

Predictive Capacity of Insolvency Models Based on Accounting Numbers and Descriptive Data

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Abstract

In Brazil, research into models to predict insolvency started in the 1970s, with most authors using discriminant analysis as a statistical tool in their models. In more recent years, authors have increasingly tried to verify whether it is possible to forecast insolvency using descriptive data contained in firms' reports. This study examines the capacity of some insolvency models to predict the failure of Brazilian companies that have gone bankrupt. The study is descriptive in nature with a quantitative approach, based on research of documents. The sample is composed of 13 companies that were declared bankrupt between 1997 and 2003. The results indicate that the majority of the insolvency prediction models tested showed high rates of correct forecasts. The models relying on descriptive reports on average were more likely to succeed than those based on accounting figures. These findings demonstrate that although some

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studies indicate a lack of validity of predictive models created in different business settings, some of these models have good capacity to forecast insolvency in Brazil. We can conclude that both models based on accounting numbers and those relying on descriptive reports can predict the failure of firms. Therefore, it can be inferred that the majority of bankruptcy prediction models that make use of accounting numbers can succeed in predicting the failure of firms.

Keywords: Insolvency models. Predictive capacity. Accounting numbers. Descriptive data.

1. INTRODUCTION

Over the years, researchers and analysts have developed models to enable anticipating the social and financial consequences of bankruptcy, by trying to determine *a priori* which companies are more likely to face financial problems.

Bankruptcy prediction models attribute a probability to the chance that a firm will be unable to meet its obligations over a determined horizon. Such insolvency models are important for managers who need to assess the financial health of their companies and take effective measures to avoid greater problems. Many researchers from the fields of accounting and finance have made contributions by proposing and testing models to forecast insolvency, all based on a statistical approach, especially discriminant analysis.

Beaver (1966), by using firms' financial statements, was a pioneer in experimental projects to analyze the deficiencies of companies. His study covered a sample of 79 firms that faced solvency problems between 1954 and 1968. His work was followed by that of Altman (1968), who performed a similar study using multivariate discriminant analysis (TRILL, RABIDOUX and AMARIA, 2008).

Multivariate discriminant analysis is seen as an important statistical technique by the researchers who have applied it. Altman obtained significant and useful results in predicting bankruptcy by applying the model and continued his work by testing the model developed in many other countries, such as France (1974), Brazil (1979), Australia (1981), Italy (1994) and others.

Ohlson (1980) took another route and developed the first logistic regression model to predict insolvency. His study contributed to the field by filling in gaps in discriminant analysis.

Onusic, Casa Nova and Almeida (2007) clarify that the works of Beaver and Altman spurred many other studies. In Brazil, mention can be made of those carried out by Elisabetsky (1976), Kanitz (1976), Matias (1978) and Silva (1983). However, the authors point out that as early as 1932 there were some essays on insolvency written by Fitzpatrick.

According to Silva (1997), the study published by Fitzpatrick in 1932 was based on examination of a sample of 19 solvent firms and 19 insolvent ones with similar qualities, analyzed between 1920 and 1929, and the main ratios used by the author were the current ratio (current assets to current liabilities) and the quick ratio (total assets over total liabilities).

Many researchers, besides developing models based on ratios, have tried to anticipate the future of firms by looking at their annual reports, such as the studies of Abrahanson and Amir (1996), Bryan (1997), Smith and Taffler (2000) and Scotá (2008).

In this respect, in attention to the importance of models that can predict the future financial health of companies, the research question here is: *What is the capacity of some insolvency prediction models to forecast the failure of Brazilian companies that have gone bankrupt?*

Despite the difficulty of obtaining a sample of companies that have gone bankrupt and the particularity of the insolvency prediction models for the different time periods and groups of companies, we believe the sample chosen here is sufficient for the general objective of verifying the capacity of some insolvency forecasting models to predict the failure of Brazilian firms that have been declared bankrupt.

