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Analysis of corporate viability in the pre-bankruptcy proceedings

Análisis de la viabilidad empresarial en el preconcurso de acreedores

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Abstract

Companies in financial difficulties can avail themselves of the pre-bankruptcy procedure, prior to its entry in the legal process of insolvency. The objective of this paper is to look for a possible diagnosis of some common distressed firm's characteristics in order to be successful at pre-bankruptcy procedure through artificial intelligence methodologies. Using a Spanish sample of bankrupt and healthy firms, our results show that financial viability and working capital ratios are fundamental for the effectiveness of pre-bankruptcy legal procedure. These findings may help to shed light on the implications for all the stakeholders involved in a pre-bankruptcy procedure.

Keywords: pre-bankruptcy legal procedure, insolvency act, re-organization, insolvency, artificial intelligence methodology.
JEL Classification: G33, K22, M41, C44

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Resumen

Las empresas en dificultades financieras pueden acogerse al preconcurso de acreedores, previo a su entrada en el proceso legal de insolvencias. El objetivo de este estudio es el posible diagnóstico de algunas características comunes que tienen las empresas con dificultades financieras para conseguir el éxito del preconcurso de acreedores, proponiendo el uso de metodologías de inteligencia artificial como complemento a los análisis tradicionales. Utilizando una muestra española de empresas en concurso y "sanas" se obtiene que los ratios de viabilidad financiera y del fondo de maniobra son determinantes para la efectividad del preconcurso. Nuestros resultados tienen importantes implicaciones para jueces, administradores concursales, auditores y gestores de empresas en concursos de acreedores.

Palabras clave: preconcurso acreedores, ley concursal, reorganización, insolvencia, metodologías de inteligencia artificial
Códigos JEL: G33, K22, M41, C44

Introduction

Economic crisis situations cause heavy losses in general for the economy, and in particular for companies. The insolvency of companies causes a significant alteration of macroeconomic figures that are as relevant for the countries as the increase of the unemployment rate, an increase of public debt in relation to the gross domestic product (GDP) or a decrease of the real growth of the GDP. In these circumstances, the focus of the bankruptcy laws is essential for the market, as they can even condition the national economy (LaPorta et al., 1998). It is therefore necessary to make an effort in the possible prediction of its causes and consequences (Du Jardin, 2015; Bauweraerts, 2016). For instance, the resolution of bankruptcy proceedings are different in each country, as there are different bankruptcy laws according to each approach (Weijs, 2012; Georgescu and Baciu, 2014). Therefore, the type of bankruptcy regulation that is established in a country is not a trivial matter. There are economic studies that justify the ways bankruptcy laws can condition the development of a country entrepreneurship (Lee et al., 2011), the national economic growth (Laporta et al., 1998), the economic stability (Beraho, 2010), and even the development of the stock markets (Levine, 1998). In fact, it has been empirically proven how a bankruptcy law can condition foreign investment in a country (Pindado et al., 2008). Furthermore, in countries like Spain, where bank dependency for the financing of companies is very high (Krivogorsky et al., 2011), the problem of insolvency becomes a global problem for the national economy. Because of this, the correct development of insolvency regulation is of utmost importance to promote the economic growth and legal certainty of the investors.

The objective of the Bankruptcy Law (BL) in Spain is to try to solve the financial viability problems of companies through the regulation of a legal procedure. In the case of viable companies that have liquidity problems, the aim is for them to reorganize and remain in the market—through an arrangement procedure—and for those companies that are not viable to disappear from the market through liquidation—through a liquidation procedure—(Fernández, 2004). However, the implementation of the BL, given the adverse situations of the current global economic context, has not been entirely as efficient as the legislator would have liked.

According to the 2011 yearbook of bankruptcy statistics[1], around 93 companies out of 100 that begin bankruptcy proceedings are liquidated.

In the Spanish BL, same as in other legislations at an international level, the legal proceeding is divided into three phases: the 'pre-bankruptcy' or anticipated proposal for settlement, the common phase, and the subsequent phase. In order to favoring refinancing, reducing the cost of the bankruptcy proceedings, and facilitating the procedure, the BL was modified in 2009 and 2011, and recently with the RD 4/2014, to make the 'pre-bankruptcy' more effective, which is the object of analysis of this article. Before requesting the start of the judicial proceeding, other solutions are sought—such as private refinancing—to be able to remain in the market without the weight of the 'bankruptcy' label. To avoid these problems, the aim is to reduce the procedure and improve its efficiency with new tools, such as refinancing agreements and protective shields (Pulgar Ezquerra, 2011).

