of this scale, with the highest classification indicated by the letters "AAA" and the lowest classification indicated by the letter "C." The better the classification, the lower is the possibility of the country imposing a repayment moratorium, and the worse the classification, the greater is the possibility of *moratorium*. Symbols ("+" and "-") and numbers are also used to distinguish categories. Table 1 shows the classifications of the main international agencies.

The agencies also define a point above which the country is defined as being "investment grade." That indication takes into account the country's creditworthiness; therefore, investment grade countries have a lower risk of insolvency. Countries classified below that point are considered "speculative grade," and have a greater risk of insolvency.

**Table 1: Sovereign ratings of the main agencies**

	<i>S &amp; P</i>	<i>Fitch</i>	<i>Moody's</i>
Investment Grade	AAA	AAA	Aaa
	AA+	AA+	Aa1
	AA	AA	Aa2
	AA-	AA-	Aa3
	A+	A+	A1
	A	A	A2
	A-	A-	A3
	BBB+	BBB+	Baa1
	BBB	BBB	Baa2
	BBB-	BBB-	Baa3
Speculative Grade	BB+	BB+	Ba1
	BB	BB	Ba2
	BB-	BB-	Ba3
	B+	B+	B1
	B	B	B2
	B-	B-	B3
	CCC+	CCC+	Caa1
	CCC	CCC	Caa2
	CCC-	CCC-	Caa3
	CC	CC	--
	C	C	--
	SD	DDD	Ca
	D	DD	C
	--	D	--

Source: [3]

#### 2.3.1 Aspects considered in the evaluation of sovereign risk

In addition to economic conditions, government decisions are subject to social and political aspects that can exert influence on a government's willingness and ability to honor its commitments. According to documents and reports published on the websites of the agencies that classify risk, economic, political, and social factors are considered in the process of risk assessment of sovereign countries. Each agency uses a set of factors it considers relevant, constituting a significant group of aspects analyzed. [2] Presented a summary of the main factors considered by three major international agencies, listing five categories of risk observed by these agencies:

- i. Political, civic, and institutional risk: aspects of the capacity of public institutions to ensure the fulfillment of contracts and aspects that may cause political instability, social discontent, conflicts, wars, and other problems.
- ii. Real sector and economic structure: level of economic growth, savings, and investment; educational level of the population; infrastructure; and availability of natural resources.
- iii. Fiscal sector: the government's fiscal

policy and the public debt profile.

iv. Monetary and financial sector: sustainability of monetary and exchange policies, development of the capital market, level of inflation, level of credit, and so on.

v. External sector: balance of payments, profile of foreign debt, flow of capital, and openness of the economy.

According to [2], agencies' process of assessing and rating risk involves three steps: (i) assessment of the situation; (ii) quantification of the factors, assessed by a scoring system; (iii) classification decision by committee vote, based on the analysis of information gathered. The committee's activities are the main part of the process, where each information item raised is discussed and evaluated openly by members. According to a survey conducted by the International Monetary Fund (IMF) in 1999, the ratings do not result from statistical models but rather from analyses that combine quantitative and qualitative research methods, considering the view of analysts [2, 24]

## 2.4 Worldwide Governance Indicators (WGI)

The Worldwide Governance Indicators (WGI) project is a World Bank project that proposes to provide information, on an individual or aggregated basis, about the quality of governance of approximately 215 world economies. This project has six dimensions of governance: "voice and transparency," "political stability," "effectiveness of government," "regulatory quality," "control of corruption," and "force of law." The indicators produced by this project are formed through a combination of many data sources, including companies, citizens, specialized analysts, research institutes, non-governmental organizations, and international bodies [15, 25].

The WGI indicators were created and maintained by Daniel Kaufmann, Aart Kraay, and Massimo Mastruzzi, supported by the World Bank through its research group and its office. Their proposal is to produce useful information about the quality of countries' public governance, organizing and summarizing the large set of perceptions and visions of other governance indicators that exist around the world [26, 27]. The composition of these indicators involves the aggregation of several other existing indicators in order to capture the essence of the information in a reduced and objective manner.

