Financial, Macroeconomic and Corporative Management Indicators to Predict the Insolvency of B3 Companies

ABSTRACT

Objective: To analyze the effect of financial, macroeconomic and descriptive (qualitative) corporative management indicators to predict insolvency of *Brazil, Bolsa, Balcão* (B3) (Brazil, Stock market, Bench) companies, between the years of 2006 and 2016.

Method: Logistic regression was estimated according to unbalanced panel data, after choosing the best predictive variables for the model, utilizing the backward stepwise model. The sample is based on 55 publicly-traded non-financial corporations.

Originality/Relevance: When macroeconomic and corporative management variables are inserted, the expectation is that the company's insolvency condition have another explanatory alternative in order to cut down on the negative aspects that such a condition imposes upon the concerned parts.

Results: The number of the model's correct classifications was 89.5% and pseudo R-squared = 0.4872. Results show that the financial indicators, just as verified by other works, are fine predictors of company insolvency. Moving onto the corporative management indicators utilized, p-value results do not dismiss the theoretical relationship that management elements might be linked to corporation insolvency. Regarding macroeconomic factors, only one variable (among 5) showed a value of statistical significance according to the definitions.

Theoretical/Methodological contributions: Results may justify why only the variable gross domestic product (among the macroeconomic ones) has presented a significant statistical relationship with the predictive model, as organization management may overcome issues caused by macroeconomic variables.

Keywords: Insolvency prediction; Financial indicators; Macroeconomic indicators; Corporative management indicators.

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1 INTRODUCTION

Managers don't always have enough capital to invest in what their companies need to maintain their daily operations, as they generally make forward sales and their receivables are not always at their disposal when resources are needed. Thus, it falls on the manager the responsibility to search for new sources of assets and assess the best payment options, as well as examine if the company has the necessary means to liquidate the debt rightfully when accorded with the eventual creditor. In this regard, insolvency indications for companies may be utilized by creditors, helping them to mitigate credit risk when there is credit concession.

Insolvency may be comprehended as when a corporation cannot afford to pay off its obligations dutifully, as the economic value of the company's assets is reduced to an amount that is smaller than that of their liabilities. Such a situation indicates that the expected cash flow is insufficient to liquidate the obligations that were acceded.

Since company insolvency is relevant to many stakeholders, the topic has been the subject in researches to verify which factors may be able to predict company insolvency. The search for insolvency indicators may be used as a way to inform managers of the better choices to make, as well as alert credit suppliers of the risk of conceding loans to certain companies.

In this regard, a fair amount of international and national literature that covers insolvency utilizes financial indices (calculated through accounting data) to predict insolvency. However, the emphasis on financial indicators does not imply that these are the only corporation insolvency predictors.

Hence, the importance of macroeconomic factors must be highlighted to predict company insolvency. Not only these, but some other factors that can be used to predict company insolvency are linked to corporative management, as its adoption correlates to good management practices. Moreover, the lack of a sound management in certain companies contributes to insolvency. Thus, the opposite is also true, i.e., when good management is present in an organization, less frequent insolvency is expected (Altman & Hotchkiss, 2006; Karamzedeh, 2013).

Taking into account the three-factor groups (financial indicators, macroeconomic indicators and governance and management descriptive indicators), the current study aims to answer the following research issue: What effect do financial, macroeconomic and corporative management (qualitative) indicators have on predicting insolvency of B3 (*Brasil, Bolsa, Balcão*) companies, between the years of 2006 and 2016?

The current research has contributed to the debate surrounding the utilization of financial, macroeconomic and/or corporative management variable groups regarding insolvency prediction, motivated by the verification of conflicting results displayed by other studies (ex.: Brito and Assaf Neto, 2008; Castro Junior, 2003; Rezende, Montezano, Oliveira, & Lameira, 2017; Soares and Rebouças, 2014; Stüpp, 2015).

By admitting that behind numerical results highlighted by financial demonstrations there is a complex number of actions and decisions that culminate in organization development, it becomes plausible to consider that corporative management has its share of contribution. Not only that, the current research demonstrates that even when the country's domestic production negatively impacts the corporation's financial situation, it is possible that good managerial and corporative governance practices help the overcoming of the aforementioned negative impacts. Taking this into account, it is important to verify how financial solvency may be pursued in order to get the companies to carry out their investments, to guarantee employability and to improve their financial aspects.

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2 THEORETICAL FRAMEWORK
2.1 Credit risk, insolvency and its prediction based on financial indicators

The current economical-financial and political conjuncture, distinguished by crises, points to a better placement of the resources in a company, especially financial ones, for them to be able to face competitors from similar segments; thus reaching significant profit to continue their activities and/or services. Based on this, it is understood that companies' managers must adopt practices that allow finance control, aiming to avoid a financial insolvency process.

Financial insolvency happens when a company is not able to meet its obligations duly (Gitman, 1997). Thus, Brito and Assaf Neto (2008) define such a situation as the possibility the creditor incurs some loss, due to the obligations that were taken on by the debtor not being liquidated when they were due.

When companies seek capital from third parties, it is consensual that the former hardly ever can afford to get by without the funding provided by these resources, these being utilized to finance several investment needs (Santos & Silva, 2014). Understanding that insolvency indices may be used by creditors to analyse the company's performance, it is recognized that better financial performances must be pursued by corporations.