Our specific objectives are: (i) to test the functionality of some bankruptcy prediction models based on accounting numbers, applied to Brazilian companies that have gone bankrupt; (ii) to analyze the prediction results between models using accounting numbers and those using descriptive reports; and (iii) to verify which model was retrospectively most successful in the tests conducted with the sample chosen.

For these purposes, we apply the insolvency prediction models of Elisabetsky (1976), Kanitz (1978), Matias (1978), Altman, Baydia and Dias (1979) and Silva (1982) to bankrupt firms based on Scotá (2008) and analyze these models’ performance to determine if they continue to be valid as instruments to forecast bankruptcy, besides discussing the functionality of these models.

This article is organized into seven sections including this introduction. The second section is dedicated to insolvency and bankruptcy in general. In the third section we describe the insolvency prediction models and in the fourth we discuss prediction of insolvency employing descriptive reports. In the fifth section we present the method employed and in the sixth we analyze the results. The seventh section concludes.

2. INSOLVENCY AND BANKRUPTCY

The studies carried out on insolvency and bankruptcy mainly involve models utilizing discriminant analysis to predict the failure of companies. When researchers develop such a model, they use past information to predict the future.

There is strong support in the literature for the use of ratios based on the financial statements. Trill, Rabidoux and Amaria (2008) stress that Beaver, in his studies, managed to identify that it is possible to detect a company that will become insolvent up to five years in advance. The three main ratios employed by Beaver to predict bankruptcy were cash flow/total debt, return on assets (net income/total assets) and total debt/total assets.

According to Beaver’s framework, a debtor can be considered insolvent when it is unable to meet its financial obligations as they mature. Pinheiro et al. (2007) stress that insolvency is only one of the difficulties to which firms are susceptible. Kanitz (1978, p. 2) points out that “the first symptoms of insolvency arise long before this materializes.” For him, it is possible to predict bankruptcy and the financial statements are sufficient for this. What is necessary is correct interpretation of the indicators of that possibility.

Requião (1998, p. 56) defines insolvency as “the result of insufficient assets of the debtor to pay its debts.” Guimarães and Moreira (2008) corroborate Requião and clarify that insolvency is a situation in which a firm’s assets are insufficient to honor the commitments assumed, which can lead to a situation of bankruptcy.

The fact that some firms will succeed while others fail is inherent to capitalism, but because of the undesirable consequences of failure for the many stakeholders, it is useful to have tools to predict failure to be able to minimize these consequences. Chart 1 presents the main economic agents interested in predicting insolvency.

USERS	USES-USEFULNESS
Investors and financial analysts	Purchase and sale of equity stakes
Shareholders	Prediction of business success or failure
Financial institutions	Granting of loans
Customers, suppliers, workers and others	Commercial and labor relations
Auditors	Evolution of compliance with the going-concern principle
Economists and external consultants	Business crises and reverses
Officers	Strategic planning, assumptions and control

Chart 1: Main economic agents and their interest in insolvency prediction models

Source: Gabas (1990, p. 16), cited in Gimenes and Uribe-Opazo (2000)

According to Almeida (2006), bankruptcy is a legal mechanism that seeks to assure that creditors will have a chance to recover what is possible from the insolvent debtor. An insolvent debtor is defined as a firm whose liabilities are greater than its net worth, i.e., whose assets are not enough to satisfy its obligations.

Bankruptcy can be divided between economic and legal categories. From the economic standpoint, Lacerda (1996) states that bankruptcy “is the condition of a party that, having received credit, does not have the ability to repay the amount borrowed when due.”

Almeida (2006, p. 17) further states that from a legal standpoint, bankruptcy “is a process of collective enforcement against the insolvent debtor, that is, a mechanism that gathers various litigants in a single proceeding, connected by a union of interests.”

According to Almeida (2006, p. 22), “a debtor will be declared bankrupt when, without a relevant legal reason it fails to pay upon maturity a specified obligation materialized by enforceable debt instruments against which protest of nonpayment has previously been lodged and whose sum exceeds the equivalent of forty times the minimum monthly wage in effect on the filing date of the bankruptcy petition.”

