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Article

Is the external audit report useful for bankruptcy prediction? Evidence using artificial intelligence

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Abstract: Despite the number of studies on bankruptcy prediction using financial ratios, very little is known about how external audit information can contribute to anticipating financial distress. A handful of papers show that a combination of ratios and audit data can provide significant predictive purposes, but a recent paper by Muñoz-Izquierdo et al. (2018) provided an 80% predictive accuracy solely by using the disclosures of audit reports. We complement this study. Applying an artificial intelligence method (the PART algorithm), we examine the predictive ability of more easily extracted information from the report and suggest a practical implication for each user. Simply by (1) finding the audit opinion, (2) identifying if a matter section exist, (3) and the number of comments disclosed, then any user may predict a bankruptcy situation with the same accuracy as if they had scrutinised the whole report. In addition, we also provide an extended literature review about previous studies on the interaction between bankruptcy prediction and the external audit information.

Keywords: bankruptcy prediction; audit report; artificial intelligence; PART algorithm.

JEL Classification: G33, M40, M41, M42, C14.

1. Introduction

During the last 70 years, the development of bankruptcy prediction models has been a challenged worldwide research topic (Sun et al. 2014; Cultrera and Brédart 2016; Altman 2018). Despite the number of studies on this field, according to recent literature, there is still a need to improve the accuracy of prediction models (Balcaen and Ooghe 2006; Du Jardin 2015; Bauweraerts 2016) and a call to apply different sources of data and techniques, such as non-parametric techniques, to tackle this issue (Calderon and Cheh 2002; Zięba et al. 2016; Amani and Fadlalla 2017). This paper aims to contribute to these questions.

The objective of this study is to examine whether or not the external audit report provides significant explanatory power when predicting bankruptcy using artificial intelligence. We propose that the audit opinion, the type of paragraphs and the number of comments included in those paragraphs are significant variables to improve the detection of bankruptcy and, to do so, we apply the PART algorithm.

While considerable research has been devoted to bankruptcy prediction using financial ratios (Altman et al. 2017), very little is known about how external audit information can contribute to anticipating a firm's doubtful financial condition. Considering that the auditing profession ensures the quality of financial statements with the issuance of an opinion in the audit report (Lennox 1999), it seems reasonable to expect that the information extracted from the report could represent a good indicator of a firm's insolvency. Only a handful of papers combine accounting ratios and some audit variables with predictive purposes (Altman and McGough 1974; Hopwood et al. 1989; Laitinen and Laitinen 2009;

Altman et al. 2010; Piñeiro-Sánchez et al. 2013; Cenciarelli et al. 2018). Altman and McGough (1974) were the pioneers in using audit information to predict bankruptcy. Hopwood et al. (1989) focused on some audit qualifications, finding that there is an association between bankruptcy and consistency, going concern and other subject-to qualifications. Altman et al. (2010) suggested that the audit opinion has high predictive power, and firms with audit qualifications, such as severe qualifications or going concern, are more likely to fail since the auditor is questioning its viability. Others, such as Piñeiro-Sánchez et al. (2013), examined the predictive ability of different auditor characteristics. According to their evidence, the auditor rotation, the qualified reports and the non-compliance with deadlines (regarding approval and filing of financial statements) present relevant differences between bankrupt and non-bankrupt firms. Similarly, Cenciarelli et al. (2018) posited that firms audited by industry-expert, large and long-tenured auditors are less likely to fail. They also found that prediction models are more effective when auditor attributes complement financial characteristics.

A recently published paper by Muñoz-Izquierdo et al. (2018) is the only one that uses the disclosures of the audit report in isolation and examines their ability to explain causes of business failure. With a predictive accuracy similar to the one obtained in prior works, this paper suggests that failure is explained by specific internal causes, such as assets' valuation and firms' real and potential debts, and also external circumstances, such as the regulatory framework or changes in the market.

The current paper is a follow-up study of Muñoz-Izquierdo et al. (2018) because we also extract information from the audit report but we introduce new variables and apply a methodology never applied before with auditing variables in isolation for bankruptcy estimation purposes. The findings of this paper also complement those of the aforementioned study because we indicate that the variables that more accurately discriminate between bankrupt and non-bankrupt firms are the audit opinion, the matter sections disclosed in the audit reports and the number of comments included in matter sections and qualification paragraphs. Due to the fact that the audit report is a standardized and regulated document, these variables are easy to detect for any user without the need of scrutinising the whole report or having any special accounting or auditing knowledge. Thus, this empirical evidence shows a practical implication for the users of the audit report: a simple identification of the opinion, the type of paragraphs disclosed and the number of auditors' comments represent a substantive approach to detect and estimate bankruptcy. Last, this study also provides an extensive review of research of the interaction between bankruptcy and auditing research contributing to both areas of knowledge.

2. Literature review and research question

Auditors are required to express in the audit report if the likelihood of default is high during the one-year period following the issuance of the document (McKee 2003). Although the role of auditors is not expected to be a predictor of bankruptcy, stakeholders might be dissatisfied if a firm fails immediately after receiving an unqualified (clean) opinion. This issue has persisted for many years, and the auditing literature has considered audit quality from the viewpoint of the users of financial statements. Indeed, during the last global financial crisis, companies sought financial support within a short period after receiving an unqualified opinion (Sikka 2009). Hence, since then, researchers have paid more attention to the association between bankruptcy and the auditing profession, suggesting that the propensity to issue going concern opinions prior to bankruptcy has increased after a crisis (Geiger et al. 2014). However, evidence for the auditing profession's ability to warn investors about upcoming failures is not unanimous because other prior studies suggested that investors perceive audit reports as informative (Dopuch et al. 1987; Piñeiro-Sánchez et al. 2013), emphasising that audit opinions provide explanatory power for predicting bankruptcy (Kim et al. 2008; Altman et al. 2010).