For the creation of six aggregate indicators, the project adopts a definition of governance as the

traditions and institutions through which authority in a country is exercised. This definition includes the processes through which governments are selected, monitored, and replaced, including their constitutions, as mechanisms of governance. In addition, this definition includes the government's capacity to formulate and implement sound policies effectively, and the consequences of such acts, as well as the respect for the people shown by the state and the institutions that exercise authority, including in economic and social interactions.

According to [27], the six dimensions of governance evaluated by WGI and the perceptions that these dimensions try to capture translate into the indicators described below:

- i. Voice and transparency: captures perceptions about citizens' ability to exercise their rights in political processes, freedom of expression, freedom of association, and freedom of the media.
- ii. Political stability: captures perceptions about the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including violence or terrorism.
- iii. Effectiveness of government: captures perceptions about the quality of public services, the quality of services for citizens, and the level of independence with regard to political pressures on the government.
- iv. Regulatory quality: captures perceptions about the government's ability to formulate and implement public policies and regulations that permit and promote private sector development.
- v. Force of law: captures perceptions about the government's ability to comply with legal determinations and property rights, and the quality of the activities performed by the courts and the police.
- vi. Control of corruption: captures perceptions about how public power is exercised, with the objective of measuring whether the public machine is used to obtaining advantages for particular interests or elites.

The creators of the WGI project believe that these definitions provide a way to assess aspects of governance, providing empirical measures. The indicators are constructed through aggregation and combination of various other indicators from various sources. To this process is added a statistical procedure that uses the model of components not observed, which, although imperfect, is capable of producing a relatively

complete picture of the aspects of governance that are difficult to observe directly [27].

Although the global indicators of governance have achieved some popularity since their inception, some researchers argue that they have a level of semantic confusion because of the multiplicity of multidisciplinary approaches used in their construction [28-31].

For [31] the current global indicators of governance have two main problems. The first criticism is related to the indicators' object of study, that is, the quality of the bureaucracy, the stability and effectiveness of the government, the transparency of executive power, and the effectiveness of public policies. Many of the indicators of governance adopt a utilitarian approach, focusing mainly on an outside view of quality of governance instead of issues more related to democracy. This argument is based on the concept that a democratic vision represents a more internal vision, and is therefore intrinsically related to the public interests of the citizens. Based on the methodology for the construction of the global indicators of governance, this more internal vision would not be captured properly.

The second criticism is related to the use of quantitative data to produce aggregate indexes to measure governance. For [31], this approach has two problems: (i) the impracticality of comparing between countries and over time; and (ii) the impracticality of evaluating radical short-term changes, as it is more focused on long-term trends. These two problems are also addressed by [29] and [30], who take similar approaches.

Contributing to the studies on this theme, [31] sought to define the quality of a government based on actions being taken with transparency and based on the principles of the law, the impartiality in the execution of its program, and respecting the balance between the powers of the state and the preferences of the majority of citizens. This vision is useful for constructing a system of evaluation of the quality of governance, but it still lacks consensus among researchers and pragmatic mechanisms able to produce information that can be used by economic agents.

The WGI project can produce indicators that may be useful for economic agents and researchers in this field. Although these indicators are criticized by the academic community for their methodology and ability to measure the quality of governance, other indicators capable of producing useful and empirically testable information have not yet arisen.

### 3 Methodological Approach

Sovereign ratings are important for the global economy; however, the process through which specialized agencies determine the ratings lacks transparency and suffers criticism based on its degree of subjectivity [2,3,10,13]. Some researchers are investigating which variables are used by the risk classification agencies in the determination of sovereign risk classification, and whether they really relate to the ratings they report. These researchers are also looking to determine the risk agencies' ability to predict financial crisis, and creating models to analyze the explanatory and predictive power of the ratings. For instance, [32] conducted a study that examined the importance of political and economic variables in the determination of sovereign ratings and observed that economic variables are the main influences; however, they also observed that political events could increase the explanatory power of regressions. Therefore, the question that leads this investigation is: What is the effect of the world's governance indicators in the determination of sovereign risk classification?