Besides the creditor, bankruptcy may be sought by the debtor itself (voluntary bankruptcy), or also by the surviving spouse, heir or estate executor of the creditor (ALMEIDA, 2006).

According to Almeida (2006), voluntary bankruptcy occurs when a company does not have resources to satisfy its obligations and requests the court to declare it bankrupt, after considering the causes and the current state of business exposed in the petition.

Most models in the literature rely on accounting numbers to forecast bankruptcy of firms. In this study, we also examine models that use the descriptive parts of annual reports, as in the model developed by Smith and Taffler (2000).

3. MODELS TO PREDICT INSOLVENCY

According to Kassai and Kassai (1998), the analysis of financial statements with use of accounting ratios has developed in the academic world thanks to the integration with the business community. For the authors, such analysis can be divided into the traditional type, which focuses on identifying the situation of liquidity, profitability, indebtedness and leverage, and predictive analysis, which relies on a series of data weighted according to statistical criteria. The latter type of analysis is at the heart of the models to predict insolvency.

Gimenes and Uribe-Opazo (2001, p. 18), citing Dietrich, state that the main objective of these models can be defined under two lenses:

1. The models permit establishing significant statistical relations between insolvency and the results of the financial ratios calculated from the financial statements, i.e., they seek to verify if the accounting data can supply reliable information on the financial health of companies.
2. The models are instruments able to forecast business failure, and thus can help different users to reach more informed decisions.

The definition suggested by Gimenes and Uribe-Opazo (2001) is present in various studies, with improvements and the use of different statistical models that seek to predict the failure of firms. A standout is the work of Ohlson (1980), who developed the first logistic regression model to predict insolvency. He applied the model to a sample of 105 insolvent firms and 2,058 solvent ones, with at least three years of data between 1970 and 1976. He aimed to find the probability of insolvency by means of financial ratios and dummy variables in relation to negative earnings.

Ohlson (1980) argued that the model based on logistic regression would help fill in gaps in discriminant analysis, enabling the use of unbalanced samples and also less constrained hypotheses. However, the results were less accurate in prediction when compared to other models, such as that of Altman.

Other more recent studies have sought to test bankruptcy prediction of firms in their contemporary configurations, such as that of Brito and Assaf Neto (2008). The authors developed a credit risk

classification model for Brazilian firms. They used listed companies classified as solvent or insolvent in the period between 1994 and 2004. The findings indicated that the model can predict default events one year in advance.

Some types of firms with specific characteristics have started to receive differentiated treatment, with the development of their own models or ones adapted for their type of business. Examples are the studies of Guimarães and Alves (2009) and Araújo (2011), examining health plan operators and credit unions, respectively.

Guimarães and Alves (2009) developed an insolvency prediction model formulated specifically for health plan operators. They used 17 financial indicators calculated for approximately 600 Brazilian health plan operators. The results demonstrated that the specific model is more precise in predicting insolvency of these firms than general models.

Araújo (2011) examined the relationship between accounting information and the insolvency risk of credit unions in Brazil and also the influence of factors that can alter the relevance of this information. By means of logistic regression, he showed that indicators that include accounting rubrics from the income statement have greater weight for perception of the risk of insolvency than those from the balance sheet.

Therefore, three questions are fundamental to develop an insolvency model: the characteristics of the model, the selection of data sources and the dimension of the indicators proposed for the analysis. In this study, we examine the insolvency models developed by Elisabetsky (1976), Kanitz (1978), Matias (1978), Altman, Baydia and Dias (1979) and Silva (1982).

3.1 Elisabetsky Model

Roberto Elisabetsky (1976) developed a model to enable commercial banks to decide on extending credit. He used discriminant analysis to study 373 wearing apparel companies. According to Silva (1983), of the firms analyzed by Elisabetsky, 274 were in good financial health while 99 were facing liquidity problems.