The 'pre-bankruptcy proceedings' are based on an 'extrajudicial' communication (with a lawyer and a court representative) by the company to inform the Court that negotiations have been started to reach a refinancing agreement or to put forth an anticipated proposal for settlement. This process is subject to several legal modifications to adapt to the economic reality at the time (Olivencia Ruiz, 2015). Its ultimate purpose is to "prevent" the corporate crisis from becoming irreversible through measures that help anticipate the situation of the business and subsequently be able to take ideal remedial actions (Fernández del Pozo, 2010). In this manner, an extension is granted to companies in a situation of insolvency in the short-term, as the law suspends the obligation of the debtor to present the voluntary declaration of bankruptcy for a maximum period of four months. This procedure also blocks the presentation of the obligatory declaration by its creditors. For a company in trouble to be able to access the pre-bankruptcy phase it must fulfill two requirements: having initiated negotiations to obtain a possible anticipated agreement and, within a period of two months, inform the competent court.

During the pre-bankruptcy period, the debtors obtain undeniable benefits, given that the company is able to look for ways to refinance its debt and thus avoid the bankruptcy proceedings; it can plan a possible agreement when it begins the bankruptcy proceedings; or it can file for voluntary bankruptcy without the stress of 'in extremis' situations. However, the pre-bankruptcy phase can also cause harm to the creditors if it is not correctly employed, as they can see their collection expectations reduced or see a greater time delay (Hernández Arranz, 2009). In practice, the implementation of the pre-bankruptcy proceedings have been questioned as some companies (the Rumasa case[2] and its subsidiaries, for example) have used this extrajudicial proceeding for their managers to avoid the risk of obligatory bankruptcy and remain in management, and, in some occasions, to be able to decapitalize it.

Taking the above into consideration, the objective of this study is to analyze the common characteristics of the companies associated to the success of their reorganization in a crisis from an empirical point of view. This with the objective of "diagnosing" in what companies the pre-bankruptcy proceedings would be effective and in which ones these proceedings would be an "induced coma situation", with the ensuing harm to its clients, creditors, and even stockholders, having to initiate the bankruptcy proceedings in an "urgent manner". For this, the financial

[1] Can be consulted on https://www.registradores.org/estaticasm/Estadistica/concursal/Estadistica_Concursal_Anuario.pdf

[2] To learn more about this case, see the following news, among others: http://www.europapress.es/economia/noticia-nueva-rumasa-pide-preconcurso-diez-empresas-20110217191039.html; http://www.cincodias.com/articulo/empresas/nueva-rumasa-sumaria-29-empresas-preconcurso-incluir-hoteles/20110303cdscdiemp_15/.

statements of all companies declared as bankrupt during 2010 in the Community of Madrid, as well as a sample of healthy companies. The year 2010 was selected because it was then that the reform introduced by the Royal Decree-Law 3/2009 of March 27, which allowed the pre-bankruptcy proceedings, came into force. Given that this article analyzes the impact of this legal form, the year in which the change of legislation took effect was selected.

The intensity of the financial crisis has given rise to the appearance of literature that tried to give an answer to the objective presented with parametric methods of the statistical kind. However, in recent years, tools from the fields of biology or physics or, in our case, artificial intelligence have been used to solve problems at the micro and macro levels. Therefore, methodologies based on artificial intelligence (decision trees) have been used to achieve the objective presented, modeling the characteristics of the companies by following a solvency criterion, which would entail a method, among others, to guarantee the continuity of a company in the market.

There are three main contributions in this study. First, it is an empirical study on the economic and financial aspects of bankrupt companies. The empirical investigations in this field are scarce (Saez-Santurun, 2010), mostly due to the difficulty to access the necessary information in several legislations. Second, some economic and financial characteristics that condition the viability of the pre-declaration, which would help interested third parties make decisions in an objective manner. And third, we try to promote the implementation of alternative methods (decision trees) different to those traditionally utilized—(statistical techniques) in general in the social sciences—and to this problem, which allows overcoming some of the inconveniences present in the more traditional methodologies, or offering another view of the same problem.

The article is structured in the following manner: first, we present the legal proceeding for the declaration of bankruptcy in Spain, analyzing its differences and similarities with Mexico. Second, we present the investigation with the development of the sample, the variables of the study and the methodology used. Finally, following the results and their discussion, we present the main conclusions of this investigative work.