The phenomenon being studied is the determination of sovereign risk ratings; this is explanatory research, as it aims to explain the determinant factors in the occurrence of the phenomenon. This research uses references published in specialized literature to gather knowledge about this theme, so it can also be characterized as documental, as it uses private and public access reports and statistics tables. As for the approach to the problem, it is quantitative research, since its objective is to measure, using statistical techniques, the effects of the governance indicators on the sovereign risk classifications. The analysis perspective is longitudinal, as it looks for cause and effect relationships between such indicators and sovereign ratings.

The variables used in this research aim to emphasize the political environment of the country and are characterized by international indicators related to government stability, social and economic conditions, existing conflicts, ethnic tensions, democratic responsibility, and bureaucracy quality, among other factors, as explained in section 2.4. The sample is formed by data available on the websites of international organizations. The data about sovereign ratings were obtained from the website of the international risk classification agency Standard & Poor's, which

is accessible after registering. The data about world governance indicators were obtained from the World Bank's WGI project website.

The dependent variable of sovereign rating was treated with an ordinal scale, as can be seen in Table 1. When the dependent variable is presented in ordinance categories, models of ordinal logistic regression can be used to analyze the data [33-35]. According to [35, 36], variables measured in ordinal (or categorical) scales are simple to interpret, but their statistical treatment can be complicated; therefore, it is still uncommon to use regression models with categorical variables in applied social studies. In this research, the data analysis is done with the support of the statistical technique of ordinal logistic regression, as such a technique allows measurement of the effects of a set of independent variables on one dependent variable of an ordinal nature. The adopted model is the proportional odds model. This model uses accumulated statistical probabilities for each independent variable; that is, the essential assumption is that the intercepts of the model (terms  $\beta$ ) differ for each of the categories, and  $\beta$  corresponds to the effects of the covariables in the response variable, regardless of the category. In other words, the categories of the dependent variable occur with the probabilities conditioned by the values of the independent variables [37]. This assumption is also called parallel regression, which leads to a test of validation of the requirements of the model used in this research, called a test of parallel lines. This test compares the proposed ordinal regression model with a set of coefficients of all categories (null hypothesis) with a general model that has a separated set of coefficients for each category. Therefore, if the general model presents an adjustment much better than the ordinal model ( $p$ -value  $< 0.05$ ) then the proportional odds assumption is rejected [38]. If this requirement is met, one can then analyze the proposed ordinal model and check which variables (coefficients) are meaningful and what effects they have on the dependent variable, as well as obtain more information about the explanatory power of the variables included in the model.

The data about ratings were collected from the report Sovereign Rating And Country T&C Assessment Histories, published by Standard & Poor's in August of 2013. This report contains short- and long-term sovereign ratings for a set of 127 countries, with dates starting in 1975; however there are not ratings for all of this period. Most of the data available in this report are concentrated in the period of 2000 and onward. The ratings of this

report are separated into national currency and foreign currency, and since the objective of this study is to evaluate sovereign risk from a global perspective, we use only the foreign currency data. The ratings in foreign currency are divided into two types: short term and long term. The long-term ratings best represent the political and economic foundations and are widely used in the papers quoted in previous sections; therefore, the data collected to compose the sample of this research are long-term sovereign ratings in foreign currency. Data from 10 Latin American countries were collected from the report. The selected countries were Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela. This country was chosen because they have more ratings events than others in the Latin American.

The independent variables "voice and transparency," "political stability," "effectiveness of government," "regulatory quality," "force of law," and "control of corruption" were collected from the database made available on the WGI project website [25]. These variables were constructed using one continuous scale represented by numbers in the interval -2.5 to 2.5, and one can assume any value in this interval, for example, 1.1496385 or 0.7650874. The closer to -2.5 the indicator is, the worse is the perception of the evaluated dimension, and the closer to 2.5, the better is the perception of the evaluated dimension. Table 2 shows how these independent variables are organized in this paper.