The model developed was as follows (ELISABETSKY, 1976):

$$\underline{Z = 1.93 X32 - 0.20 X33 + 1.02 X35 + 1.33 X36 - 1.12 X37}$$

Where:

X32 = Net profit/sales revenue

X33 = Cash and banks/permanent assets (property, plant and equipment, equity investments and deferred charges)

X35 = Accounts receivable/total assets

X36 = Inventory/total assets

X37 = Current liabilities/total assets

According to Matarazzo (2003), the classification employed by Elisabetsky determines that if Z is less than 0.5, the company is insolvent, while Z greater than that indicates solvency.

Kassai and Kassai (1998) pointed out that insolvency prediction models are developed based on a determined sample chosen at the time of the particular study, so they may not have the same efficacy at a later date.

3.2 Kanitz Model

According to Mario (2002), Kanitz was a pioneer in the study of insolvency in Brazil. The author's first work involved formulation of a mathematical framework with balance sheet ratios. Kanitz (1978) utilized discriminant analysis and multiple regression.

Castro Júnior (2003) clarifies that Kanitz, besides projecting future balance sheet numbers, analyzed the balance sheets of various companies and assumed as a criterion that managers would take the same types of decisions in future years that they did in the last year of available data.

The model of Kanitz, which according to Kassai and Kassai (1998) is obtained from information from the financial statements by a “magic” formula, is represented in the following form, where the insolvency factor is determined by:

$$\text{IF} = 0.05x_1 + 1.65x_2 + 3.55x_3 - 1.06x_4 - 0.33x_5$$

IF = Insolvency factor

X1 = Net profit/net worth

X2 = (Current assets + long-term assets)/total liabilities

X3 = (Current assets - inventories)/current liabilities

X4 = Current assets/current liabilities

X5 = Total liabilities/net worth

The model presented by Kanitz does not have a critical point, but rather a critical region, as shown in Figure 1.

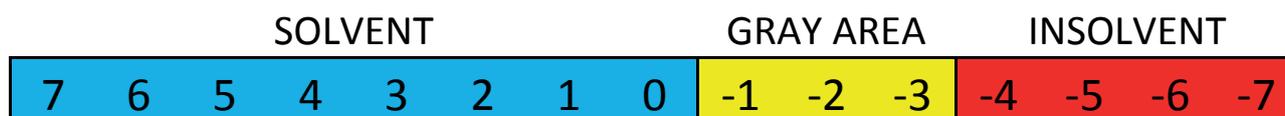


Figure 1: Insolvency Model of Kanitz

Source: Adapted from Matarazzo (2003).

As shown in Figure 1, Matarazzo (2003) explains that the firm will be insolvent if the result of the equation is lower than -3, undefined in between -3 and 0, and solvent if greater than 0.

3.3 Matias Model

In 1978, Matias developed a model to study the solvency of firms. According to Matarazzo (2003), the model’s basic structure is constructed in the following form:

$$Z = 23.792x_1 - 8.26x_2 - 9.868x_3 - 0.764x_4 - 0.535x_5 + 9.912x_6$$

Where:

Z = Total points obtained

X1 = Net worth/total assets

X2 = Financing and bank loans/current assets

X3 = Accounts payable to suppliers/total assets

X4 = Current assets/current liabilities

X5 = Operating income/gross income

X6 = Cash and cash equivalents/total assets

Further according to Matarazzo (2003), this model’s critical point is zero.

