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Employer ratings in social media and firm performance: Evidence from an explainable machine learning approach

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Abstract

This study examines the ability of crowdsourced employee opinions about their workplace to reveal value-relevant information about corporate culture. We investigate the employee-friendly (EF) corporate culture values that are strongly associated with firm value and operating performance using a unique social media dataset of approximately 250,000 crowdsourced employee reviews to evaluate 18 distinct characteristics of a firm's corporate culture. The explainable machine learning model is used to examine the nonlinear associations and relative importance of employee-friendly cultural values. We find that several employee-friendly corporate culture features are associated with firms' value (Tobin's *Q*) and operating performance (ROA). Our findings reveal two features whose association is clearly superior to other EF culture variables in our explainable machine learning model: *pride in the company* for Tobin's *Q* and *job security* for ROA. Based on the SHAP values, their effects are positive, significant, and relatively linear.

KEYWORDS

corporate culture, employee treatment, firm value, machine learning, social media

JEL CLASSIFICATION

C1, M4

1 | INTRODUCTION

Rapid advancements in social media have greatly facilitated the generation and diffusion of information by non-professionals and caused changes in corporate disclosure channels (e.g., Andrew & Baker, 2020; Linnenluecke et al., 2017). These social media platforms have recently enabled individual employee opinions about their firms to be more easily shared and accessed. Recent research suggests that these platforms, where employees can share their insider opinions on various characteristics of their employer, such as Glassdoor.com, provide information relevant in predicting future corporate performance (e.g., Green et al., 2019; Hales et al., 2018; Huang et al., 2020). Social media information has also been suggested as a valuable channel to reveal inside information about true corporate culture values. In a recent study by Graham et al. (2016, p. 38), interviewed executives suggested several avenues to measure a firm's corporate culture and outlined that employees' opinions on social media websites are an important source for measuring a firm's corporate culture.

In this study, our aim is to examine whether employee ratings in social media reveal fundamental information about the association of corporate culture and company performance that is practically meaningful. The previous accounting and finance literature has widely supported corporate culture as an essential driver of business value. However, it has largely ignored the role that corporate culture can play (Guiso et al., 2015; Karolyi, 2016; Rajgopal, 2020); therefore, it is arguably one of the most under-researched value drivers among the important contributors to firm performance (Graham et al., 2016). Despite the strong agreement among executives, policymakers, and academics about the high importance of corporate culture and the long-standing research suggesting culture's crucial role in fixing contractual inefficiencies (Kreps, 1990), empirical research has reported relatively little about corporate culture, with a few recent notable exceptions (e.g., Fauver et al., 2018; Graham et al., 2021; Grennan, 2019; Guiso et al., 2015; Li et al., 2020). One evident argument for the scarce empirical evidence is the absence of large-sample, high-quality data about the features of corporate culture.

This study focuses on one crucial part of corporate culture, employee-friendly (EF) values. We use a novel, large, and comprehensive database to measure EF corporate culture values, allowing us to investigate, with the help of the explainable machine learning (ML) model, which features of EF culture are associated with the profitability and value of a company. For that purpose, we gathered a unique dataset of 250,000 crowdsourced employee ratings of 18 different features related to corporate culture, representing 493 of the S&P 1500 firms. Our data include a comprehensive set of EF corporate culture values, which have theoretical justification for being associated with corporate performance but which have not been studied in prior accounting and finance research.

Previous research has largely ignored the association between EF corporate culture and firm performance (see Faleye & Trahan, 2011; Fauver et al., 2018 for recent exceptions), even if the human resource theories suggest that employee satisfaction can reinforce motivation and retention and, as such eventually increase shareholder value (Huang et al., 2015). Prior studies have supported the positive and favourable impacts of positive employee treatment schemes on firms' financial performance, stock price performance, and capital structure (Bae et al., 2011; Edmans, 2011; Ertugrul, 2013; Faleye & Trahan, 2011; Fauver et al., 2018; Huang et al., 2015; Jiao, 2010) and on the firm innovation (Chen et al., 2016; Mao & Weathers, 2019). For example, the recent study by Fauver et al. (2018) found that a firm's EF culture is associated with better financial performance (ROA, return on equity [ROE]) and higher firm value. However, prior research does not provide any evidence or suggestions on which particular corporate culture values and employee-friendly practices are most important to focus on. For research to advance and lead policy, it is crucial to recognise which aspects of corporate culture are the most meaningful, when, and why (Graham et al., 2016).