We have conducted a systematic literature review to organise and narrow the prior literature on this matter, in which we address the integration between the social science disciplines of auditing and bankruptcy.

2.1. Systematic literature review: scope of the review

We compiled all academic papers from the ISI Web of Knowledge database as of October 2016, according to two keywords: "audit" and "bankruptcy". The preliminary search identified many

papers focused on the broad areas of bankruptcy. The process of reading the abstracts and introductions of the articles led to the further elimination of studies outside the scope. After filtering the results, 67 articles about the integration between auditing and bankruptcy remained for our study. With the purpose of systematising and organising the literature, we assembled and classified these papers according to their main themes, dividing them into four lines of research: the effects of auditing; audit quality and auditor independence; audit opinion prediction; and bankruptcy prediction using auditing. A list of all of the reviewed articles appears in Table 1, explaining their samples, methodologies and key findings.

Table 1. Literature review of bankruptcy and auditing

Studies/year	Sample (country/type of firms/years/number)	Key findings/methodology
Line of research: effects of auditing		
Lowe and Reckers (1994)	US / 92 prospective jurors	Outcome knowledge bias jurors' evaluations of the auditor's judgement / Experiment
Menon and Williams (1994)	US / Public / 1990 / 100 L&H clients and 4,523 non-L&H clients	The disclosure of bankruptcy has an adverse effect on market prices and the market does not react to an auditor's replacement / Multivariate test (OLS)
Chen and Church (1996)	US / Public / 1980-1988 / 98 bankrupt	Firms receiving GC opinions experience less negative excess returns in the period surrounding bankruptcy filings than those receiving clean opinions / Multivariate test (logit)
Buchman and Collins (1998)	US / Public / 1977 / 60 with qualified opinions for litigation uncertainty and 331 with unqualified	Qualified opinions are useful to financial statement users in predicting material litigation losses / Multivariate test (logit)
Charitou et al. (2007)	US / Public / 1986-2004 / 859 bankrupt and 859 non-bankrupt	Managers of highly distressed firms shift earnings downwards before filing for bankruptcy / Multivariate test (earnings management accrual models)
Blay et al. (2011)	US / Public / 1989-2006 / 431 with GC opinion and 431 without	GC opinions represent a risk communication to the equity market and result in a shift of the market's perception of distressed firms / Multivariate test (models based on Barth et al. 1998)
Van Caneghem and Van Campenhout (2012)	Belgium / Private / 2007 / 79,097 SMEs	The amount and quality of financial statement information are positively related to SMEs' financial structures (leverage) / Multivariate test (OLS)
Stanisic et al. (2013)	Serbia / 2007-2011 / 163 audit reports of 33 banks	Special attention should be paid to banks with explanatory paragraphs or qualifications on their auditors' reports / Univariate analyses
Amin et al. (2014)	US / Public / 2000-2010 / 114 year observations with GC opinions and 5,343 without	There is a positive relationship between the issuance of a GC opinion and the firm's subsequent cost of equity capital / Multivariate test (models based on Khurana and Raman (2006) and Ogneva et al. (2007))
Eutsler et al. (2016)	US / Public / 1995-2012 / 314 fraud firms	Auditors are penalised for documenting their awareness of fraud risk if subsequent financial statements are fraudulent / Multivariate test (probit)
Line of research: auditor independence and audit quality		

Schwartz and Menon (1985)	US / Public / 1974-1982 / 132 failed and 132 non-failed	Greater tendency of failed firms to switch auditors than non-failed firms; neither qualifications nor management changes are associated with auditor displacement in failing firms / Univariate analysis
McKeown et al. (1991)	US / Public / 1974-1985 / 134 failed and 160 non-failed	Auditors are less likely to modify opinions of failed firms that are large, have ambiguous probabilities of bankruptcy, or have shorter lags between fiscal year end and audit opinion dates / Multivariate test (logit)
Pratt and Stice (1994)	US / 243 responses	Poorer firms' financial conditions are associated with higher levels of litigation risk, more audit evidence and higher audit fees / Questionnaires to Big 6 partners
Carcello et al. (1995)	US / Public / 1972-1992 / 446	Increase in the propensity to modify bankruptcy-related opinions after the issuance of SAS No. 34 but not after SAS No. 59 / Multivariate test (logit)
Raghunandan and Rama (1995)	US / Public / 1987-1991 / 174 and 188 distressed from pre- and post-SAS No. 59 periods, respectively	After SAS No. 59 became effective, auditors were more likely to issue GC opinions for distressed non-bankrupt firms and for bankrupt firms prior to failure / Multivariate test (logit)
Ragothaman et al. (1995)	US / Public / 1960-1980 / 34 error and 58 non-error	A prototype expert system that evaluates material errors and potential fraud classifies firms into error and non-error categories correctly / Rule induction
Daily (1996)	US / Large / 1988-1993 / 53 bankrupt and 53 non-bankrupt	No association between affiliated director representation on audit committees or institutional holdings and the incidence of bankruptcy / Multivariate test (logit)
Carcello et al. (1997)	US / Public / 1985-1991 / 248 bankrupt and 440 non-bankrupt	Any evidence of a significant SAS No. 59 effect is highly dependent on the transition period treatment / Multivariate test (logit)
Krishnan and Krishnan (1997)	US / Public / 1986-1994 / 141 auditor resignation firms	Resignation firms differ from dismissal firms along dimensions that capture the likelihood of litigation: distress, the variance of abnormal returns, auditor independence, tenure and GC opinions / Multivariate test (logit)
Louwers (1998)	US / Public and private / 1984-1991 / 808 distressed firms	When issuing GC opinions, auditors focus on the client's financial condition and other indicators of financial distress and not on factors related to litigation or loss of revenues / Multivariate test (logit)
Louwers et al. (1999)	US / Public / 1984-1994 / 210 with first-time GC opinions	The "self-fulfilling prophecy" effect has little impact on future company prospects / Multivariate test (logit)
Carcello and Neal (2000)	US / Public / 1994 / 223 distressed	The greater that the percentage of affiliated directors on the audit committee is, the lower that the likelihood is of receiving a GC opinion / Multivariate test (logit)
Vanstraelen (2000)	Belgium / Large / 1992-1996 / 398 distressed and 398 non-distressed	Long-term auditor-client relationships increase the likelihood of an unqualified opinion / Multivariate test (logit)
Citron and Taffler (2001)	UK / Public / 1986-1993 / 99 with GC opinions and 99 without	No empirical support for the self-fulfilling prophecy in UK / Multivariate test (logit)