When it comes to empirical work, financial indicators are frequently utilized to estimate insolvency prediction models. Such indicators are widely known in companies' financial analysis literature as being linked to capital structure liquidity, debt, profitability, and activity levels. After the selection of variables and sample, it is common the application of statistical techniques such as logistic regression, discriminant analysis, neural networks, and so on (exemplified by Brito and Assaf Neto, 2008; Rezende et al., 2017; Scalzer, Rodrigues and Macedo, 2015; Soares and Rebouças, 2014). Bearing in mind the literature that covers financial indicators, the first research hypothesis to be followed is presented:

H01: Financial indicators predict the probability of company insolvency.

However, the emphasis on financial indicators does not imply that these are the only company insolvency predictors (Beaver, 1966). From such affirmation, other variables are indicated as capable of influencing corporation insolvency. In that regard, Oliveira (2014) expresses that a few of the works highlight the importance macroeconomic factors have and their effects on company bankruptcy.

2.2 Macroeconomic indicators

As previously seen, although financial indicators are important parameters when analyzing company insolvency, its prediction cannot be solely based on utilizing data from accounting reports as that may not be enough. Preoccupation with the non-exclusive utilization of financial indicators to insolvency estimation is verified ever since Beaver (1966) and, additionally, may be brought together with worries about another factor – managing accounting data information. Castro Junior (2003) explains that accounting indicators might – depending on the moment – not offer great reliability in risk and insolvency assessment due to fraud scandals in accounting and/or suspicion of masking balance sheets.

In any way, search for the utilization of other variables – not exclusively data from companies' finance reports – to estimate capability that companies have to honor their commitments (i.e. solvency) is supported by the fact that results (good or bad) assessed by organizations may be linked to other factors.

The current economic and political environment in which world markets are into, in particular, the Brazilian economy, has demanded a greater capacity for the economic agents to comprehend the way that the different variables behave and influence one another. The need

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for adaptation makes organizations adapt to new dynamics and market requirements, especially when it comes to the future of the economy and its businesses (Andrade & Melo, 2016).

The strength that predicting models that employ financial variables may have a slight decrease in explanatory capacity, which may be compensated by explanatory increment that comes from the combination of all indicators, from an accounting nature, with economic variables (Beaver, McNichols & Rhie, 2005). Thus, including macroeconomic variables may lead to the reduction of mistakes associated with bankruptcy prediction, as on very few occasions these predictive models utilize macroeconomic factors as categorical variables (Liou & Smilth, 2006).

Therefore, some macroeconomic factors that may influence the ability companies have to honor their debt can be cited: inflation movement (Wadhwani, 1986); interest rate (Young, 1995); exchange rate (Yoshitake, 2004), Gross Domestic Product (Oliveira, 2014), among others. Accordingly, the literature brought to light here suggests a connection between macroeconomic indicators and insolvency prediction, hence this research's second hypothesis:

H02: Macroeconomic indicators predict the probability of company insolvency.

However, when it comes to the issue of insolvency prediction, the importance to introduce categorical management variables in addition to quantitative variables must be reinforced, for the attainment of predictive models.

2.3 Corporative Management

A brief analysis of performance evaluation models linked to bankruptcy prediction makes possible the observation of a prevailing existence of financial measures that indicate payment capacity, profitability, and earnings; it can also be observed a lack of model utilization that uses categorical variables (qualitative) (Vasconcelos, 2007).

Behind all of the numerical data, there are complex non-financial factors that may interfere in company performance. For that matter, it is necessary to investigate which actions the companies might take to remain competitive and under which principles these decisions must be made (Vasconcelos, 2007). Corporative management may be understood as an important factor to support company continuity, as corporations that bear a frail corporative management system tend to have financial difficulties (Wruck, 1990).

Corporative management refers to a group of practices that aim to optimize company performance as it protects its stakeholders, facilitating the access to capital and that depicts the best managerial practices according to the demands of the market (*Instituto Brasileiro de Governança Corporativa* - IBGC, 2015) (Brazilian Institute of Corporative Management). Thus, four are the principles which are the backbone of good corporative management practices:

a) Fairness: equality when dealing with shareholders;
b) Disclosure: information transparency;
c) Accountability: responsible accountability; and
d) Compliance: conformity to legislation and norms.

So, a higher level of corporative management may indicate company continuation. Thus, a poor management of a company is another factor that may impact its insolvency, as corporations plan their strategies through their managerial leadership, as well as correct mistakes and control financial resources which belong to the owners and/or shareholders. Therefore, when there is a lack of a sound management, it can impact the company's financial solvency (Altman & Hotchkiss, 2006; Karamzedeh, 2013).

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Thus, insolvency prediction encapsulates factors that go beyond the economic-financial ones, as data from financial demonstrations come from a slew of complex decisions, situations, and attitudes that the organization has when facing its daily routine. In the face of the arguments on company insolvency and corporative management, the third hypothesis of this research is disclosed:

H03: Corporative management qualitative indicators predict the probability of company insolvency.