**Table 2:** Name, scale, and code of the covariables

<i>Variable</i>	<i>Scale</i>	<i>Code</i>
Voice and Transparency	-2.5 to 2.5	Voz_Transp
Political Stability	-2.5 to 2.5	Estab_Pol
Effectiveness of Government	-2.5 to 2.5	Efet_Gov
Regulatory Quality	-2.5 to 2.5	Qual_Regul
Force of Law	-2.5 to 2.5	Vigor_Lei
Control of Corruption	-2.5 to 2.5	Contr_Corrup

Source: [25]

As the WGI project has only been in existence for a few years, its database contains data about governance indicators starting from the year 1996. In the period between 1996 and 2002, the data are registered in two-year intervals. From 2002 to 2012, the data are registered in annual intervals.

The sample was formed with the data available in the WGI project database and in the Standard & Poor's *Sovereign Rating and Country T&C Assessment Histories* report, so it includes data for the 10 countries mentioned above for the period between 2002 and 2012. The countries that did not have complete data were excluded from the sample.

SPSS software version 19 was used for the modeling and application of the statistical tests. The ratings were inserted as a numeric variable with a scale between 1 and 23, as shown in Table 3. Based on the principle of parsimony, the scale chosen in this research indicates that lower the number, the lower the perception of risk, with a direct proportional relation between perception of risk and rating scale. The independent variables were configured in the SPSS software as continuous numeric variables with five decimal places.

**Table 3:** Codification of the ratings scale

Rating	Scale	Rating	Scale	Rating	Scale
AAA	1	BBB	9	CCC+	17
AA+	2	BBB-	10	CCC	18
AA	3	BB+	11	CCC-	19
AA-	4	BB	12	CC	20
A+	5	BB-	13	C	21
A	6	B+	14	SD	22
A-	7	B	15	D	23
BBB+	8	B-	16		

Source: [25]

The standard SPSS tests were performed to evaluate the model. As the independent variables are continuous, the goodness-of-fit tests of the model adjustment may present results that should be analyzed carefully. The Pearson and deviance goodness-of-fit tests of the model adjustment use a distribution chi-square that is very sensitive to empty cells in the tables generated by SPSS software during the data processing. When models with continuous independent variables are used, it is common to have empty cells during data processing, that is, combinations of categories of the dependent variable with the values of independent variables with zero frequencies. In these cases, the Pearson and deviance statistical tests should not be considered very rigorous, as they become not very reliable [38]. These characteristics can be overcome using the pseudo- $R^2$  tests. The pseudo- $R^2$  tests provided by SPSS software are enough to assume the model's goodness of fit, since these tests offer great enough approximation to confirm the model's explanation.

Finally, one of the assumptions of any regression model is the absence of multicollinearity between the independent variables, as such behavior will render unviable an adequate

explanation of the effects of the explanatory variables in the model. In this research, the explanatory variables have semantically related characteristics; for example, "regulatory quality" is related to "force of law," as countries are usually regulated through laws and other similar instruments. In the same way, it is implied that "control of corruption" is also related to "force of law," and that the "voice and transparency" of a nation is related to "political stability." Therefore, we believe that performing the multicollinearity tests on the set of variables chosen could remove some of them from the model, maybe many, in a way that would interfere with the viability of this study and the results. In this research, we choose to keep these variables in the application of the model of ordinal regression without performing multicollinearity diagnosis based on two arguments: one of parsimony and one of reference. The first argument is that although the variables are apparently correlated semantically, their construction by the WGI project involves the capture of a variety of perceptions about the quality of public governance in other to gather and sum up these perceptions in a few objective indicators; therefore, it is possible to accept that these indicators have intrinsically some ability to explain these perceptions clearly. The second argument is that in the specialized literature references consulted in this research, the authors did not present multicollinearity diagnoses, or did not deepen the discussion about that subject, and were still able to find meaningful results [35-37, 39, 40].

## 4 Results Presentation And Analysis

Table 4 shows the descriptive statistics of the variables analyzed in this research. The ratings available for the sample vary between categories 3 and 19, not occupying all 23 possible categories according to Table 3. The average rating is approximately 10, which corresponds to rating BBB-. This information conforms to the sample of 10 Latin American countries, whose ratings are close to this classification. The other six variables match the six dimensions captured by the WGI indicators and are independent variables (covariables) of the study. It is possible to verify the continuous quantitative nature of the six covariables based on the variation described on Table 2. It is also possible to observe that the average values are concentrated in negative values just below the 0 level, with the exception of the indicator Voz\_Transp.