Geiger and Raghunandan (2001)	US / Public / 1991-1998 / 383 bankrupt	The likelihood of issuing prior GC opinions for bankrupt firms decreased after the Private Securities Litigation Reform Act (1995) / Multivariate test (logit)
DeFond et al. (2002)	US / Public / 2000 / 1,158 distressed	There is no association between non-audit service fees and impairment of auditor independence / Multivariate test (logit)
Vanstraelen (2002)	Belgium / Large / 1992-1996 / 392 bankrupt, 392 distressed non-bankrupt and 392 non-distressed non-bankrupt firms	In a limited litigious environment, the likelihood of issuing GC opinions decreases with higher audit fees and higher proportions of client losses / Multivariate test (logit)
Geiger and Raghunandan (2002)	US / Public / 1996-1998 / 117 distressed	There is an inverse relationship between audit tenure and audit reporting failures / Multivariate test (logit)
Carcello and Neal (2003)	US / Public / 1988-1999 / 124 with GC opinions and 250 without	Audit committees with greater independence are more effective in protecting auditors from dismissal after the issuance of first-time GC opinions; also, the association between committee independence and auditor protection from dismissal has grown stronger over time; finally, the turnover rate for independent committee members increases after auditor dismissals / Multivariate test (logit)
Joe (2003)	US / 90 in-charge auditors from an international public accounting firm	Negative press coverage increases auditors' perceptions of clients' probability of failure, leading more qualified opinions / Experiment
Ruiz-Barbadillo et al. (2004)	Spain / Public / 1991-2000 / 1,199 year observations of distressed firms	For a distressed company, audit quality affects the likelihood of receiving a GC opinion / Multivariate test (logit)
Geiger et al. (2005)	US / Public / 2000-2003 / 226 distressed	Auditors were more likely to issue GC opinions in the period after December 2001, with the number increasing even more in 2002-03 due to the Sarbanes-Oxley Act (2002) / Multivariate test (logit)
Carey and Simnett (2006)	Australia / Public / 1995 / 1,021	For long audit partner tenure, there is a deterioration in audit quality, measured by a lower propensity to issue GC opinions / Multivariate test (logit)
Cunningham (2006)	-	Financial statement insurance could be a way to restructure the auditing industry, so large audit firms can leave without upsetting the financial system / Theoretical study
Knechel and Vanstraelen (2007)	Belgium / Large / 1992-1996 / 309 distressed bankrupt and 309 distressed non-bankrupt	Auditors are not less independent over time, nor do they become better at predicting companies' failures / Multivariate test (logit)
Carey et al. (2008)	Australia / Public / 1994-1997 / 68 with first-time GC opinions and 68 without	Audit switching is positively associated with the issuance of GC opinions; also, the issuance of a first-time GC opinion leads to a loss of clients; however, there is no evidence of the self-fulfilling prophecy / Multivariate test (logit)
Gaeremynck et al. (2008)	Belgium / Public and private / 1997 / 200 distressed	While solvency characteristics of an audit-firm portfolio are positively associated with the financial reporting quality amongst firms, there is no association between reporting quality and the portfolio size / Multivariate test (logit)

Robinson (2008)	US / Public / 2001-2004 / 209 bankrupt	There is a positive association between the level of tax services fees and the likelihood of correctly issuing a GC opinion prior to bankruptcy filing / Multivariate test (logit)
Callaghan et al. (2009)	US / Public / 2001-2005 / 92 bankrupt	There is no connection between the issuance of GC opinions and audit and non-audit fees / Multivariate test (logit)
Feldmann and Read (2010)	US / Public / 2000-2008 / 565 bankrupt	While the issuance of GC opinions increased sharply in 2002-03 compared to 2000-01, the number decreased immediately after returning to the pre-Enron level / Multivariate test (logit)
Lim and Tan (2010)	US / Public / 2000-2005 / 12,783 year observations	Audit quality is higher for firms audited by industry specialists relative to non-specialists when auditor tenure increases / Multivariate test (qualified discretionary accruals model (McNichols 2002)
Stanley (2011)	US / Public / 2000-2008 / 31,057 year observations	There is little evidence of an association between audit fees and changes in clients' solvency, including bankruptcy / Multivariate test (audit fee model, adapted from DeFond et al. (2002) and others)
Arnedo-Ajona et al. (2012)	Spain / Public and private / 1992-2002 / 236 bankrupt and 236 non-bankrupt	Significant increases in the probability of bankruptcy following a GC opinion are limited to those cases in which the opinion was considered unexpected / Multivariate test (OLS)
Carey et al. (2012)	Australia / Public / 1995-1996 and 2004-2005 / 142 with GC opinions	Auditors maintained GC reporting accuracy before and after corporate collapses in 2001 / Multivariate test (logit)
Basioudis et al. (2012)	US / Public / 2000-2007 / 10,394 year observations of distressed firms	High non-audit fees affect auditor independence only when audit tenure is long or when auditor quality is poor / Multivariate test (logit)
Chen et al. (2013)	US / Public and private / 2000-2007 / 801 year observations with first-time GC opinions and 11,528 without	The likelihood of receiving a GC opinion is negatively associated with the level of insider selling / Multivariate test (logit, probit and OLS)
García-Blandón and Argiles-Bosch (2013)	Spain / Public / 2001-2009 / 881 year observations	The probability of issuing audit qualifications decreases with audit tenure / Multivariate test (logit)
Geiger et al. (2014)	US / Public / 2004-2010 / 414 bankrupt	The propensity of issuing a GC opinion prior to bankruptcy increased after the GFC / Multivariate test (logit)
Rodríguez-López et al. (2014)	Galicia (Spain) / Private / 1990-1997 / 60 distressed and 60 non-distressed	Distress prediction models that use financial ratios show higher performance rates than audit-based forecast models / Multivariate test (MDA and logit) and neural networks
Aguiar-Díaz and Díaz-Díaz (2015)	Spain / Private / 2007-2010 / 733 distressed	Auditors' behaviours change depending on the client size, suggesting that larger auditors provide higher audit quality for larger clients / Multivariate test (probit) and simultaneous equation model
Kuhn et al. (2015)	One firm (Frontier Airlines, a low-cost US airline)	The development of a systems design theory for continuous auditing systems / Case study
Kumar and Lim (2015)	US / Public / 1996-2000 / 4,669 Andersen clients and 17,793 other Big 5 clients	Andersen's audit quality did not differ materially from its peers prior to its failure / Multivariate tests (earnings response