3 METHODOLOGY
3.1 Characterization and Sample

The current research is quantitative in its core. When it comes to the research's aims, they are classified as descriptive. Concerning the strategies for data acquisition, this study is based on documental research. To attain financial data, two databases were utilized: Economatica® and ComDinheiro. Regarding macroeconomic data acquisition, it was done with information from the websites: *Banco Central do Brasil* (BC) (Brazilian Central Bank) and *Instituto Brasileiro de Geografia e Estatística* (IBGE) (Brazilian Institute of Geography and Statistics). Obtaining qualitative data on corporative management was achieved through the insertion of dummy variables, according to information found on the ComDinheiro database.

It was verified that the situation of companies that are registered in receivership and/or bankruptcy (insolvent) on the *Boletim Diário de Informações* (BDI) (Daily Information Bulletin) and *Suplemento de Orientação* (Orientation Supplement) reports, published by B3, as well as the records for open corporations by *Comissão de Valores Mobiliários* (CVM) (Securities and Exchange Commission). Thus, the selected sample contemplates publicly-traded non-financial corporations from cyclical consumption sectors (which concentrated most of the corporations that were under a situation of receivership between the years of 2006 and 2016) from B3.

From the identification of companies which were going through insolvency, similar companies (known as solvent) were singled out to be analyzed along with their counterparts, where two criteria were obeyed: they had to belong to the same economic segment/business activity; and have similar size (determined by the total active) as the insolvent company. In summary, the analysis contemplates 1955 observations and data from 55 corporations over 44 trimesters (from 2006's 1T to 2016's 4T), on unbalanced panel. This configuration is due to the number of observations not being the same for all corporations (Pedace, 2013). The absence of some data on specific periods is justified by the sample's characteristics, as some of the insolvent companies did not have any activity on the stock market.

The choice for the beginning of the study (2006) is justified as it follows Law 11.101/05; which brought on new rules that go over receivership, out-of-court reorganization and corporation bankruptcy, that being the applicable law on the matter.

3.2 Variables used and statistical treatment

The dependent variable is binary and also a dummy which reflects the company situation, taking the value of either 1 if the company is insolvent or 0 if the company is solvent. When it comes to the explanatory variables, initially, the ones more frequently used in previous studies were the ones taken into consideration. Thus, financial variables concerning the capital structure and debt, liquidity, profitability, activity, macroeconomic variables and corporative management were identified. These variables can be visualized in Table 1.

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Table 1
Explanatory variables

Acronym	Variable	Formula	Expected relationship	Authors
Financial Variables				
Debt Variables/Capital structure				
X01	Fixed Assets to Net Worth	(Investiments + Fixed Assets + Intangible Assets) / Net Worth	Positive	Brito and Assaf Neto (2008), Castro Junior (2003)
X02	Third-party capital participation	(CL + NCL) / NW	Positive	Stüpp (2015), Castro Junior (2003), Martins (2003)
X03	Short-term debt	CL / TL	Positive	Stüpp (2015), Brito and Assaf Neto (2008), Castro Junior (2003)
X04	Total debt	(CL + NCL) / TA	Positive	Brito and Assaf Neto (2008)
X05	Outstanding debt	Loans and Financings / TA	Positive	Martins (2003)
X06	Financial Leverage	Loans and Financings / NW	Positive	Stüpp (2015)
X07	Interest Coverage Ratio	EBIT / Financial Expenses	Positive	Stüpp (2015), Soares and Rebouças (2014)
Liquidity Variables				
X08	General Liquidity	(CA + NCA) / (CL + NCL)	Negative	Stüpp (2015), Brito and Assaf Neto (2008), Castro Junior (2003), Martins (2003)
X09	Current Liquidity	CA / CL	Negative	Stüpp (2015), Brito and Assaf Neto (2008), Castro Junior (2003), Martins (2003)
X10	Quick Ratio	(CA - I – PE) / CL	Negative	Stüpp (2015), Brito and Assaf Neto (2008)
Profitable Financial Variables				
X11	Asset Turnover	Net Sales / TA	Negative	Brito and Assaf Neto (2008), Castro Junior (2003)
X12	Return on Sales	Operating Profits / Net Sales	Negative	Brito and Assaf Neto (2008), Castro Junior (2003)
X13	Return on Assets	Operating Profits / TA	Negative	Stüpp (2015), Brito e Assaf Neto (2008), Castro Junior (2003), Martins (2003)
X14	Operating Margin Before financial result	EBIT / Operating Profits	Negative	Brito and Assaf Neto (2008), Martins (2003)
Activity Variables				
X15	Financial Cycle	AIT + DSO – DPO	Positive	Stüpp (2015)
X16	Operational Cycle	AIT + DSO	Positive	Stüpp (2015)
Macroeconomic Variables				
X17	LN GDP	It corresponds to the growth in added value for goods and services which occurs over a certain period of time for an specific economy	Negative	Andrade and Melo (2016), Liu (2004)
X18	BCPI	It represents the official	Positive	Andrade and Melo (2016),

		inflation index in a country		Liu (2004), Wadhwani (1986)
X19	Occupation Rate	It represents the periodic balance of a company's admissions and terminations	Negative	Sachs and Larrain (2000)
X20	Interest Rate – Credit Operations LE	It corresponds to the interest rate attributed to credit operation carried out with a legal entity	Negative	Liu (2004), Yoshitake (2004)
X21	Exchange Rate	It indicates the value of a certain currency in comparison to the others	Positive	Andrade and Melo (2016)
Corporative Management Variables				
X22	Corporative Management	It represents the adoption, by the corporations, of good management practices	Negative	Altman and Hotchkiss (2006) and Mendes (2014)
X23	Delay to release financial statements	It represents a situation where the corporation may be going through difficulties in finishing up their reports due to revision and/or procrastination	Positive	Proposed by the authors