3.4 Altman Model

The model developed by Altman (1968) relies on multivariate discriminant analysis to predict the bankruptcy of firms. The author was specifically interested in identifying variables (indexes) with high prediction power. Later, Altman, Baydia and Dias (1979) proposed the following model, in which the critical point is zero, based on his observations between the relations proposed.

$$\begin{aligned} Z1 &= -1.44 + 4.03X2 + 2.25X3 + 0.14X4 + 0.42X5 \\ Z2 &= -1.84 - 0.51X1 + 6.32X3 + 0.71X4 + 0.53X5, \end{aligned}$$

Where:

Z1 = Insolvency factor of Model 1

Z2 = Insolvency factor of Model 2

X1 = (Current assets – current liabilities)/total assets

X2 = Reserves and suspended earnings/total assets

X3 = Total assets

X4 = Book value/total assets

X5 = Sales/total assets

3.5 Silva Model

Pinheiro et al. (2007) present the model to predict insolvency developed by Silva in 1982. Silva's model is based on discriminant analysis and it intended for application to short-term operations.

The ratios used aim to measure dynamic aspects related to the financial cycle of companies, their capacity for growth and generation of resources, as well as aspects associated with their capital structures. Silva (1982) utilized 419 commercial and industrial firms.

The insolvency factor of this model is given by:

$$Z = 0.722 - 5.124E23 + 11.016L19 - 0.342L21 - 0.08L26 + 8.605R13 - 0.004R29$$

Where:

Z = Total points obtained

E23 = Trade bills cashed /trade bills receivable

L19 = Inventory (final)/cost of goods sold

L21 = Accounts payable to suppliers/sales

L26 = Average inventory/cost of goods sold

R13 = (Operating income + financial expenses)/(total assets – average investment)

R29 = Total liabilities/(net income + 0.1 average fixed assets + debt balance from inflation adjustment).

The critical point determined by the model is zero (MATARAZZO, 2003). We now turn our attention to prediction models based on descriptive reports.

4. PREDICTING INSOLVENCY USING DESCRIPTIVE REPORTS

The work of Scotá (2008) is one of the first in Brazil to try to forecast business failure by means of the descriptive information disclosed in companies' reports. He conducted a descriptive and quantitative survey of 30 Brazilian companies, of them 15 solvent and 15 that had gone bankrupt.

In an attempt to test the models developed by Smith and Taffler (2000), Scotá (2008) applied them to Brazilian firms and obtained a success rate of over 95% from one of them, concluding that although the models had been developed in a country other than Brazil, for firms with different characteristics, the results were similar to those of Smith and Taffler (2000).

Chart 2 lists some studies that have sought to predict the future of companies based on descriptive data obtained from reports disclosed by companies.

Authors	Objectives, Methods and Results
Abrahanson & Amir (1996)	Sought to associated the information contained in the “President’s Letter” or similar message with the future financial performance of firms and the price of their shares, using over 1,000 annual reports between 1989 and 1990. Concluded there is an association, even using those reports, which are not regulated or scrutinized by authorities.
Bryan (1997)	Studied the association between the descriptive report and the future financial health of firms and their stock returns. Used 250 “Management Discussion and Analysis” (MD&A) sections of company reports for 1990. The results indicated that the data presented in these reports are significantly associated with the future of companies, particularly the next year.
Smith & Taffler (2000)	Sought to predict the failure of firms employing their discretionary reports, by combining two linear models. Applied the models developed on 66 firms, of them 33 that had gone bankrupt. As a result obtained a correct prediction rate of 98% for the objective model and 95% for the subjective model.

Chart 2: Studies using descriptive reports to make predictions

Source: Adapted from Scotá (2009).

These studies demonstrate that it is possible to predict future scenarios of firms based on descriptive information disclosed by them, even though these reports are not regulated or supervised by specific agencies.

The insolvency prediction models based on descriptive data from firms’ reports employed by Scotá (2008) were those of Smith and Taffler (2000). The first model, called the objective model, relies on searching for keywords in the text.

$$Z = 1.2 + 364.6 (\text{PROF}) + 1.005 (\text{ECON}) - 557.8 (\text{CLOSE}) - 6.4 (\text{NOMDIV}) - 1.005 (\text{LEND}) - 2.8 (\text{BS}) - 718.9 (\text{REC})$$

Where:

Z-score

PROF: (Profit – loss)

ECON: Economy (better)

REC: Recession

CLOSE: Closing (reduction of sales)