		coefficients, magnitudes of abnormal accruals, propensity to issue GC opinions, the usefulness of GC opinions in predicting bankruptcy) and frequency of AAER
Shu et al. (2015)	Taiwan / Public / 1999-2010 / 9,876 year observations	The level and volatility of audit report lag are positively related to clients' credit risk / Multivariate test (logit)
Read and Yezegel (2016)	US / Public / 2002-2008 / 401 bankrupt	There is no association between audit tenure and Big 4 firms not issuing prior GC opinions to bankrupt firms, and there is a non-linear association for non-Big 4 firms / Multivariate test (logit)
Line of research: audit opinion prediction		
McKeown et al. (1991)	US / Public / 1974-1985 / 134 bankrupt and 160 non-bankrupt	Firms that do not receive qualified opinions are more likely to have ambiguous bankruptcy probabilities, to be larger, and to have shorter time periods between their fiscal year ends and audit report dates than those that do receive GC opinions. Also, hidden fraud does not explain auditors' failure to modify opinions of distressed companies that go bankrupt / Multivariate test (logit)
Lenard et al. (1995)	US / Public / 1982-1987 / 40 with GC opinion and 40 without	Neural networks are proposed as a robust alternative for auditors to support their issuance of GC opinions / Neural networks and multivariate test (logit)
McKee (1995)	US / Public / 1986-1989 / 30 with GC opinion and 30 without	Induction algorithm predicts bankruptcy using a simple and theoretically consistent model with 97% accuracy / Inductive inferencing algorithm
Lundberg and Nagle (2002)	US / 55 professional auditors	Professional auditors edit crucial signals, but the extent of the post-decision editing depends on the task and the presence/absence of feedback / Experiment
Zdolsek and Jagric (2011)	UK and Ireland / Public / 1997-2002 / 265 with qualified opinion and 265 with non-qualified	Development of a model to identify qualified opinions using accounting ratios / Multivariate test (logit)
Cassell et al. (2013)	US / Public / 2004-2009 / 6,702 year observations with comment letter	Low profitability, high complexity, engaging a small audit firm and weaknesses in governance are positively associated with the receipt of SEC comment letters / Multivariate tests (logit and OLS)
Line of research: bankruptcy prediction using auditing		
Casterella et al. (2000)	US / Public / 1982-1992 / 100 bankrupt	Auditors do not appear to be able to predict either bankruptcy filings or resolutions / Multivariate analysis (logit)
McKee (2003)	US / Public / 1991-1997 / 146 bankrupt and 145 non-bankrupt	Rough set models do not provide significant comparative advantage regarding prediction accuracy over auditors' methodologies / Artificial intelligence (rough sets)
Kim et al. (2008)	Republic of Korea / 1991-2003 / 35 firms that recovered from financial distress and 24 non-recovered	Audit opinion, client risk and client size are accurate predictors of the survival prospects of distressed firms / Multivariate test (logit)

Altman et al. (2010)	UK / Private / 2000-2007 / 5.8 million SMEs, of which 66,000 failed	Creditors' legal actions, company filing histories, comprehensive audit reports and audit opinions contribute to increasing the default prediction power of risk models for SMEs / Multivariate test (logit)
Piñeiro-Sánchez et al. (2012)	Galicia (Spain) / Private / 1998-2008 / 101 distressed and 101 non-distressed	The accumulation of qualified opinions and high auditor rotation rates are reliable measures of credit risk and predictors of bankruptcy / Multivariate test (logit)
Piñeiro-Sánchez et al. (2013)	Galicia (Spain) / Private / 1998-2008 / 98 distressed	High auditor rotation, qualified reports, and non-compliance with deadlines of financial statements' publication are accurate indicators of financial distress / Multivariate test (logit)
Van Peursem and Chan (2014)	New Zealand / Public / 2001-2010 / 25 failed and 25 non-failed	There are significant differences between failing and non-failing firms that can be detected using financial ratios and audit data / Univariate analysis

In Table 1, GC: going concern; SAS: Statement on Auditing Standards; SMEs: small and medium-sized enterprises. In the Sample column: US: United States; UK: United Kingdom; L&H: Laventhol and Horwath. In the Key findings/methodology column: SEC: Securities and Exchange Commission; OLS: ordinary least squares; GFC: global financial crisis; MDA: multiple discriminant analysis; AAER: Accounting and Auditing Enforcement Releases.

2.1.1. Line of research: effects of auditing

Qualified opinions issued by auditors could have an impact on different aspects. Audited financial statements with qualifications or even emphasis of matter paragraphs should be reviewed more carefully than unqualified audit reports (Stanisic et al. 2013). This advice is especially salient when qualifications are related to going concern uncertainties. Going concern opinions can be interpreted as a communication of risk to the equity market (Blay et al. 2011), they have an adverse effect on market prices (Menon and Williams 1994) and can cause an increase in the subsequent cost of capital (Amin et al. 2014).