Spanish bankruptcy system

Bankruptcy Law in Spain is regulated by law 22/2003, which took effect in September 2004 and which has been modified recently on several occasions as consequence of the impact of the global and European economic crises. Furthermore, said law introduced the creation of one of the specialized commercial courts. Remaining in line with similar European laws, the main characteristic of the BL is that it unifies, in one legal proceeding, the entire judicial insolvency proceeding, denominated 'bankruptcy proceedings'. A diagram of the bankruptcy law can be seen in Figure 1.

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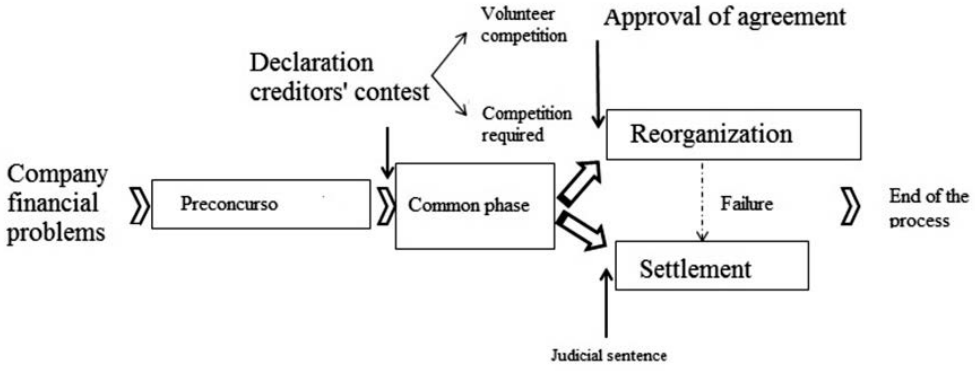

Figure 1. Diagram of the Spanish bankruptcy proceedings.
Source: Own elaboration

The Spanish BL, inspired in the Italian commercial law, allows a bankruptcy prevention mechanism through the negotiation of the interested parties before the declaration of bankruptcy, in order to attempt the survival of the company in the market. In many cases, bankruptcy represents a burden for the companies in their attempt to survive. For example, the trust of third parties decreases when said companies have to present their financial statements expressly indicating the label of "bankrupt". A company can file for bankruptcy provided that it is solvent and that it is only temporarily that it cannot fulfill its financial obligations. Consequently, a reorganization or anticipated agreement entails, for the managers, that the probability of liquidation, the bad image, possible unnecessary costs and bureaucracy that occur after a traditional agreement reorganization are reduced in time.

If a company cannot resort to the pre-bankruptcy phase, then the bankruptcy proceedings begin with the declaration of insolvency being stated before a judge, and the "common phase" begins, where the managers and the insolvency administrators (judges, economists, auditors, creditors…) meet with the judge to analyze the economic and financial situation of the failed company. Said procedure can be obligatory when it is the creditors who go to the judge, or voluntary when it is the directives or managers of the company who go to court and declare that they cannot meet their payment obligations (article 2 of the BL). The distinction between the voluntary and the obligatory declaration of bankruptcy is important, given that in the former the managers are able to continue directing the company, whereas in the latter they will be replaced by the insolvency administrators indicated by the court in charge of the proceeding. The common phase finalizes when, once the report of the insolvency administrators has been submitted to the court, the agreement or liquidation is established between all the pertinent parties of the proceeding. The subsequent phase of the proceeding then begins., this being the last phase. Once the court has accepted the agreement, the creditors and the company can negotiate the reorganization of the company. If such agreement does not exist or the company is not solvent or does not have a future to continue developing its activity, then its liquidation is initiated. Therefore, the purpose of the agreement is to preserve the business and allow the company to remain in the market. The purpose of the liquidation is to sell all the assets of the company and use the money obtained to satisfy the collecting rights of the creditors, finalizing

the life of the company. Upon fulfillment of the requirements of the court, the legal proceeding for the declaration of bankruptcy ends. In any case, it is clear that there are significant differences in the impact that both results have on the company and its managers, employees, suppliers, clients and all third parties with an interest in the same. An efficient legal proceeding should correctly analyze the most adequate final result. This means that a liquidation decision should be made when there are economic and financial problems difficult to resolve, with result manipulation practices and with the integrity of the management compromised, and when the opportunity to succeed is remote. On the other hand, we have those companies that have experienced temporary financial problems due to an economic recession, the lack of dynamism in the sector, and/or the implementation of bad management strategies, but that once reorganized are able to perform their activities without trouble, having entirely refocused their mission, strategy, management and financial structure.