**Table 4:** Descriptive Statistics of the variables

	<i>n</i>	<i>Min</i>	<i>Max</i>	<i>Average</i>	<i>Standard Deviation</i>
Rating	110	3	19	9.90	3.524
Voz_Transp	110	-0.96037	1.24415	0.1268208	0.56716275
Estab_Pol	110	-2.39011	1.00049	-0.5089828	0.79490216
Efet_Gov	110	-1.18907	1.26118	-0.2216145	0.65944125
Qual_Regul	110	-1.60809	0.50037	-0.3508280	0.57061775
Vigor_Lei	110	-1.68562	1.36682	-0.4640646	0.78966720
Contr_Corrupt	110	-1.44546	1.56187	-0.2082336	0.82112876

The total size of the sample is 110 elements: 10 countries for an interval of 11 years corresponding to the 2002 to 2012 period. The data that describe the years related to 2002 to 2012 were not used; therefore, this research did not consider the transversal cuts in the analysis, and this is a limitation of this research.

After the analysis of the descriptive statistics, the ordinal regression analysis procedures were executed in the SPSS software. There were no missing data because of the care taken during sample selection. The most common rating was B-, with 19.1% of the sample, followed by BB-, BB, and B; this information matches the countries' characteristics and the period analyzed. The less-common ratings were CCC- and AA-, with both represented 0.9% of the sample.

Before analyzing the effects of each explanatory variable (covariable) in the model, it is necessary to verify the adjustment. The adjustment of the model was tested using the *-2 log likelihood* (-2LL) statistic. This method compares the model with a basic one without any explanatory variables, also called *intercept only*. The test determines whether the proposed model produces better predictions of the results [35,36]. The results were -2LL of 446.117 and *p-value* < 0.000; therefore, the null hypothesis that the proposed model presents better results than the basic model is accepted.

The appropriateness of the adjustment of the ordinal regression model is usually checked using the Pearson chi-square or deviance tests for goodness of fit, but these tests cannot be trusted when there are many explanatory variables or when there are continuous explanatory variables [38]. As this research uses continuous covariables, the pseudo-R<sup>2</sup> tests are more suitable. The pseudo-R<sup>2</sup> test used was the statistical Nagelkerke an adapted version of the coefficient of determination (R<sup>2</sup>), which can be used in logistic regression approaching the total proportion of the variance in the data. The result found was a pseudo-R<sup>2</sup> of 0.569, indicating that the significant covariates model explains 56.9% of the variation of the long-term sovereign ratings for the sample countries.

Table 5 presents the results for the estimation of parameters (coefficients) of the model. The statistical Wald test was used to test whether the covariables produce significant contributions to predictions based on the model. The Wald test uses a chi-square distribution, and values of *p* < 0.05 are considered statistically significant; that is, covariables that meet this criterion should be selected for the model. The results were that the significant covariables in the model are Voz\_Transp, Efet\_Gov, and Qual\_Regul. The other three variables, Estab\_Pol, Vigor\_Lei, and Contr\_Corrupt are not significant at the 5% level and therefore should not be used in the proposed model.

**Table 5:** Estimated parameters

<i>Covariables</i>	<i>Estimate</i>	<i>Pattern Error</i>	<i>Wald</i>	<i>g.l.</i>	<i>p-value</i>	<i>95% Confidence Interval</i>	
						<i>Inf. Limit</i>	<i>Sup. Limit</i>
Voz_Transp	-5.897	1.522	15.005	1	0.000	-8.880	-2.913
Estab_Pol	0.588	0.603	0.952	1	0.329	-0.594	1.771
Efet_Gov	2.311	1.032	5.013	1	0.025	0.288	4.334
Qual_Regul	1.407	0.516	7.440	1	0.006	0.396	2.418
Vigor_Lei	1.749	0.935	3.497	1	0.061	-0.084	3.582
Contr_Corrupt	1.511	0.771	3.838	1	0.050	-0.001	3.023

Source: Research data

Before undertaking a deeper analysis of the model, it is necessary to verify the proportional odds assumptions, that is, the assumption that the model interceptors differ for each of the dependent variable categories and that the coefficients correspond to the independent variables' effects on the dependent variables, regardless of the category. This verification is done using the SPSS software test of parallel lines, where the null hypothesis assumes that the general model possesses better adjustment than the proposed model, as presented in section 3. Therefore, if the null hypothesis is rejected, the proposed model meets the proportional odds assumption. The result found for this test was a -2LL value of 381.076 and a *p-value* > 0.852; therefore, the null hypothesis that the general model possesses better adjustment is refused, confirming that the found ordinal model meets the proportional odds requirement. This means it is possible to proceed with the analysis using the proposed model.