NOMDIV: Reduction of dividends

LEND: Loans/debts

BS: Bank support (financial)

The critical point of this model is zero, so when the Z-score is negative, the firm is at risk of bankruptcy. The second model of Smith and Taffler (2000) also produces a Z-score, with the same critical point.

$$Z = 0.41 + 10.4 (\text{Good news}) - 17.0 (\text{Bad news}) - 14.5 (\text{Reduction})$$

Where:

Z-score

Good news – positive performance and positive news regarding dividends (evaluative: benefit)

Bad news – negative performance and negative/no news of dividends (evaluative: adverse)

Reduction – reduction of operations/recession

This model is called subjective because its variables permit judgments and dissonance of analysts or users of the model.

5. RESEARCH METHODS AND PROCEDURES

This study can be characterized as having a descriptive objective. According to Triviños (1987), a descriptive study requires technical delimitations, methods, models and theories. Raupp and Beuren (2008, p. 81) state that “descriptive studies are intermediate between exploratory and explanatory studies, i.e., not as preliminary as the former and not as comprehensive as the latter.”

With respect to procedures, this article can be classified as documental. For Gil (2002, p. 45), “documental research relies on materials that have not yet received analytical treatment or still can be reformulated according to the objectives of the study.” This study can be called documental because we used information disclosed by the companies in their financial statements posted at the website of the Brazilian Securities Commission (CVM).

Regarding the approach, this is a quantitative study. Richardson (1999) points out that quantitative studies employ statistical instruments, both in the collection and treatment of the data. In this respect, to analyze the data we applied the insolvency models developed in Brazil starting in the 1970s, namely those of Elisabetsky (1976), Kanitz (1978), Matias (1978), Altman, Baydia and Dias (1979) and Silva (1982).

We selected firms that had been declared bankrupt, taken from the sample of Scotá (2008). We excluded some companies, because we only used firms that presented insolvency. In some other cases we eliminated firms because it was not possible to calculate all the ratios required by the insolvency models.

Therefore, we opted for an intentionally non-probabilistic sample. The final sample consisted of 13 listed Brazilian corporations that went bankrupt in the study period, as shown in Chart 3.

Nº	Companies	Year	Nº	Companies	Year
01	Casa Anglo Brasileira	1997	08	Império Lisamar	1997
02	Transbrasil	1999	09	Cia Paulista	1997
03	Cia Itaunense	1997	10	Elebra	1999
04	Cia Lorenz	1997	11	Sharp	1998
05	Kalil Sehbe	1997	12	CNV	1997
06	Braspérola	1999	13	Coest	1997
07	Vasp	2003			

Chart 3: Companies in the sample

Source: Adapted from Scotá (2009).

The models used to calculate the insolvency prediction based on accounting numbers were those of Elisabetsky (1976), Kanitz (1978), Matias (1978), Altman, Baydia and Dias (1979) and Silva (1982). In turn, the models employed to calculate the insolvency prediction based in descriptive information from standardized financial statements were those of Smith and Taffler (2000).

We opted to use the values found in Scotá (2008) for the scores of the models based on descriptive information. Scotá (2008) utilized the annual reports to perform his calculations. Our focus here is to verify whether the insolvency prediction models that rely on accounting numbers continue being valid instruments to predict bankruptcy.

6. DESCRIPTION AND ANALYSIS OF THE DATA

In this section we analyze the results of applying the insolvency models to the firms making up the sample. To provide a better analysis, this section is divided into two sub-sections. The first presents the results of applying the insolvency models based on accounting numbers and the second compares these results against those obtained by Scotá (2008) employing models relying on descriptive data.

6.1 Insolvency Prediction Models Based on Accounting Numbers

We obtained the accounting data from the financial statements of the firms in the sample and analyzed the data according to each of the forecasting models: Elisabetsky (1976), Kanitz (1978), Matias (1978), Altman, Baydia and Dias (1979) and Silva (1982).