Legend: CA = Current Assets; NCA = Non-current assets; TA= Total assets; PE = Prepaid expenses; EBIT= Earning Before Interest and Taxes; I = Inventory; CL = Current liability; NW= Net worth; AIT = Average Inventory Turnover; DSO = Days of Sales Outstanding; DPO = Days of Payables Outstanding; NCL = Non-Current Liability; TL = Total Liability; GDP = Gross Domestic Product; BPCI = Broad Consumer Price Index; LE = Legal Entity

Logistic regression was utilized to carry out this research according to panel data. Thus, for the logistic regression, the dependent variable corresponds to a probability ratio, with posterior transformation to a variable on a logarithmic basis. As it is non-linear, the regression coefficients are calculated by the maximum likelihood estimation (Brito & Assaf Neto, 2008). In this regard, the logistic regression model may be represented as it follows:

$$ln\left(\frac{p}{1-p}\right) = b_0 + b_1 X_1 + b_2 X_2 + \ldots + b_k X_k \quad (1)$$

p is the probability of occurrence of an event; 1 – p is the probability of non-occurrence of an event; p/(1 - p) is the probability ratio (or logit); X represents the vector for explanatory variables (independent) and b the estimated coefficients.

Subsequently, it is known that the coefficients measure the effects of independent variable changes on the natural logarithm of the probability ratio (a.k.a. logit). According to Fávero et al. (2009), in order to evaluate the true impact of the parameters on the probability of occurrence of an event, coefficients must be transformed using antilogarithm. The probability associated with the occurrence of an event of interest may be obtained by the expression:

$$p = \frac{1}{1+e^{-(b_0+b_1 X_1+b_2 X_2+\ldots+b_k X_k)}} \quad (2)$$

in which *e* is the base of natural logarithms (approximately 2.718).

Panel model, in which the dependent variable is qualitative; estimation with fixed effects is not recommended due to the discreet nature of the data, for which the error part cannot be constantly estimated (Hsio, 2014). So, Chow's test was carried out, in which the null hypothesis to utilize the pooled panel technique was not rejected, and this is the treatment used on this research's data.

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Regarding the interpretation of how much the independent variables explain the dependent one (i.e., model prediction strength), the Count R^2 was considered. According to Gujarati and Porter (2011), as the value for the logit model may be either 1 or 0, when the probability is over 0.5, it is classified as 1; however, if it is under 0.5, it is classified as 0. In percentage, these classifications indicate how much independent variables explain the observed values. Therefore, the number of observations that were correctly predicted is given according to Equation 3.

$$\text{Count } R^2 = \frac{number\ of\ correct\ predictions}{total\ number\ of\ observations} \qquad (3)$$

The number of cases correctly classified according to the company group (solvent or insolvent) and the model's specificity and sensibility, also using the Receiver Operating Characteristic (ROC) curve were characterized.

4 PRESENTATION OF RESULTS

For this research, the backward stepwise technique was utilized which verifies the importance of each categorical variable, leaving out those whose coefficients do not present statistical significance for the model's logistic regression. Parameters utilized were 10% of significance for the variables' input and output. Thus, Table 2 presents the results of the procedure, hence, which variables were considered for the final model.

Table 2
Variable identification results – backward Stepwise method

Acronym	Variable	p > | z |	Variable group	Decision
X13	Return on assets	0.077	Financial of profitability	Consider
X01	Fixed assets to Net Worth	0.070	Financial of Capital Structure	Consider
X02	Third-party capital participation	0.018	Financial of Capital Structure	Consider
X03	Debt composition	0.004	Financial of debt	Consider
X08	General Liquidity	0.002	Financial of liquidity	Consider
X15	Financial cycle	0.000	Financial of activity	Consider
X04	Total debt	0.000	Financial of debt	Consider
X11	Asset turnover	0.000	Financial of profitability	Consider
X05	Outstanding debt	0.000	Financial of debt	Consider
X17	LN Gross Domestic Product	0.000	Macroeconomic	Consider
X22	Corporative Management Level	0.000	Corporative management	Consider
X23	Delay to release	0.000	Corporative management	Consider

4.1 Descriptive Statistics

For this section, the descriptive analysis of each variable that was utilized on the solvency model is presented. Therefore, Table 3 displays the results for some parameters of descriptive statistics.

Table 3 shows data regarding descriptive statistics of variables used in the solvency model. The choice was made to segment the average, standard deviation and minimum and maximum values for the solvent and insolvent corporations. As it can be verified, the variable general liquidity (X08) for solvent companies has a greater average when compared to insolvent ones, mirroring what the theory on the matter advocates for this indicator, for which the greater, the better (clearing the possibility of entering/being in financial difficulties).