The mexican bankruptcy system

The current financial crisis has brought along a fundamental context change for the survival of companies in Mexico. In fact, some Mexican companies have underestimated—as with previous crises (Watkins, 2003)—the impact of this adverse economic context in their financial statements and the risk management assumed by said companies has become a key factor for their future. A poor risks management of the economic context led to several companies having to file legal proceeding for insolvency, known as "Bankruptcy proceedings", be it at the request of the company or demanded by one of its creditors. Similar to the Spanish case, the number of declarations of bankruptcy in Mexico has significantly increased according to the IFECOM Labor Report.

The current Commercial Bankruptcy Law (LCM for its acronym in Spanish) in Mexico was promulgated and Published on May 12th, 2000, in the Official Journal of the Federation (DOF for its acronym in Spanish), derogating the former Bankruptcy and Suspension of payments Law of 1943. The origin of the LCM had two objectives, one was to reduce the procedural abuses of the Bankruptcy and Suspension of Payments Law, and the other was the introduction of a new current in the treatment of commercial insolvency problems (Rojas Vertiz, 2002). One of the objectives of the new law would be to preserve the value of the companies under financial stress by facilitating a voluntary agreement between the debtors and the creditors and by propitiating extrajudicial solutions. The aim is to obtain a viable plan for reorganization, or, otherwise, to provide an organized and efficient liquidation process, maximizing the value of the assets and legally distributing them among the different creditors.

There are three stages of Bankruptcy in Mexico: the stage before the declaration of bankruptcy, the conciliation stage, and bankruptcy. The first stage is fundamental, the second and third stages can be alternatives. The conciliation stage has the objective of ensuring that the trader and his creditors reach an agreement regarding the terms and conditions under which the trader will meet his payment obligations. This begins when the trader is declared to be in bankruptcy proceedings. The bankruptcy stage, which aims to liquidate will entail selling the entirety of the assets in order to pay its debts. The existence of commercial bankruptcy must be determined before the conciliation or bankruptcy stages. This means that there would be a "previous stage" in which insolvency would be determined. For this, the judge will order a verifier who, through an analysis or audit, will determine if the financial situation of

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the company leads to insolvency according to the criteria established by the LCM. In other words, the fundamental objective of the so-called 'verification visit' is to confirm that the requirements established by the law for the pre-bankruptcy phase are complied. This situation allows companies with financial troubles to present a previous restructuring plan, leaving the reorganization of the business open at the conciliation stage. Therefore, we understand that the pre-bankruptcy proceedings are similar to the Spanish case since their main objective coincides, that is, to commence the restructuring of the company in the conciliation stage (Contreras et al., 2015). This important improvement made to the current LCM was implemented in 2007 by introducing the fourteenth section (articles 339-342).

Thus, in the Mexican case, similar to the Spanish case, it would be advisable to have additional and objective methodologies that make it possible to see the patterns or characteristics of the companies that would successfully overcome the declaration of bankruptcy and that could help the verifier of the LCM in the making of decisions. In other words, the aim is to recognize, in a fast and inexpensive manner, the companies that are economically viable and which can be financially reorganized, and those that are not economically viable, thus proposing their liquidation as soon as possible.

Empirical study for the diagnosis of success in the pre-bankruptcy proceedings.

The viability of the pre-bankruptcy proceeding will have major implications (among which is the possibility to save in costs and time) for all interested parties. Having a simple, fast and precise tool at hand for the discrimination of companies that will be able to survive in the market through the pre-bankruptcy proceedings, is fundamental for the company managers, insolvency administrators, creditors, and judges. With the empirical study proposed we try to answer the following question: Is it viable for a specific company, with certain characteristics, to resort to pre-bankruptcy proceedings?

There are several studies that analyze the insolvency prediction of the companies (see a review of the literature in Tascón and Castaño, 2012, or Altman et al., 2016) and there is also literature on the different methodologies, both traditional (see Bauweraerts, 2016) and of applied artificial intelligence (Kumar and Ravi, 2007; Chaudhuri, 2013, among others). However, specific literature regarding the prediction of insolvency situations prior to the declaration of bankruptcy, object of this study, has not been found.

Study sample

The proposed empirical study is comprised of 1,713 companies, 799 of which are healthy companies and 914 are in bankruptcy proceedings. The elaboration process of the sample began with the selection of all companies in bankruptcy proceedings in the twelve commercial courts of the Community of Madrid, extracted from the website of the Association of Registrars of Spain (www.publicidadconcursal.es) from May to July of 2010. Meanwhile, we selected a sample of healthy companies taking into consideration the sector, the legal form, and the years presented in their financial statements. Once all the companies were selected, the economic and

financial information available in the SABI[3] database was collected, according to their CIF. Those without any available information were eliminated.