Normally, in one regression, the coefficients are added to the interceptor to obtain a prediction of the result according to the equation  $y = a + bx$ . In the SPSS software, the regression ordinal model is parameterized with the equation  $y = a - bx$ ; however, this characteristic does not interfere with the results [38]. This regression equation used in the SPSS software indicates that when positive coefficients occur, the highest values for the

explanatory variable are associated with results with high values. In a similar way, when negative coefficients occur, the lowest values for the explanatory variable produce results with low values.

The results show that the ordinal regression logistic model indicates as meaningful the independent variables “voice and transparency,” “political stability,” and “regulatory quality.” To measure the effects of these variables on the dependent variable, long-term sovereign rating, the odds ratios must be calculated for the coefficients. To perform this calculation, the reverse of the logistic function used in the model has to be utilized, which can be done by calculating the exponent of the estimated coefficient. The calculated value indicates the probability of the variable switching categories. For example, the coefficient estimated for “voice and transparency,” according to Table 5, is -5.897. Calculating the exponent of -5.897 with the equation  $\exp(-5.897)$  obtains 0.002748, or approximately 0.003. This value of 0.003 means that a change of unity in the scale of the variable “voice and transparency” increases by 0.003 times the probability of switching category, that is, increasing the rating. Table 6 was built to simplify the coefficient interpretation with the calculation of the reverse of the logistic function to the meaningful coefficients. The column *Exponent* indicates the effect of each covariable (coefficient) on the ratings (interceptors). This effect is measured in terms of probability of switching category for each change of one unity in the scale of the coefficient. We can observe in table 6 that a change of one unity in the scale of “effectiveness of governers” increases by 10.085 times the chances of switching to a higher rating category, while a change in the scale of “regulatory quality” increases by 4.084 times the chances of switching to a higher category.

**Table 6:** Exponent calculations for the meaningful coefficients

<i>Coefficient</i>	<i>Estimate</i>	<i>Exponent</i>
Voz_Transp	-5.897	0.003
Efet_Gov	2.311	10.085
Qual_Regul	1.407	4.084

Source: Research data

It is also possible to analyze the data using the average and pattern deviation optic found for each coefficient. For example, the pattern deviation for “voice and transparency” presented in Table 1 is approximately 0.57. Taking the estimate and the

pattern deviation for this explanatory variable and extracting its exponent, we have  $\exp(-5.987 \times 0.57) = 0.04$ . This means that a country that obtains a score with 1 pattern deviation above the average for the indicator “voice and transparency” has 0.04 times more chance of switching to a higher category than a country that obtains the average score for this indicator. In a similar way, if one country obtains a score with 1 pattern deviation below the average for this indicator, it has 0.04 times less chance of obtaining a higher rating than a country that obtains the average score. In a similar way, Table 7 was built to show the calculations for the exponents related to the estimate and the pattern deviation of each meaningful coefficient in the model.

**Table 7:** Exponent calculations for the meaningful coefficients with pattern deviation

<i>Coefficients</i>	<i>Estimate</i>	<i>Pattern Deviation</i>	<i>Exponent (estim. x pattern deviation)</i>
Voz_Transp	-5.897	0.003	0.04
Efet_Gov	2.311	10.085	4.59
Qual_Regul	1.407	4.084	2.23

Source: Research data

It is observed in Table 7 that the variables “effectiveness of the government” and “regulatory quality” have, respectively, 4.59 and 2.23 times more chance of producing a switch in the rating category of a country if the score is 1 pattern deviation higher or lower. In terms of the influence of the covariables on the response variable, these data show a more meaningful association between ratings and the “effectiveness of the government” and “regulatory quality” indicators, and a less meaningful association between “voice and transparency” and the ratings.