Table 3
Descriptive statistics of selected categorical variables

Variable	Code	Average		Standard Deviation		Min		Max	
		I	S	I	S	I	S	I	S
Third-party capital participation	X02	483.97	199.18	836.83	361.55	58.01	10.25	9674.46	4534.82
Total debt	X04	649.14	62.79	1876.35	51.39	38.65	9.30	10066.86	453.77
Asset turnover	X13	15.58	2.45	48.76	3.60	0.02	0.00	499.45	65.92
General liquidity	X08	0.64	1.73	0.53	1.28	0.01	0.03	2.32	10.68
Debt composition	X03	71.81	49.85	26.67	25.58	6.48	0.00	100.00	100.00
Return on assets	X11	0.11	0.19	0.12	0.11	0.00	0.00	0.75	0.65
Fixed assets to Net Worth	X01	113.05	47.96	313.35	82.06	0.11	0.04	5311.87	1297.43
Outstanding debt	X05	53.42	30.02	95.22	32.79	0.00	0.00	614.68	384.34
Financial Cycle	X15	607.61	314.48	1297.21	280.63	0.35	0.00	8174.73	1752.64
Ln GDP	X17	13.83	13.89	0.31	0.30	13.23	13.23	14.31	14.31
Corporative Management Level	X22	-	-	-	-	-	-	-	-
Delay to release	X23	-	-	-	-	-	-	-	-

Legend: I = Insolvent; S = Solvent.

When it comes to the variables fixed assets to net worth (X01), third-party capital participation (X02), debt composition (X03), total debt (X04) and outstanding debt (X05), there was a better behavior for solvent companies when compared to their insolvent counterparts as observed before, stated by the average of each indicator, whose perspective for these variables is the lower, the better. Results so far corroborate with the ones found by Stüpp (2015), whose liquidity and debt variables from solvent corporations showed better averages than the ones from insolvent companies.

The variable asset turnover (X13) from insolvent companies had an average approximately 5 times greater than the one from solvent corporations. Behavior for the variable return on assets (X11) had a similar average, for both corporation groups. The variable financial cycle (X15) behaved as expected, as the solvent companies of the sample displayed better performance.

The variable Gross Domestic Product (X17) obtained the same values for the average and standard deviation for solvent and insolvent companies as the same data for both groups were utilized. Regarding the variables corporative management level (X22) and delay when releasing financial demonstrations (X23), descriptive statistics do not present other information as these were operationalized based on dummies.

When it comes to standard deviations and minimum and maximum values, it is noticeable that some variables present relatively different values for each group (solvent and insolvent), the explanation is based on the fact that some insolvent corporations displayed numbers significantly different from the others. However, these discrepancies were not considered outliers because results persisted for different periods; hence, these can be considered as a characteristic of each company (and its management) when faced with several variables that generated these results.

4.2 Inferential Statistics: Logistic regression
4.2.1 Model

Based on the data collected from the variables taken into consideration for this study, Table 4 presents the main results of the logistic regression, subsequently commented and discussed.

Table 4
Logistic Regression

Dependent	Code	Coef.	Std. Err.	Z	P > |z|	[95% Conf. Interval]	
3rd Par. Cap. Part.	X02	0.0005131	0.0002167	2.37	0.018	0.00008	0.00094
Tot. Debt	X04	0.011944	0.0021732	5.50	0.000	0.00768	0.01620
ROA	X13	0.0209008	0.011838	1.77	0.077	-0.00230	0.04410
Gen. Liquid.	X08	-0.5685961	0.1791204	-3.17	0.002	-0.91966	-0.21753
Debt Comp.	X03	0.0097189	0.0033934	2.86	0.004	0.00306	0.01637
Asset turnover	X11	-4.953337	0.9317509	-5.32	0.000	-6.77953	-3.12713
FANW	X01	0.0019156	0.0010577	1.81	0.070	-0.00015	0.00399
Outst. Debt	X05	-0.0231454	0.0042004	-5.51	0.000	-0.03137	-0.01491
Finan. Cycle	X15	0.0010201	0.0002252	4.53	0.000	0.00057	0.00146
LN GDP	X17	-1.247995	0.289243	-4.31	0.000	-1.8149	-0.68109
CML	X22	-1.63615	0.2437913	-6.71	0.000	-2.11397	-1.15832
Del. Rel.	X23	0.9029592	0.1873668	4.82	0.000	0.53572	1.27019
_cons	-	15.88099	4.079163	3.89	0.000	7.88598	23.876

Number of obs =	1955
LR *chi2*(12) =	933.93
Prob > chi2 =	0.0000
Pseudo **R2** =	0.4872
Count **R2** =	0.895
Log *likelihood*	-491.59499

As evidenced by Table 4, variables X04, X08 X03, X11, X05, X15, X17, X22, and X23 statistically add up to 1%. Coefficient interpretation of the logit model follows the orientation of Gujarati and Porter (2011), where the antilogarithm calculation of the regression coefficient is made so that results are interpreted on the odds ratio.

Therefore, it is possible to verify that for each unit that increases for the variable total debt (X04), the company will increase in 1.20 times the chance to enter insolvency, as there is a positive sign from the relationship with the dependent (as expected).