Study variables

According to the information of the database and from other previous studies on the prediction of insolvencies (Bhirmani et al., 2010, Tascón and Castaño, 2012, among others), Table 1 presents the variables or characteristics of the companies used for this study.

Table 1.- Variables selected for our study

VARIABLE	Explanation	WEKA Code
Legal Form	Corporation and limited company	Legal_Form
Number of stockholders		NSh
Number of subsidiaries		NSt
Sector	Construction, industry, commerce and services	sector
% of noncurrent assets on the total assets	=Noncurrent assets/total assets	NCA_to_TA
Return on Assets (ROA)	=Operating profit/total assets	ROA
Financial viability ratio	=Interest expenses/EBITDA	Financial Viability ratio
Company size	=Total assets logarithm	Size
Sales	Net business turnover	Sales
EBITDA	=Results before interest and amortization of the assets	EBITDA
Working capital ratio	=(Current asset - current liability)/total assets	WC_to_TA
% Total equity on total liabilities	=Total equity/total liabilities	ETL
Asset turnover	=Sales/total assets	ASSET_ TURNOVER
Financial Independence ratio	=Total equity/total assets	FINANCIAL_ INDEP
Interest coverage ratio*	=Benefit before interests and taxes / interests	DISTRESS_ CRITERIO
Acid test ratio*	=(Current asset – inventory) /current liabilities	cash
Coverage ratio	=Total equity/total liability	guaranty
DECISION VARIABLE		
Capital adequacy ratio*	=Current asset/current liability	insolvency

Source: Own elaboration
*Variables listed with values 1 or 2.

3 More information available at http://www.informa.es/informa/index.php/en/Financial-products/SABI-AMADEUS-y-ORBIS

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It is worth noting that there are some variables that have been assigned value 1 or value 2 since they meet certain characteristics. These characteristics are the values generally taken as reference in the accounting analyses (see Rivero Romero, 2009). These variables are indicated by an asterisk (*) in Table 1 and are:

- interest coverage ratio: has a value of 1 if the interest coverage ratio is inferior to zero and a value of 2 when the interest coverage ratio is equal to or greater than zero. Meaning that if the company can pay its interests with the benefits generated before interests and taxes, the variable will have a value of 2; otherwise, its value will be of 1.

-acid test ratio: has a value of 1 if the ratio is inferior to one, and a value of 2 when said ratio is equal to or greater than one. Companies with acid test ratios inferior to one are not able to pay their current liabilities with the liquidity and the payment rights that they possess, and their viability must be analyzed with caution.

-coverage ratio: has a value of 1 if the ratio is inferior to 2 and a value of 2 when said ratio is equal or inferior to 2. This value is considered to be ideal for the continuity of the company in the market.

-capital adequacy ratio: has a value of 1 if the ratio is inferior to 1.5, considering the company as not financially sound. The ratio has a value of 2 if it is equal to or greater than 1.5. The capital adequacy ratio is considered ideal when the value of the current asset is 50% greater than the current liability, according to the traditional ratio literature. This ratio is considered as the decision variable of our study since there are different studies that justify its use in the prediction of insolvency (see: Bryan et al., 2002; Mongrut et al., 2011; Rose-Green and Lovata, 2013; among others).

Methodology

We resorted to a new approach when addressing several financial problems based on the application of non-parametric techniques and methodologies that are framed in the field of Artificial Intelligence (AI). The fundamentally statistical parametric techniques that are traditionally used present satisfactory results, but they have the limitation that several of the statistical hypotheses required for the model or the distribution that follow data to estimate the parameters (for example, whether there are atypical observations) are not complied with when real data are used. Furthermore, the results are complex to interpret for a user that is not an expert in said techniques. AI techniques, due to not requiring the data to satisfy any type of hypothesis can overcome said limitations and, in any case, they can be used in a complementary manner to provide a new approach to the problem being addressed. These methodologies have been previously tested for insolvency problems and risk prediction (Kumar and Ravi, 2007; Wu, 2010; Chen, 2011; Koyuncugil and Ozgulbas, 2012; Du Jardin, 2015; among others).