2.1.2. Line of research: auditor independence and audit quality

Per our review of the research, many studies have evaluated audit quality. Audit quality is one of the most relevant issues facing the auditing profession, and it depends on the auditor's competence and independence (Vanstraelen 2000). Competence relies on the auditor's knowledge and technological capabilities, and prior studies have shown that auditors are capable of discovering errors in the accounting system (Kida 1980).

Since audit quality is crucial for the effectiveness of the auditing profession (Vanstraelen 2000), factors that can impact independence, such as the pricing of audit services (Vanstraelen 2002; Robinson 2008; Callaghan et al. 2009; Stanley 2011; Basioudis et al. 2012), auditor tenure (Geiger and Raghunandan 2002; Carey and Simnett 2006; Knechel and Vanstraelen 2007; Read and Yezegel 2016), audit report lags (Shu et al. 2015), auditors' decisions to resign (Krishnan and Krishnan 1997), auditor switching (Schwartz and Menon 1985; Carey et al. 2008), or the composition of the audit committee (Carcello and Neal 2000, 2003), have been extensively studied. The issuance of going concern opinions has been also accepted as a measure of auditor independence and quality throughout the literature (Carey and Simnett 2006; Robinson 2008; DeFond and Zhang 2014). Because auditor independence is difficult to assess directly, other common proxies used in the literature have been linked to characteristics of clients, such as their size (McKeown et al. 1991; Aguiar-Díaz and Díaz-Díaz 2015) and financial condition (Pratt and Stice 1994; Louwers et al. 1999).

Although the empirical evidence is not unanimous, many studies have supported auditor independence. For instance, Louwers et al. (1999) confirmed that their assessments focused on the client's financial condition and other indicators of financial distress and not on factors related to litigation risk or loss of clients. Also, DeFond et al. (2002) did not find an association between non-

audit fees and impairment of independence, and Knechel and Vanstraelen (2007) stated that independence is maintained over time.

Additionally, audit quality has received increased attention after regulatory changes, corporate collapses or economic crises. Carcello et al. (1995) found that qualified opinions increased after the issuance of Statement of Auditing Standard (SAS) No. 34 and not after SAS No. 59. While Feldmann and Read (2010) argued that going concern opinions increased sharply immediately after the Enron collapse, Carey et al. (2012) showed that the likelihood of these opinions returned to pre-Enron level shortly thereafter. Finally, Geiger et al. (2014) posited that the propensity to issue going concern opinions increased after the recent global financial crisis.

Qualified reports might be interpreted as external signals of potential financial instabilities (Buchman and Collins 1998); thus, they also communicate information about audit quality (Piñeiro-Sánchez et al. 2013). Once judgements about audit quality and auditor independence have been discussed, the forecasting relevance of qualified opinions can be examined (Piñeiro-Sánchez et al. 2013).

2.1.3. Line of research: audit opinion prediction

Prior research has shown that auditors signal bankruptcy in approximately half of the cases in which companies subsequently file for bankruptcy (McKee 2003; Laitinen and Laitinen 2009). In our review of the research, some studies assessed the circumstances in which the audit opinion can be predicted more accurately. McKeown et al. (1991) suggested that auditors issue less qualified opinions to larger firms, to firms with shorter time lags between the fiscal year end and the audit opinion dates, and when the probability of bankruptcy is ambiguous. Additionally, empirical evidence has also shown that accounting data can be used to identify qualified opinions, and different methodologies, such as logistic regression (Zdolsek and Jagric 2011), neural networks (Lenard et al. 1995) or inductive inferencing algorithms (McKee 1995), have been applied for this purpose.

2.1.4. Line of research: bankruptcy prediction using auditing

In the literature, prior works have found associations among audit quality, financial distress and qualified reports (Blay 2005; Arnedo-Ajona et al. 2012). However, there seems to be no consensus on the accuracy of auditing information to predict the bankruptcy or the survival of firms. On the one hand, it is argued that auditors are not able to predict either bankruptcy filings or resolutions (Casterella et al. 2000). On the other hand, other researchers agree with the idea that differences between failing and non-failing firms might be detected using financial ratios and audit data (Van Peursem and Chan 2014). Some audit information contributes to increasing default prediction power, such as the type of audit opinion, the accumulation of qualified opinions or a high auditor rotation (Kim et al. 2008; Altman et al. 2010; Piñeiro-Sánchez et al. 2012, 2013).

2.2. Research question development

Although the auditing profession ensures the credibility of firms' financial statements, it seems that information related to external auditing has not been well studied as a measure of bankruptcy prediction, so research opportunities in this area still exist.

The main role of the external auditors is to guarantee the reliability of the financial statements presented by any company. Thus, it seems that the information included in audit reports is likely to improve the accuracy of bankruptcy prediction modelling. As per this reasoning, this information should be incorporated as explanatory variables in the statistical models. Then, the research question to be investigated is specified as follows:

Research question: Which is the information of external auditing that helps to predict bankruptcy?

We expect that information about external auditing, included as explanatory variables in bankruptcy prediction modelling, will improve the power of prediction models to detect bankruptcy. We consider that our work may complement previous studies. This is the first study that makes such an extensive application of the audit report as a bankruptcy predictor. Also, this is a novel approach

as the audit variables are used in isolation, not in combination with accounting data or non-financial information, and a non-parametric technique (an artificial intelligence called the PART algorithm) is applied to answer this research question.

3. Methodology

3.1 Sample and the dependent variable

As per previous bankruptcy studies, in the present work, we apply a matched sample of bankrupt and non-bankrupt firms (Schwartz and Menon 1985; Carcello and Neal 2003; Knechel and Vanstraelen 2007; Blay et al. 2011). We selected an ad-hoc sample of 808 Spanish private non-financial audited firms, evenly divided between bankrupt and non-bankrupt, prepared manually from the entire population of firms in the Spanish Bureau Van Dijk (hereafter BVD) database.