Table 1 presents the companies utilized to verify the predictive ability of the models and the success rates obtained in the analysis, according to the critical values of the scores of the models.

Table 1: Predictions based on accounting numbers

N°	Companies	Elisabetsky (1976)	Kanitz (1978)	Matias (1978)	Altman, Baydia and Dias (1979)		Silva (1982)
					Z1	Z2	
01	Casa Anglo Brasileira	-0,247	2,928	2,117	-0,783	-0,681	-0,083
02	Transbrasil	-0,921	-2,324	0,385	-1,958	-3,558	-0,450
03	Cia. Itaunense	-1,692	-2,397	-18,883	-1,990	-3,123	-1,185
04	Cia. Lorenz	0,154	4,323	9,096	-0,571	-0,540	0,969
05	Kalil Sehbe	-4,325	5,689	-36,480	-4,522	-3,521	-1,768
06	Braspérola	-1,085	-1,739	-0,965	-2,597	-3,430	-3,948
07	Vasp	-0,057	0,018	-15,451	-1,227	-1,555	-1,152
08	Império Lisamar	-1,057	-0,054	-8,319	-3,408	-3,381	-1,307
09	Cia. Paulista	-0,307	2,038	-0,700	-0,800	-1,150	-7,622
10	Elebra	-0,591	3,162	5,221	-1,079	-2,319	-0,911
11	Sharp	-0,679	0,006	-6,358	-1,824	-2,262	-1,093
12	CNV	0,510	-3,436	-10,996	-4,519	-1,218	-2,099
13	Coest	-0,429	4,646	6,065	-2,242	-1,352	0,283
Percentage of correct predictions		92%	8%	62%	100%	100%	85%
Critical points: Elisabetsky (insolvency when lower than 0.5); Kanitz (insolvency when lower than -3,0); other models (insolvency when lower than 0.0)							

Source: Research data.

Table 1 shows that the majority of the models tested for the sample obtained high success rates in predicting bankruptcy. The standouts were the two models of Altman, Baydia and Dias (1979), which achieved success rates of 100% for this group of companies.

The next best models were those of Elisabetsky (1976) and Silva (1982), with success rates of 92% and 85%. Among the models tested, that of Matias (1978) presented the greatest variation of the indexes obtained, demonstrating great instability in its predictions.

The model that performed worst was that of Kanitz (1978), which only managed to predict the bankruptcy of one firm, CNV. The majority of the indexes obtained by applying the model of Kanitz (1978) indicated the companies were solvent, with a few being in the gray area.

6.2 Insolvency Prediction Models Based on Descriptive Reports

In this topic we added the insolvency prediction models relying on descriptive data in the annual reports and the study carried out by Scotá (2008) employing the models of Smith and Taffler (2000). Scotá (2008) mentions that to adjust a model to the reality of Brazilian companies, he used the annual reports disclosed by the companies.

Table 2 contains the predictions made with the different models and different information sources.