The prediction based on the ordinal regression model is made with the calculation for each interceptor, with which the probabilities of switching category are calculated. The categories are called thresholds, and the probabilities of switching category are calculated based on the exponents of the estimated coefficients. As there are different categories (thresholds), there are different interceptors, one for each category, according to the mathematical proportional odds. The values of the *interceptors* found in this research may be observed in the *Estimate* column of table 8. For example, the interceptor for category 3 of the sample, corresponding to rating AA, has the value of -8.011. For the category 4 rating (AA-), the value of the interceptor is -7.695, and so on. These interceptors correspond to the threshold of the ordinal regression model, and the interpretation

considers the switching threshold probabilities according to the coefficient. Therefore, the accumulated probabilities for each coefficient are used, and the interceptors differ for each of the categories. As the accumulated probabilities are used for each coefficient, the categories of the dependent variable occur with probabilities conditioned to the values of coefficients [33,39,40]. Obviously, the coefficients correspond to the effects of the independent variables on the response variable, long-term sovereign rating.

In the same Table 8, along with the interceptors (thresholds), the explanatory variables are shown for the *coefficients*. The meaningful coefficients are featured in bold. The prediction of results, or estimate based on the model, may be done for each category using the interceptors and the estimated coefficients in Table 8, always using the exponent of the estimated parameters.

**Table 8:** Estimated parameters

	Estimate	Pattern Error	Weid	g.l.	p-value	95% Confidence Interval			
						Inf. Limit	Sup. Limit		
Interceptors	[Rating = 3]	-8.011	1.064	56.647	1	0.000	-10.097	-5.925	
	[Rating = 4]	-7.695	1.021	56.857	1	0.000	-9.695	-5.695	
	[Rating = 6]	-6.281	0.913	47.348	1	0.000	-8.070	-4.492	
	[Rating = 7]	-4.701	0.844	30.992	1	0.000	-6.356	-3.046	
	[Rating = 8]	-4.054	0.819	24.505	1	0.000	-5.659	-2.449	
	[Rating = 9]	-3.485	0.797	19.103	1	0.000	-5.047	-1.922	
	[Rating = 10]	-2.519	0.765	10.853	1	0.001	-4.018	-1.020	
	[Rating = 11]	-1.665	0.747	4.968	1	0.026	-3.130	-0.201	
	[Rating = 12]	-1.205	0.744	2.625	1	0.105	-2.663	0.253	
	[Rating = 13]	-0.305	0.750	0.165	1	0.685	-1.774	1.165	
	[Rating = 14]	0.376	0.768	0.240	1	0.624	-1.129	1.881	
	[Rating = 16]	0.815	0.787	1.072	1	0.301	-.728	2.357	
	[Rating = 17]	1.799	0.860	4.383	1	0.036	0.115	3.484	
	[Rating = 18]	3.782	1.320	8.216	1	0.004	1.196	6.369	
	Coefficients	<b>Voz_Transp</b>	-5.897	1.522	15.005	1	<b>0.000</b>	-8.880	-2.913
		Estab_Pol	0.588	0.603	0.952	1	0.329	-0.594	1.771
		<b>Efet_Gov</b>	2.311	1.032	5.013	1	<b>0.025</b>	0.288	4.334
		<b>Qual_Regul</b>	1.407	0.516	7.440	1	<b>0.006</b>	0.396	2.418
Vigor_Lei		1.749	0.935	3.497	1	0.061	-0.084	3.582	
Contr_Corrupt	1.511	0.771	3.838	1	0.050	-0.001	3.023		

Source: Research data

In analyzing the estimation model, an existing association was perceived between some of the world governance indicators and the long-term sovereign ratings for the sample of 10 Latin America countries in the 2002 to 2012 period. By analyzing the model's degree of explanation by means of the Nagelkerke pseudo-R<sup>2</sup> statistic, it has been observed that the variation in the independent variables explains up to 56.9% of the variations in the dependent variable, sovereign rating. In the assessment of the estimated parameters, it has been shown that the variables that possess some degree of influence in the determination of the sovereign ratings are "voice and transparency," "effectiveness of the government," and "regulatory quality." The variable "voice and transparency" is associated with

lower chances of provoking switches in the ratings, while the variables "effectiveness of the government" and "regulatory quality" are associated with higher chances of provoking switches in the ratings. Therefore, it is expected that changes in the indicators "effectiveness of the government" and "regulatory quality" are more important for improving the sovereign ratings of Latin American countries.