Within AI, machine learning consists on the elaboration of computer programs that are capable of generating knowledge through data analysis and then use said knowledge to draw conclusions based on new data. Within the techniques of this approach applied to Spanish data, we found: artificial neural networks, or more recently, *support vector machines* (Gutierrez et al., 2010), rule induction algorithms (Sanchis et al., 2007), rough set methodology (Camacho-Miñano et al., 2015), and decision trees (Díaz et al., 2009). Some of them have an explanatory nature (rule induction and decision trees), others are characterized by a black box approach, such as neural networks, wherein it is difficult to explain the knowledge extracted from their

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utilization. Given the nature of the problem being addressed, we will make use of explanatory techniques. Concretely, we will use the C4.5 decision tree, as it is possibly one of the more flexible decision trees used in different areas, including in relation to the bankruptcy or insolvency of companies (recently: Abellán and Mantas, 2014; Serrano-Cinca and Gutiérrez-Nieto, 2013; Sathyadevan and Nair, 2015; among others).

Algorithm J48 is the free-access Java implementation of algorithm C4.5 which contains WEKA. WEKA is the data mining package developed by the University of Waikato (Witten and Frank, 2005; Bouckaert et al., 2015) with which we have developed the aforementioned algorithm analysis. Below, we will indicate in short, the essential characteristics of this methodology.

The C4.5 methodology, as any decision tree, is a model used to represent the patterns that lie behind a set of data as a set of exhaustive conditions that are mutually exclusive. These conditions are organized according to an arborescent structure comprised by nodes that connect through branches. Decision trees are used in the following manner: to obtain a prediction or classification, each case or example is filtrated as you go down the tree, starting from the root until reaching a leaf (in this work the example will be a company studied for the variables indicated in Table 1). In each node, the example is tested and, according to the result of each test, it continues its path through the tree. The prediction is the class indicated on the sheet in which said case or example has ended once it has traveled the tree.

The way in which trees are generated is based on different learning algorithms. However, all of them generate the tree structure through the realization of recursive divisions from top to bottom of the set of data, becoming smaller each time. This means that the data from the root node, in each node, are divided according to the test result and so on obtaining the sub-sets of the same. The process finalizes when the sub-sets are *pure* or when their *purity* cannot increase. A subset is pure when it contains examples that belong to one class. The objective is to do a lower amount of possible divisions so that the resulting tree is smaller and the set of examples that verify each class is bigger.

Different learning algorithms have been developed for the generation of trees, and in each node said algorithm determines the most adequate division. Among them, the most known and utilized algorithm is the one developed by Quinlan (1993) and implemented in the C4.5 methodology (Quinlan, 2014).

In the C4.5 methodology, the criterion used to do the divisions is supported by a series of concepts from the Information Theory. It departs, like other algorithms, from the premise of taking—from each branch of the tree to make the corresponding division—the variable that provides the most information when classifying the elements that comprise the training set or set of data used to create the tree. To establish the variable that provides the most information, the gain ratio (Gain Ratio $\frac{I(x;y_i)}{H(y_i)}$,) is used, this is, the percentage of the provided information times y_i which is useful to know x.[4]

[4] For more information on these concepts see Quinlan (1993, 2014).

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Obtained empirical results

The C4.5 tree is indicated for the analysis of object classification problems with multiple variables. This entails assigning a series of objects designated by said variables to a previously defined category. We depart from a set of companies characterized by the values of a series of economic, financial and legal variables and we try to assign them to one of these two categories: solvent or insolvent. It is worth remembering that the criterion used to classify the companies into solvent or insolvent is the short-term capital adequacy ratio, as has been previously indicated. The short-term capital adequacy ratio is the quotient divided into the total short-term assets and the total short-term debts, this means that it determines the ability of a company to pay its debts with a maturity of less than twelve months with the resources available in the same period.

For the implementation of the methodology, we have created two information tables, one for healthy companies and another for bankrupt companies, for which there was full information available for all the variables considered. The first of them comprises 799 healthy companies, among which 422 are solvent (class 2) and 377 are insolvent (class 1). The second table is comprised by 914 companies in bankruptcy proceedings, among which 113 are solvent (class 2) and 801 are insolvent (class 1). This means that there are 377 healthy companies with financial problems and 113 companies in bankruptcy proceedings without serious financial problems and both can start pre-bankruptcy proceedings. The first are insolvent and, though they remain in the market, may be reorganized to avoid starting bankruptcy proceedings that will burden their future. The solvent companies in a state of bankruptcy can reorganize in the pre-bankruptcy proceedings, without having to initiate the bankruptcy proceedings since they can pay their debts, and in this manner, avoid the negative impact of the bankruptcy proceedings: client and supplier mistrust, bad commercial image, possible problems with the supply of goods, etc.

Both types of companies—healthy and in a state of bankruptcy—have been evaluated according to the values taken by the 18 economic, financial and legal variables selected and exposed in Table 1.