We consider a company to be bankrupt if it has filed for bankruptcy protection (Piñeiro-Sánchez et al. 2013). Thus, we identified all bankrupt firms included on the database that had filed for bankruptcy proceedings as of January 31st, 2015 (1,821 firms), and we extracted their financial and audit data from this source for the fiscal year prior to the bankruptcy filing date. The filing dates were also manually collected from the "Registro Público Concursal" (the official Spanish source of bankruptcy data), as they did not appear in the BVD database. All of the bankruptcy filing dates along the sample belong to the 2004-2014 period. Out of the 1,821 firms, the final bankrupt sample consisted of 404 observations as we dropped firms due to missing data.

We subsequently matched manually each bankrupt observation with a non-bankrupt firm, extracting also their financial and audit data from the BVD database for the correspondent year -the year identified for each bankrupt pair-. The matching procedure was done by year, firm size -using the measure of total assets- and industry, as in prior literature (Schwartz and Menon 1985; Knechel and Vanstraelen 2007). Therefore, the process resulted in a total sample of 808 firms: 404 bankrupts, matched with 404 non-bankrupt firms.

Following prior literature, we use a dummy variable (*BANKRUPT*) as the dependent variable (Piñeiro-Sánchez et al. 2013) because it provides a legal, objective and narrow definition of bankruptcy, as it represents the start of court bankruptcy proceedings. The variable *BANKRUPT* takes the value of 1 if the firm has filed for bankruptcy proceedings, and 0 otherwise.

3.2. Independent variables: audit report variables

In this paper, the independent or explanatory variables of bankruptcy are related to the audit report (see Table 2 for a definition of the independent variables). The first variable tested is the audit opinion issued in the period prior to bankruptcy -or the correspondent year for the non-bankrupt firms-. We examine the role of the opinion in predicting bankruptcy using a dummy variable (*AUDIT_OP*) with the following two categories: qualified (1) and unqualified (0) opinion. We expect the opinion to contribute to distinguishing between bankrupt and non-bankrupt firms, according to prior findings (Altman et al. 2010; Piñeiro-Sánchez et al. 2013).

The second and third independent variables of this study represent the type of paragraph that auditors include in the report (if any). The dummy variable *EMPHASIS* takes the value of 1 if an emphasis of matter paragraph is added in the report, and 0 otherwise. Similarly, the categorical variable *SCOPE_VIOLATIONS* has a value of 1 when either a qualification regarding a scope violation or a qualification due to a violation of generally accepted accounting principles (GAAP) is included, 2 when both qualifications are issued in the report, and 0 if the opinion is unqualified. In line with the expectations for the *AUDIT_OP* variable, we hypothesize that the inclusion of any of these paragraphs in the audit report reveals a sign of possible bankruptcy, indicated by the auditor. The implications of matter sections and qualification paragraphs are different for stakeholders. A qualification provides a statement on material uncertainties related to events that might cast significant doubt about the firm's ability to continue as a going concern. However, emphasis sections point out matters appropriately presented in the firm's financial statements of such importance that

is fundamental to users' understanding. The emphasis of matter sections do not qualify opinions, so users of the audit report might get less disturbed by them (Herbohn and Ragunathan 2008).

Furthermore, not only we test the type of paragraphs disclosed in the audit report but also the number of comments mentioned by auditors in those paragraphs. We incorporate a categorical variable (*NUMBER_COMM*) based on the idea that an increase in the number of comments might point to higher chances of bankruptcy and more concerns for users when reading the audit report. This variable takes the value of 0 when no comments are disclosed, and 1 to 11 in agreement with the number of comments shown. 11 comments are the maximum number found in one firm of our database. We identified and counted the comments by reading and labelling manually all disclosures of our sample's reports (for a detailed explanation of the process, please see Muñoz-Izquierdo et al. 2018). Most of the comments that auditors mention are related to accounting elements, such as valuation of assets, liabilities, accumulated losses, or negative working capital, but also auditors write about regulatory issues, concerns regarding markets in which firms operate, or companies being involved in legal processes. A definition of all variables appears in Table 2.

Table 2. Classification and description of the audit report variables in this study

AUDIT OPINION	***AUDIT_OP***	Dummy variable with a value of 1 if the auditor's report is qualified, and 0 if it is unqualified.
TYPE OF PARAGRAPH	***EMPHASIS***	Dummy variable with a value of 1 if the auditor's report has an emphasis of matter paragraph, 0 otherwise.
	SCOPE_VIOLATIONS	Categorical variable with a value of 0 if no qualifications appear in the report, 1 if the audit report has a qualification due to a scope limitation or due a GAAP violation, and 2 if the report shows both.
NUMBER OF COMMENTS	***NUMBER_COMM***	Categorical variable with a value of 0 if no comments are disclosed in the report, and 1 to 11 according to the number of comments shown.

Table 2 summarizes the independent variables used in this study or the audit report variables.

3.3. Artificial intelligence methodology: the PART algorithm

In spite of the popularity of parametric models (such as the commonly used multivariate discriminant analysis or the logit regression model) for bankruptcy prediction, another research approach at present to tackle financial problems is based on non-parametric techniques, such as artificial intelligence (Calderon and Cheh 2002; Zięba et al. 2016; Amani and Fadlalla 2017). While parametric techniques show satisfactory results, they have a drawback when applied to real bankruptcy data because some hypotheses required are not satisfied (especially, if outliers exist). However, the artificial intelligence techniques, which are non-parametric, do not entail the data to satisfy any concrete assumptions. Therefore, this advantage allows them to predict bankruptcy more accurately. Indeed, artificial intelligence methods have been already used to explain insolvency risk (Kumar and Ravi 2007; Wu 2010; Koyuncugil and Ozgulbas 2012; Kirkos 2015) and prior research has also applied these methods for anticipating going concern issues (Lenard et al. 1995; Yeh et al. 2014).