Table 2: Predictions based on accounting numbers and descriptive reports

Nº	Companies	Elisabetsky (1976)	Kanitz (1978)	Matias (1978)	Altman, Baydia and Dias (1979)		Silva (1982)	Smith & Taffler (2000)	
					Z1	Z2		1	2
01	Casa Anglo Brasileira	-0,247	2,928	2,117	-0,783	-0,681	-0,083	1,901	0,810
02	Transbrasil	-0,921	-2,324	0,385	-1,958	-3,558	-0,450	-1,080	-3,215
03	Cia. Itaunense	-1,692	-2,397	-18,883	-1,990	-3,123	-1,185	-3,368	-4,840
04	Cia. Lorenz	0,154	4,323	9,096	-0,571	-0,540	0,969	-1,419	-0,701
05	Kalil Sehbe	-4,325	5,689	-36,480	-4,522	-3,521	-1,768	-7,563	-6,190
06	Braspérola	-1,085	-1,739	-0,965	-2,597	-3,430	-3,948	-4,158	-0,533
07	Vasp	-0,057	0,018	-15,451	-1,227	-1,555	-1,152	1,101	-0,762
08	Império Lisamar	-1,057	-0,054	-8,319	-3,408	-3,381	-1,307	-4,435	-8,947
09	Cia. Paulista	-0,307	2,038	-0,700	-0,800	-1,150	-7,622	-2,115	-3,270
10	Elebra	-0,591	3,162	5,221	-1,079	-2,319	-0,911	-0,945	-6,390
11	Sharp	-0,679	0,006	-6,358	-1,824	-2,262	-1,093	-1,548	-3,881
12	CNV	0,510	-3,436	-10,996	-4,519	-1,218	-2,099	-0,294	-2,990
13	Coest	-0,429	4,646	6,065	-2,242	-1,352	0,283	-1,848	-1,661
Percentage of correct predictions		92%	8%	62%	100%	100%	85%	85%	92%
Critical points: Elisabetsky (insolvency when lower than 0.5); Kanitz (insolvency when lower than -3,0); other models (insolvency when lower than 0.0)									

Source: Research data.

The models of Smith and Taffler (2000) obtained high success rates for the sample of firms utilized, near those obtained by the models based on accounting indicators. The success rates of the two models of Smith and Taffler (2000) were 85% for model (1), known as the objective model, and 92% for model (2), the subjective model.

The average success rate of the models based on accounting numbers was 75%, while the average for the models that rely on descriptive reports was 89%. Therefore, the models using descriptive reports were more successful in predicting insolvency than those based on accounting numbers.

Finally, special mention should go to the models that correctly predicted bankruptcy for all the firms, those of Altman, Baydia and Dias (1979). Although some studies have indicated that prediction models formulated for a particular business setting lose their power when applied in other environments, the tests here indicated good predictive capacity of these models, which rely on accounting numbers in realities that are relatively near each other.

On the whole, the results here show that both the insolvency prediction models based on accounting numbers and those relying on descriptive reports are able to predict the failure of firms.

7. CONCLUSIONS

The aim of this study was to test the ability of some insolvency prediction models to forecast retrospectively the failure of some Brazilian firms that have gone bankrupt. For this purpose, we tested the models of Elisabetsky (1976), Kanitz (1978), Matias (1978), Altman, Baydia and Dias (1979) and Silva (1982). In complementation, we investigated whether models relying on companies' descriptive reports can assist in predicting bankruptcy, using two models developed by Smith and Taffler (2000) as applied by Scotá (2008).

The results show that the majority of the models tested produced high rates of correct predictions. That of Matias (1978) presented the greatest variation between the indexes obtained, demonstrating great instability in its prediction.

The model of Kanitz (1978) presented the lowest rate of correct forecasts, only managing to indicate the bankruptcy one of the 13 companies, CNV. The majority of the scores obtained indicated the companies were solvent, with a few falling in the gray area.

The insolvency models based on descriptive reports on average obtained better prediction rates. Therefore, based on the calculations of the models applied in this sample of failed companies, we suggest that those using information from descriptive reports can be more effective in forecasting insolvency, a matter that should be tested further in other samples.

The most accurate models in predicting bankruptcy were those of Altman (1968). The two models had success rates of 100%. These findings demonstrate that although some studies indicate that forecasting models developed for one business setting can lose validity when applied in other settings, some models can perform well across borders.

In conclusion, both models based on accounting numbers and those relying on descriptive reports are able to predict the failure of firms. It can also be inferred that the majority of insolvency prediction models that make use of accounting numbers can forecast the failure of firms.

The main limitation of this study is that it only applies to the companies investigated, so it is not possible to make generalizations. It is also limited by the models chosen, since others have been proposed that can be tested. For future studies, we suggest choosing other companies that have failed, to see if similar results are found to those here, to solidify these findings. Further investigation can also be given to the advance time frame of the models for effective prediction. Such studies can contribute to and expand on the results of this study.

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