The coefficient for the variable general liquidity (X08) showed a sign for the relationship with the dependent variable as expected (negative). Regarding the odds ratio, it is possible to say that if the variable decreases one unit of its value, the corporation will have 1.76 times more chances to face difficulties of solvency and ability to honor financial obligations. This result may be easily comprehended due to the indicator dynamics (general liquidity), for its basic premise being that a general liquidity value of 1 (one) indicates the company has all of its assets compromised to honor its obligations of short and long-term liabilities.

The variable debt composition (X03) displayed positive relationship with company insolvency, as increases in the total values of obligations with third parties that must be dealt with shortly lead to difficulties for the company to honor such obligations, in case there are not enough resources and there is lack of financial planning. When it comes to the odds ratio, the positive change of one unit, for this variable, increases in 0.97 times the chance that the corporation become insolvent while the other variables remain constant.

The variable asset turnover (X11) has been proven statistically meaningful, reflecting the efficiency (or not) of the application of resources and a certain level of operational activity

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due to values employed on assets. Likewise, it is worth reflecting on the expected relationship (negative) which was confirmed, therefore positive alterations on this indicator's values decrease the chances that the company become insolvent.

The variable outstanding debt (X05) presented an odds ratio of 1.02 times when altering one logit unit, based on a negative relationship (opposing the expected sign). At first, the expectation is that financial debt (or yet, outstanding debt) compromise corporation solvency, especially when the latter is poorly managed/administered.

The variable financial cycle (X15) was estimated to have a positive association, based on the insolvency prediction model used in this study, with the dependent. The insertion of the variable can be easily comprehended: it can be a thermometer to assess how much a corporation needs to use third-party capital. According to Table 4, with the alteration of one unit for the variable, there is an increase in the chances that the company become insolvent in 0.10 times. If the first impression is that such odds ratio seems small, it is worth mentioning that the financial cycle is established for days (which spread out between paying suppliers and receiving sales), and that the alteration of 1 (or over) is easily applicable.

The only macroeconomic variable that was confirmed as statistically meaningful for the model was the one regarding gross domestic product – X17 (embedded in the model with the natural logarithm), having a negative relationship (as expected). Rezende *et al.* (2017) utilized this variable to justify embedding macroeconomic variables in insolvency prediction and financial difficulty models, for which it proved to be statistically meaningful. The estimated ratio was that the corporation has 3.48 times the chance to become insolvent in case the economy goes through some period(s) of recession(s) or even still, for a sluggish economy.

The variable X22, which reflects corporative management level, to which the B3 companies described belong, showed negative relationship (as expected); and it bases itself on good management practices that are known to help the corporation not to get into several difficulties, the financial one, for instance. Mendes (2014) operationalized the same variable but did not find enough statistical meaning to justify the association between this variable and the dependent one for their study, based on the sample used. However, the current study found out that the chance that the corporation has of becoming insolvent decreases in 5.13 times if the company participates in one of the several segments of B3's corporative management.

The other corporative management variable considered for the study is X23 (delay to release financial statements) which had its statistical significance presented as 1%. Delay to release financial statements harms the principles of information transparency, accountability to users (mainly external ones), equity among stakeholders and compliance (not obliging to rules by regulatory agencies). According to Table 4, the positive relationship that was expected was in fact confirmed, the idea is that if the company is insolvent, it will emit a few signs, among them the delay to release information.

It is necessary to reflect over the variable X23: delay to release financial statements and quarterly information does not cause or lead the company to insolvency, but not abiding by this obligation (to inform) may cause awkwardness with the the stock market, signal the stakeholders that something might be happening, and for this study specifically, it is statistically meaningful to predict insolvency.

According to Table 4, variable X02 (third-party capital participation) displayed a statistical significance of 5% and it confirmed the expected relationship sign (positive). The impact, when there is a change of one unit, increases the chance that the company become insolvent in 0.05 times. From a practical point of view, it is possible to identify an association between these results as a function of utilization, proportion, dependence and cost of living

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with capital from third parties or their own as well as the possibility that the company become insolvent.

Finally, if a statistical significance level of 10% is considered, variables return on assets (X13) and fixed assets to net worth (X01) are also explanatory of the dependent variable. For variable X13, the odds ratio was estimated to be 2.11. However, as seen in Table 4, variable X13 displayed a positive association regarding the variable; which differs from the expected.

When it comes to variable X01, a positive association regarding the dependent variable was identified; whose odds ratio equals to 0.19 times. Thus, according to what was also recognized by Stüpp (2015), the greater the fixation proportion of their own resources for certain non-current assets, the bigger the chance the company has of being insolvent.

After identification of results for each variable, the variance inflation factor (VIF) was calculated in order to verify if there are hints that point to parameter multicolinearity which, if true, may hinder the model estimations and interpretations. Therefore, results are displayed in Table 5.

Table 5
Variance Inflation Factor

Variables	**VIF**	**1/VIF**
Total Debt	3.51	0.284832
ROA	2.54	0.392990
Third-party capital participation	1.95	0.512773
Outstanding debt	1.93	0.518639
Fixed assets to Net Worth	1.92	0.521247
Corporative management level	1.35	0.740759
General liquidity	1.35	0.741218
Financial cycle	1.30	0.769914
Asset turnover	1.28	0.782452
Debt composition	1.19	0.840608
Delay	1.14	0.873694
LN Gross Domestic Product	1.14	0.876760
Average VIF	**1.72**	-

According to what is featured in Table 5 as well as what is advocated by Fávero *et al.* (2009) (i.e. values that go over 5 (five) support the possibility that there are multicolinearity problems), the variables in this study did not present VIF values over 5. Moreover, the average for all of the elements was not over 2 (two), hence the conclusion that variable behavior does not present multicolinearity.