In this paper, we use the PART algorithm, an explicative artificial intelligence technique based on a rule induction method. We chose this explicative technique because of the clearness and simplicity of its rules, which are then easy to interpret (Díaz-Martínez et al. 2009).

The PART algorithm is a rule induction classifier developed by Frank and Witten (1998). The rules created by the algorithm classify objects into decision classes depending on a series of variables or conditions. These rules are expressed in logical statements with the following form:

IF < conditions are fulfilled> THEN < the object belongs to a given decision class >

In our study, the objects are firms, the two decision classes are bankrupt and non-bankrupt, and the conditions are all audit report variables or independent variables. Thus, we apply the PART algorithm to classify firms (objects) into bankrupt and non-bankrupt (decision classes) depending on a set of audit report variables (conditions).

4. Results and discussion

4.1. Summary statistics

Summary statistics of the sample are provided in Table 3. Bankrupt and non-bankrupt firms have the same frequency per industry due to our matching technique. The total sample includes a variety of industries, being the construction and real-estate firms the largest group (35%), mainly due to the impact of the housing bubble during the global financial crisis in Spain (Conefrey and Gerald 2010). Accordingly, along with our matching procedure, we control for firm size in our statistical analyses, measured by firms' total assets in thousands of euros.

Regarding the financial condition of the sample, bankrupt companies are generally more illiquid (lower working capital to total assets ratio), less profitable (lower return on assets ratio) and more leveraged (higher book value of equity to total liabilities ratio) than non-bankrupt firms, consistent with prior studies (Bellovary et al. 2007; Tascón-Fernández and Castaño-Gutiérrez 2012; Altman et al. 2017).

Table 3. Descriptive statistics

Frequency of industries by bankruptcy classification				
	Bankrupt firms	Non-bankrupt firms	Total	Total (%)
Construction and real-estate	141	141	282	35%
Manufacturing	110	110	220	27%
Commercial	79	79	158	20%
Services	70	70	140	17%
Primary	4	4	8	1%
Total	404	404	808	100%

Means and Standard Deviations by bankruptcy classification				
	Bankrupt firms		Non-bankrupt firms	
	Mean	S.D.	Mean	S.D.
Age (years)	22	13	23	14
Size (total assets)	84,352	276,969	84,431	293,514
WCTA	-.090	.401	.239	.307
EBITTA	-.169	.329	.026	.104
BVETL	.278	1.098	1.728	3.015
# of obs.	404		404	

Table 3 presents the summary statistics of the sample. The total sample comprises 808 firms, 404 of which have filed for bankruptcy legal proceedings. The rest, or non-bankrupt group, have been manually selected to match by year, size (total assets) and industry one of the bankrupt observations. Industries of the sample are created based on NACE codes. The age of the sample is expressed in years and the size in thousands of euros. WCTA stands for "Working capital divided by total assets", EBITTA for "Earnings before interest and taxes divided by total assets", and BVETL for "Book value of equity divided by total liabilities". Data used to calculate the financial ratios is winsorised at the 1% and 99%. Finally, # of obs. is the number of observations.

4.2. The results of the PART algorithm

4.2.1. PART algorithm: Model 1

Results of the estimation models using the PART algorithm appear below. Model 1 is based on the audit opinion (*AUDIT_OP*) as the only explanatory variable of bankruptcy (see Figure 1). The classification power of the model is 68.20% (31.80% of incorrectly classified cases). According to this

model, this dummy variable classifies 513 firms as non-bankrupt with 36% of error (183 errors) and 295 as bankrupt (25% of error). This result suggests that, in isolation, the audit opinion anticipates the financial condition of two thirds of the sample accurately. Although this prediction seems not to be very precise, it is relevant considering that the model includes only one variable. This evidence complements previous studies in which the audit opinion was a bankruptcy predictor (Hopwood et al. 1989; Laitinen and Laitinen 2009; Altman et al. 2010; Piñeiro-Sánchez et al. 2012, 2013). However, this variable has never been used solely before, probably due to the number of incorrectly classified cases obtained. In the following models, we decide to include more explanatory variables to increase the predictive accuracy.

Figure 1. Model 1: The audit opinion PART model

***AUDIT_OP* = 0: 0 (513.0/183.0)**

: 1 (295.0/74.0)

Number of Rules: 2

=== Stratified cross-validation ===

Correctly Classified Instances	551	68.1931 %
Incorrectly Classified Instances	257	31.8069 %
Total Number of Instances	808	

4.2.2. PART algorithm: Model 2

As the prediction is relatively low in Model 1, Model 2 adds to the initial model the two dummy variables of the type of paragraphs disclosed in the audit report (*EMPHASIS* and *SCOPE_VIOLATIONS*), when those paragraphs exist in the firms (see Figure 2). As said before, auditors place their comments in the audit report, either in emphasis of matter sections that do not qualify the opinion (*EMPHASIS*) or in qualification paragraphs (*SCOPE_VIOLATIONS*). In Model 2 the predictive power raises to 76.49% (23.51% of incorrectly classified cases). This result shows the relevance of the type of paragraph for explaining bankruptcy, as the prediction improves 8% compared to Model 1. Even more importantly, it provides evidence about the importance of matter sections when predicting bankruptcy. The existence of qualifications does not appear in the model because it is embedded in the qualified opinion (when the opinion is qualified, a qualification paragraph is disclaimed), that is, when the dummy variable *AUDIT_OP* takes the value of 1.