The two tables have been uploaded to WEKA, which we have used to develop the analysis of the C4.5.

Firstly, we will analyze the model obtained through the C4.5 methodology for healthy companies, as can be observed in Figure 2. Said tree has a success percentage of 97% which justifies its interpretation.

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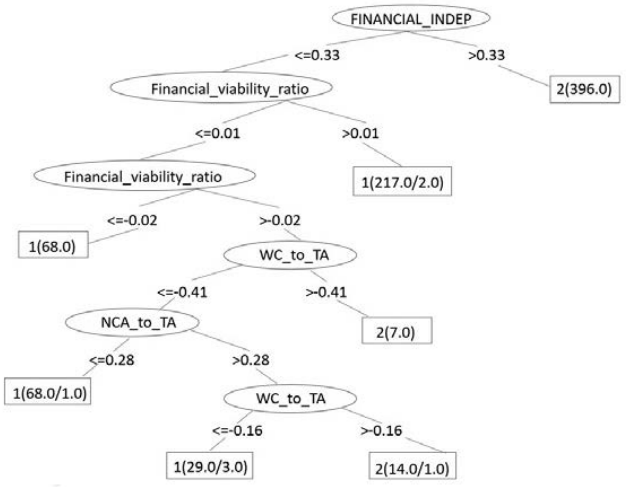

Figure 2**.** Results of the C4.5 tree for **healthy** companies
Source: Own elaboration using the WEKA program
Legend: Financial_indep= financial Independence ratio; Financial_viability-ratio= financial viability ratio; WC_to_TA= Working capital/Total assets; NCA_to_TA= noncurrent assets /Total assets.

Below we explain each one of the decision tree branches, taking into consideration that all variables and the boundary values that appear have been automatically generated by the tree:

-The first branch is the financial independence ratio. All healthy companies, according to the solvency criterion can be classified, first of all, according to the financial independence ratio; that is, the quantity of the net worth in function of the total available resources (assets) of the company to perform its activities. If this ratio is greater than 0.33, the healthy company is viable in the short-term, which means that it can pay its debts in the short-term with its short-term assets. This situation occurs in 396 cases of the sample of healthy companies, a total of 49.5% of the sample. However, if the company has a quantity of funds below 33% of its assets, then the analysis of an additional variable will be required—the financial viability ratio. Therefore,

-The second branch is the financial viability ratio. If this ratio is greater than 0.01, then the healthy branches are not solvent in 217 cases. If the ratio is equal to or lower than -0.02, the healthy company is not solvent in the short-term, either. This condition occurs with 68 companies of the sample. Therefore, the companies with a financial independence ratio equal to or lower than 0.33 and with a financial viability ratio equal to or lower than -0.02 or greater than 0.01 should directly initiate the "express" liquidation process within an abbreviated bankruptcy proceeding. On the other hand, if the financial viability ratio, that is, the results before taxes, interests, and amortizations cover between 1% and -2% of the interest expenses, then we have a third branch in the decision tree.

-The third decision branch is the working capital ratio. If said ratio is greater than 0.41, then the healthy company is solvent, which occurred for seven cases in the sample. However, if the working capital does not cover at least 41% of the total assets, then we would have to analyze a fourth branch of the tree.

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-The fourth branch of the tree is the percentage of noncurrent assets on the total assets, the resources that comprise the operational structure of the company. If said percentage is lower than 28%, the company is not solvent. It is then necessary to initiate a solution to the insolvency problem of the company. If that percentage is greater than 28% of the fixed assets on the total resources, then it will be the working capital ratio which determines the solvency of the companies, obtaining a fifth and final branch.

-The fifth branch of the tree is, once again, the working capital ratio. If said ratio is equal to or lower than -0.16, then the company is not solvent. If the ratio of the working capital is greater than -0.16, the healthy company is solvent and will not have any liquidity problems in the short-term.

Regarding the decision tree of the companies in bankruptcy proceedings, Figure 3 shows that with only one branch, one variable alone (as with the previous tree, the selected variable and the boundary value are both automatically established by the software), companies can be classified into solvent and insolvent with a high classification percentage (greater than 98% in cross-validation).