Interactions between the covariables were tested using interactions at two and three levels, but it was not possible to validate the presumption of the proportional odds for these models, making them inadequate. The interactions between the variables were tested at a superficial level, and were withdrawn from the model because they did not meet the requisites of the ordinal model. Thus, it was necessary to perform the binary logistic analysis separately for each category, creating cutting points. This way, more detailed information could be found about the data, requiring much work with the data to explain the possible relationships.

## 5 Final Considerations

Some of the research showed the existence of a relation between economic variables and sovereign ratings, some included political variables and social variables in statistical models to investigate their influence on the determination of sovereign ratings. That research showed that economic aspects have more influence than political or social aspects, but, apparently, little research has focused only on the study of political aspects. Investigating the influence of political aspects is relevant to (i) confirm some of the theoretic assumptions of the specialized literature, which assumes the influence of such aspects in the process of evaluation of sovereign risk; (ii) validate the statistical models that aim to explain the determination of ratings; (iii) investigate the effectiveness of the current world governance indicators; and (iv) produce useful information for researchers, governments, and economic agents.

Although the current world governance indicators are able to produce relevant information about political aspects of government decisions, there is still a lot to be done to perfect those measures. It is acceptable that these indicators have limitations in their methodical process of construction, and criticisms and suggestions for improvement are opportunities to address gaps and produce more effective indicators. The results of this research show that the indicators of the WGI

project could be used in more research to test and measure their effectiveness, but it is also noted that other approaches could be used to more deeply investigate the relation between these indicators and sovereign ratings.

The present paper aimed to contribute to the investigation of the influence of the WGI project indicators on the determination of long-term sovereign ratings using ordinal logistic regression statistical techniques based on the proportional odds model. The results found point to a degree of influence by some world governance indicators on the determination of long-term sovereign ratings in Latin American countries. The estimated model explains 56.9% of variations in ratings; the significant indicators in the model are, by order of probability of producing changes in ratings: “effectiveness of government,” “regulatory quality,” and “voice and transparency.” These results are similar to some of the results found by [33], where these variables were significant to some of the panel data models with a high level of explanation. Using another kind of approach, [10] and [41,42-45] also found evidence that political aspects are significant and positively related to sovereign ratings. It is now possible to infer that political variables related to governance have some degree of influence on the determination of sovereign ratings.

The significant variables found in the ordinal model of this research indicate that questions related to government’s autonomy, public service quality, the government’s capacity to formulate and implement policies, and regulations that promote the development of the private sector are factors that influence the determination of sovereign ratings. Factors such as freedom of speech and the ability to exercise political rights have a lower degree of influence on the determination of sovereign ratings.

The statistical model used was able to detect the effects of the political variables on the determination of the sovereign ratings, but some aspects need to be more deeply investigated. First, the continuous nature of the explanatory variables causes difficulty in performing adjustment tests for the model, making it necessary to use pseudo-R<sup>2</sup> approximations to check the results. The model of ordinal regression can be used in applied social sciences fields, and specifically in risk management, the subject of this research, because it is relatively simple and parsimonious, allowing the extraction of direct conclusions from the found results [33,36].

Among the limitations of this research is the non-utilization of transversal cuts in the investigation, which would allow the study of passage of time and the similarities between countries. Also not deeply investigated were the possible interactions between the model covariables, considering the direct principal effects of the covariables in the response variable. A deeper investigation of the interactions between the covariables, investigation of transversal cuts to measure the effects of time and various effects for different countries, and investigation of the formation of conglomerates are all recommended subjects for future research. These approaches can be useful to increase the explanatory power of the ordinal model for the variables proposed in this paper.

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