As per Model 2, if the audit opinion is unqualified (*AUDIT_OP* = 0), the viability of the firm is determined by the existence of a matter section. Without an emphasis of matter paragraph, the model classifies the firms as non-bankrupt (*AUDIT_OP* = 0 and *EMPHASIS* = 0) in 324 cases (17% of error). Interestingly, even when the opinion is unqualified, the algorithm classifies a firm as bankrupt when a matter section is disclosed (*AUDIT_OP* = 0 and *EMPHASIS* = 1), and this rule codifies 484 firms (28% of error). This empirical evidence validates prior studies that suggest that auditors issued unqualified reports to some bankrupt firms during the recent global financial crisis (Sikka 2009). However, the role of external auditors during that period cannot be fully questioned because their main task is to guarantee the reliability of the firms' financial statements and, according to our results, they were at least issuing matter sections emphasizing their financial concerns about soon-to-be bankrupt firms.

Figure 2. Model 2: The audit opinion and type of paragraphs' PART model

***AUDIT_OP* = 0 AND**		
***EMPHASIS* = 0: 0 (324.0/55.0)**		
: 1 (484.0/135.0)		
Number of Rules: **2**		
=== Stratified cross-validation ===		
Correctly Classified Instances	618	76.4851 %
Incorrectly Classified Instances	190	23.5149 %
Total Number of Instances	808	

4.2.3. PART algorithm: Model 3

In Model 3, the number of comments in the paragraphs is aggregated to the PART algorithm as a new independent and categorical variable (see Figure 3). The model strongly codifies firms as non-bankrupt when there are no paragraphs, so in the absence of comments (*NUMBER_COMM* = 0). This rule classifies 324 firms as non-bankrupt (17% of error). The same classification is provided by the algorithm when one comment is disclosed but the opinion is unqualified so that the comment is disclosed in a matter section (55 firms classified as non-bankrupt, 20% of error). However, with one comment in a qualification paragraph (*NUMBER_COMM* = 1 and *AUDIT_OP* = 1), the classification already moves to bankruptcy (121 bankrupt firms, 40% of error). From one comment onwards (*NUMBER_COMM* = 2; 3; 4), there is a prevailing discrimination towards bankruptcy with a low percentage of error. In line with prior studies that incorporate different qualifications to their estimations (Hopwood et al. 1989; Piñeiro-Sánchez et al. 2012), the inclusion of the number of comments increases the predictive ability of the model (in our study the classification goes up 5%, from 76.49% to 80.82%), indicating that if auditors disclose several concerns in their reports, it is very plausible that the viability of the firm is certainly questioned.

Figure 3. Model 3: The audit opinion, type of paragraphs and number of comments' PART model

***NUMBER_COMM* = 0: 0 (324.0/55.0)**

***NUMBER_COMM* = 1 AND**
***AUDIT_OP* = 1: 1 (121.0/48.0)**

***NUMBER_COMM* = 2: 1 (115.0/27.0)**

***NUMBER_COMM* = 3: 1 (87.0/8.0)**

***NUMBER_COMM* = 4: 1 (70.0/7.0)**

***NUMBER_COMM* = 1: 0 (55.0/10.0)**

: 1 (36.0)

Number of Rules: 7

=== Stratified cross-validation ===

Correctly Classified Instances	653	80.8168 %
Incorrectly Classified Instances	155	19.1832 %
Total Number of Instances	808	

In conclusion, after analysing the findings of our three models, our research question could be answered. The audit report information, mainly the audit opinion, a matter paragraph disclosed and the number of comments shown, represent accurate measures for predicting bankruptcy.

5. General conclusion

The aim of this paper is to examine the explanatory power of the external audit report when predicting firms' bankruptcy situations. We introduce new prediction models using an artificial intelligence methodology, the PART algorithm, which is a rule induction method. Our evidence indicates that the information extracted from the audit report is useful to analyse the probability of filing for bankruptcy, anticipating doubtful financial conditions with high accuracy. Specifically, we find classification rules in which the most significant variables to distinguish between bankrupt and non-bankrupt firms are the audit opinion, the matter sections disclosed in the audit reports and the number of comments included in matter sections and qualification paragraphs.

Some implications are drawn from our results. We contribute to the literature of bankruptcy prediction. This is the first study that uses a non-parametric methodology and only the variables extracted from the audit report of audit opinion, type of paragraphs and number of comments in the report to forecast a bankruptcy situation. The only study that is closely related to ours is Muñoz-Izquierdo et al. (2018), which deals with explaining failure using the external audit report and parametric and non-parametric techniques (logistic regression, the Rough Set method and the C4.5 algorithm) and it is focused on the content of the auditors' comments. Our current work is a follow-up study of the aforementioned paper with a practical implication for the users of the report. A user can strongly benefit from this study because here we find that more easily extracted variables obtained from the audit report lead to a similar predictive power. There is no need to be an expert in accounting and auditing areas to be able to detect if a firm is going bankrupt using the audit report.

Simply by identifying the type of opinion, if a matter section is disclosed by the auditor, and the number of comments included in this section or in a qualification paragraph, any user can predict fast and easy the chances of bankruptcy with the same accuracy as if he/she had scrutinised the complete audit report. Therefore, this result may save costs in terms of time and effort to financial analysts, creditors, firms' stakeholders and other potential users of the audit reports.

Finally, the auditing profession might also benefit from this paper because our evidence confirms that, during the global financial crisis, there is an important number of bankrupt firms that issued qualified reports or, at least, a warning in a matter section about the imminent failure, whereas non-bankrupt companies issued unqualified reports. Thus, even though the role of auditors is to ensure the reliability of the financial information provided to stakeholders, the audit report can also be a "first glance" signal to evaluate a firm's probability of bankruptcy.

The limitations of this study are mainly related to the sample. First, the non-bankrupt group was selected based on a matching process using the variables of firm's size, year and industry, according to prior literature. Nevertheless, it seems reasonable to think that other variables could have been chosen. Second, this study is focused on Spanish private non-financial firms so some results might be driven by specific socio demographic characteristics of the sample. For comparison purposes, an extension of the study to other regulatory contexts and periods of time could lead to very interesting results.

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