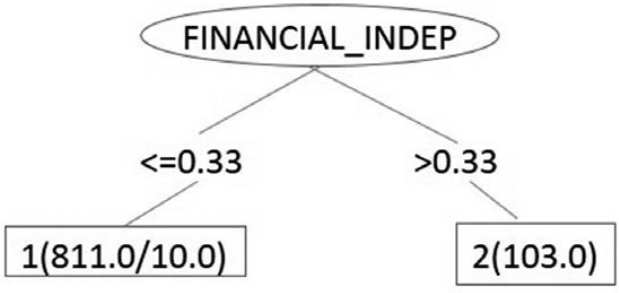

Figure 3. Results of the C4.5 tree for **companies in bankruptcy proceedings**
Source: Own elaboration based on the WEKA program
Legend: Financial-indep= financial independence ratio.

If the financial independence ratio is equal to or lower than 0.33, the companies in bankruptcy proceedings are insolvent. This means that the companies with a net worth value equal to or lower than 33% on its total assets should be liquidated. This is the case for 811 companies from the sample, with 10 errors. If the net worth value is greater than 33% of the total assets the companies in bankruptcy proceedings would be the ideal candidates for a previous reorganization in the pre-bankruptcy phase. This is the case for 103 companies from the utilized sample.

Conclusions and practical implications

The objective of this study is to know the characteristics of the companies associated to a successful reorganization in a situation of crisis, in order to "diagnose" which companies

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could use the pre-bankruptcy proceedings effectively and which companies would only be in an "induced coma situation". According to the sample used, any third party interested in analyzing the efficiency of a pre-declaration situation, in a fast and easy manner, should calculate the value of two key variables: the financial viability ratio and the working capital ratio. According to the figures obtained, it is possible to discriminate if the pre-bankruptcy phase would be successful or if it would only be an unnecessary delay for a problem that is very difficult to solve.

The obtained results have interesting implications for the third parties interested in the viability of companies with financial problems. The resolution of this problem could be readapted to any other bankruptcy legislation at an international level, for example, Mexico, where the LCM establishes a situation prior to the declaration of bankruptcy. If a company is planning to communicate to a judge its wish to initiate pre-bankruptcy proceedings, then the parties involved in said proceedings would have a first diagnosis on the probable success of the pre-bankruptcy proceedings. For example, if a company has a working capital ratio greater than 0.4 and its EBDITA can cover 33% of its interest expenses, then there are high probabilities that the reorganization is viable. This would entail high savings in time, costs and resources, both public (mostly legal) and private. Furthermore, company managers would be able to endorse, with this type of tools, the reorganization of their companies in an objective manner before creditors and, mainly, before the financial entities. The usefulness of the results of the algorithm can also extend to other stakeholders of the company. Particularly, the investors of the company will be able to make investment or divestment decisions, taking into consideration the variables that would condition the solvency or insolvency of the company. For example, if the administrators consider that an increase in capital could prevent the company from initiating bankruptcy proceedings, then its current or future investors can support or reject said increase based on the results of the algorithm. It would also be useful for those investors that look to invest in companies with economic problems in order to obtain high profits in expanding sectors or sectors with a high-risk exposure. In the same manner, once the key variables for the corporate reorganization of the companies are known, creditors would be able to prolong their collection processes or concede payment waiting periods to those companies that comply with the characteristics indicated by the algorithm and which would prevent them from initiating the legal proceedings.

Consequently, the efficiency of the legal proceedings would also improve in general, as the companies that are viable would be reorganized and those that are not would be liquidated almost automatically. In this manner, we would prevent the high costs of legal administrators, the collapse of commercial courts and the delay in the collection of the creditors, among others. Let us remember that in the current financial crisis many economically viable companies have had to initiate bankruptcy proceedings due to the 'domino effect', that is, companies that were granted benefits still had liquidity problems because other companies credited by them could not pay their outstanding debts.

Nevertheless, this work has its limitations. The sample is limited, as it refers to only one autonomous community in Spain (Madrid). In this sense, more studies are needed to support our results. As future lines of research we propose expanding the sample with companies from other countries and at different points in time, so as to be able to generalize our conclusions.

Annex: Example weka code for application J.48 (C4.5)

```
@relation SOLVENCY+BANKRUPTY_DISTRESS

@attribute Legal_Form {1,2}
@attribute NSh numeric
@attribute NSt numeric
@attribute sector {1,2,3,4}
@attribute NCA_to_TA numeric
@attribute ROA numeric
@attribute RATIO_VIABILIDAD_FINANCIERA numeric
@attribute Size_log10 numeric
@attribute Sales numeric
@attribute WC_to_TA numeric
@attribute ROTACION_ACTIVOS numeric
@attribute FINANCIAL_INDEP numeric
@attribute cash {0,1,2}
@attribute garantia {1,2}
@attribute DISTRESS_CRITERIO {0,1,2}
```

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