4.2.2 Model Assessment and Validation

From the LR chi2 (12) test = 933.93; it is possible to notice that the coefficients are collectively meaningful to explain the dependent variable, where it is possible to reject with 1% of significance the null hypothesis which says all coefficients are equal to 0 (zero), given that the value of Prob>Chich2 = 0.000 (as seen in Table 4).

In regards to the model adjustment degree, one of the parameters to be analyzed is the value of Pseudo R2 = 0.4872; which indicates that approximately 48% of the variation from the dependent variable may be explained by the model's independent variables. When it comes to the logistical models, Count R2 may also be considered as a way to attest the determination coefficient. Utilizing the latter indicates the model predicts 89.5% (as seen in Table 4) of the observations correctly; which is the ratio between the number of correct predictions and the number of model observations. Here, Gujarati and Porter (2011) highlight

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that regarding binary regression models, there is more priority in verifying the expected regression coefficient signs and their statistical significance than in adjustment quality.

When it comes to specificity, solvent corporations were correctly classified in 94.99% of the cases. Regarding sensibility, the number of cases correctly classified as insolvent companies was 66.31%. Model validation is also identified in Figure 1, in which the area under the ROC curve is equal to 0.9361, which is an outstanding model discrimination capacity, according to the classification by Hosmer and Lemeshow (2000).
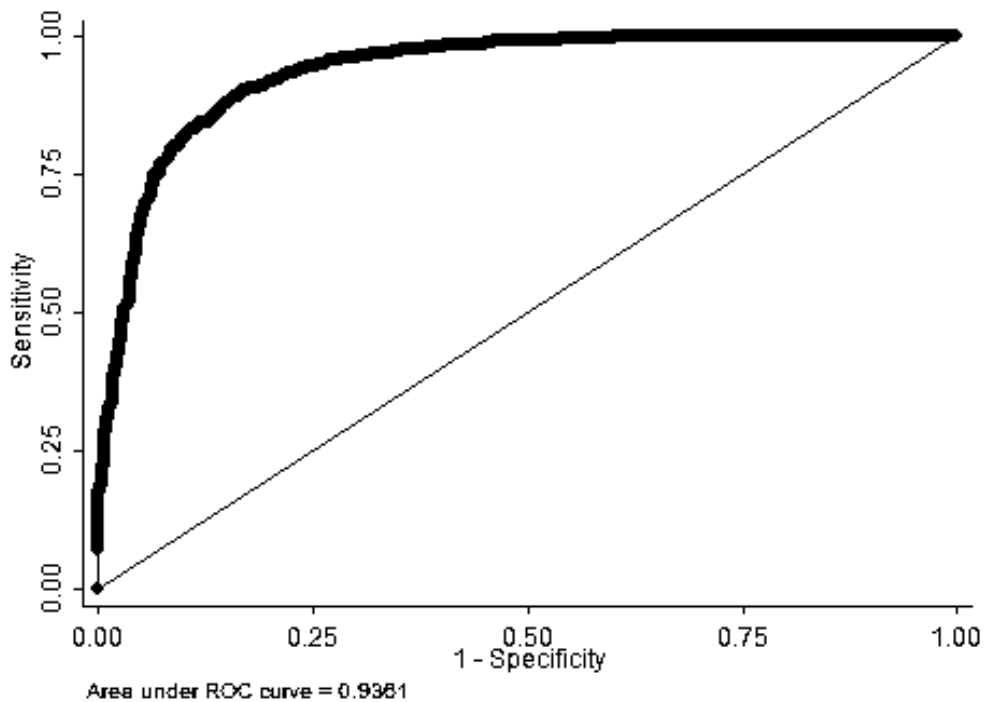

Figure 1 – ROC curve.

5 DISCUSSION OF RESULTS

When it comes to the financial indicators, many of the results and expected signs corroborate with the findings by Rezende *et al.* (2017), Scalzer *et al.* (2015), Soares and Rebouças (2014) and Stüpp (2015). However, it is worth reflecting on the two results for which the expected signs were not confirmed:

a) Concerning outstanding debt (X05) not presenting the expected sing, looking from a wider perspective, it is possible to justify the presentation of the negative sign based on some alternatives: debt level might have been well handled (debt management) by the corporations of the sample; drop on the rate of taking new loans and financings by the corporations due to the negative credit and/or difficulties imposed by the financial institutions; asset reduction to pay off debt that had already been contracted by the corporation implicating in a less valuable asset, in case there are no new investments.

b) The variable return on asset (X13) displayed a positive sign, different from the expected. Briefly reflecting on it, there was a consideration that companies may have a negative return on assets, due to the losses during the time taken into account (quarterly and/or yearly). A characteristic that was verified during data treatment also confirmed this

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scenario; a great portion of the corporations (especially insolvent ones) had negative returns, explaining the sign found during regression.

When it comes to the macroeconomic variables, only the variable GDP (when using the natural logarithm) was statistically meaningful. The results for macroeconomic variables are usually cited in the theoretical references from works focused on insolvency prediction for companies; however, empirical works do not confirm this relationship in absolute. Mendes (2014) was not able to validate all macroeconomic variables that he used. Rezende *et al.* (2017) utilized the variable gross domestic product to justify introducing macroeconomic variables in models for insolvency prediction and financial difficulty, as it was statistically significant in them. As a result, the fact that not all macroeconomic variables showed statistical significance for the model might indicate that corporations design strategies to overcome economic difficulties that may appear.

Concerning the corporative management variables, it was observed that they were significant for the insolvency prediction model. Mendes (2014) could not find this result during his research, mainly regarding the variable that classifies corporations based on different corporative management segments from B3. In general terms, this finding brings along the reflection that companies have to get used to the factors that concern their own activity. In doing so, good strategies and general practices are drawn out to avoid difficult economic periods.

However, this research still contributes to the theme when pointing out that the differentiated corporative management levels may wield some influence over the general structure of a company. The affirmation that a higher level of corporative management is able to promote company continuity (Altman & Hotchkiss, 2006; Karamzedeh, 2013) could be confirmed. From a different perspective, corporations may give out signs indicating that something is dissonant with the normality, for instance, delay of releasing financial statements which causes aversion of the financial market and makes them susceptible to sanctions from regulatory agencies.

6 CONCLUSIONS

This study aimed to analyze the effects of financial, macroeconomic and descriptive (qualitative) corporative management indicators to predict insolvency for companies from *Brasil, Bolsa, Balcão* (B3), between the years of 2006 and 2016.

After identifying companies that would compose the study and selecting explanatory variables, results relating to the objective revealed that financial indicators, as verified by other authors, are good predictors of company insolvency. Regarding corporative management indicators utilized in the research, p-value results did not reject the theoretical relationship that management elements may be linked to company insolvency. When it comes to macroeconomic factors, only one (among 5) variable (GDP, through natural logarithm) displayed a statistical significance value that was admissible.

The number of correct classifications the model had was 89.5%, and a value of Pseudo $R^2 = 0.4872$, showing that the model has a fairly reasonable explanative power. It was established that the variables employed did not have colinearity, which conditions the model to a good evaluation and validation.

Regression results lead to a reflection that companies must analyze the financial indicators, as they always bring along important information regarding the company's situation. Moreover, corporations must look into macroeconomic conditions in order to

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identify opportunities and threats and transform this monitoring into strategies to be utilized by the company in order to avoid adverse situations during its operation.

It is worth highlighting that some macroeconomic indicators, even if they did not show statistical significance, may influence, to a higher or lower degree, some situations that involve the company's operation. Applying the reflection brought up in the previous paragraph, maybe macroeconomic conditions are avoided from decisions made by the company that reflect, many times, their corporative management structure.

The non-generalization of the findings from this research is considered a limitation. Other limitations of the research relate to the number of observations that could have been greater and more harmonic, in case there had not been a considerable lack/shortage of data (especially management data with qualitative nature).

Suggestions for future researches are to introduce new proxies that try to capture the effect corporative management practices have when predicting insolvency; to broaden the study sample and operationalize macroeconomic variables in different ways to verify if they continue not showing statistical significance or if the outcome changes.

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Indicadores Financeiros, Macroeconômicos e de Governança Corporativa na Previsão de Insolvência em Empresas da B3

RESUMO

Objetivo*: Analisar o efeito de indicadores financeiros, macroeconômicos e descritivos (qualitativos) de governança corporativa na previsão de insolvência de empresas da Brasil, Bolsa, Balcão (B3), entre os anos de 2006 e 2016.*

Método: *Foi estimada a regressão logística com dados em painel não balanceado, após a escolha de melhores variáveis preditoras do modelo, utilizando o método backward stepwise. A amostra se baseia em 55 empresas não financeiras de capital aberto.*

Originalidade/Relevância: *Ao inserir variáveis macroeconômicas e variáveis de governança corporativa, espera-se que a condição de insolvência de empresas tenha mais uma alternativa explicativa, a fim de diminuir os aspectos negativos que tal condição impõe sob as partes relacionadas.*

Resultados: *O número de classificações corretas do modelo foi de 89,5%, com um valor de Pseudo R2 = 0.4872. Os resultados revelam que os indicadores financeiros, assim como verificado em outros trabalhos, são bons preditores de insolvência de empresas. Em relação aos indicadores de governança corporativa utilizados na pesquisa, os resultados do p-value não rejeitam a relação teórica de que elementos de gestão podem estar relacionados a insolvência de empresas. No tocante a fatores macroeconômicos, apenas uma (dentre 5) variável mostrou um valor de significância estatística conforme o definido.*

Contribuições teóricas/metodológicas*: Os resultados podem justificar o fato de apenas a variável produto interno bruto (dentre as macroeconômicas) tenha apresentado relação estatística significativa com o modelo de previsão, uma vez que a gestão das organizações pode superar dificuldades causadas por variáveis da macroeconomia.*

Palavras-chave*: Previsão de insolvência; Indicadores financeiros; Indicadores macroeconômicos; Indicadores de Governança Corporativa.*

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