The basic argument explaining why positive employee treatment is beneficial for organisations is based on their potential to increase employee satisfaction, commitment, loyalty, and productivity and support lower turnover, reduced absenteeism rates, and, ultimately, enhanced profitability and higher firm value (Edmans, 2011; Edmans et al., 2020; Faleye & Trahan, 2011; Fauver et al., 2018). In addition, two theories concerning the psychological relationship between the individual and the organisation: the social exchange theory (Blau, 1964; Levinson, 1965) and the social identity theory (SIT) (e.g., Ashforth & Mael, 1989; Hogg & Terry, 2000), have been used in prior research to explain the positive and value-enhancing effects of employee-friendly practices (e.g., Faleye & Trahan, 2011; Farooq et al., 2017; Jones, 2010).

Recent accounting and finance research in the field of corporate culture has pointed to several important and unanswered research questions, which remain to be addressed and await further studies (see Graham et al., 2016, 2021 for extensive suggestions). Our study seeks to make progress and shed light on the following questions: (1) does crowdsourced employer ratings in social media reveal value-relevant information about the fundamentals of corporate culture; (2) does an EF corporate culture matter for corporate performance; (3) which values of an EF corporate culture are most strongly associated with firm value and profitability, and (4) how large effect each EF corporate culture variable has on the prediction of firm value and profitability of the trained ML model?

Our paper contributes to the studies on machine learning in accounting and finance to answer these questions. A major part of current accounting and finance research applies ML methods for textual analysis or other unstructured datasets (e.g., Ahmed et al., 2023; Belloque et al., 2021; Cai et al., 2019; Clarkson et al., 2020; Garanina et al., 2021; Zengul et al., 2021; Zhu et al., 2017). When ML is used for modelling the relationship between covariates, the approach has mainly been purely predictive (e.g., Bao et al., 2020; Bei et al., 2021; Jones, 2017; Rehan et al., 2021). However, the progress in the field of explainable AI opens up the possibility of using ML methods for explanatory modelling. By implementing the explainable ML procedure in our study, we allow the data to guide our understanding of the importance of various cultural values and their interrelationships, which we then interpret in the context of the theory. Our research approach can best be described by the recent suggestion of Bertomeu (2020, p. 1152):

> Unless one is willing to embrace the structural approach used in the hard sciences (where theories are not simply taken as directional predictions), machine learning offers a completely different solution. The machine learning exercise need not organize data without reference to theory and therefore is not contaminated by a goal to validate a theory. Yet, by reporting over important features and their interactions, it can provide insight as to which theories speak to a feature likely to explain a sample. In short, machine learning offers an approach in which evidence comes before theory.

This paper introduces a novel extreme gradient-boosting ML model approach with the SHAP (SHapley Additive exPlanations) model interpretation method (Covert et al., 2020; Lundberg & Lee, 2017) to study corporate culture. Firstly, as our goal is to assess the association of an EF corporate culture's features and future financial outcomes, we show that our gradient-boosting model exhibits good overall predictive accuracy and that the corporate culture values have meaningful predictive power; and as such, studying the relative importance of these independent variables (features) is a valid approach. Secondly, we demonstrate that, because of the potential nonlinearities in the data, a tree-based extreme gradient-boosting ML method has higher accuracy than least absolute shrinkage and selection operator (LASSO) or ordinary least square (OLS) regression and hence is the most appropriate method for our study. Thirdly, to find out which features of an employee-friendly corporate culture are the most important predictors of firms' performance

and to explore the statistical significance and possible nonlinearities of these relationships in more detail, we extend and complement the earlier research efforts by using some of the latest and most advanced explainable ML techniques to interpret the gradient-boosting ML model – the SHAP method. Finally, in further analysis, we explore the inner relationships between the features of an EF corporate culture to gain an in-depth understanding of the mechanisms.

SHAP is a game-theoretic method based on the Shapley values and is currently among the most advanced methods to explain local interpretability (individual predictions) and global interpretability (a model's behaviour across the whole dataset) (Covert et al., 2020; Lundberg & Lee, 2017). We use the SHAP values to discover the relationships between individual cultural features and company performance. For evaluating the statistical significance, the SHAP values are divided into four bins based on employee ratings (grades 1–2, grades 2–3, grades 3–4, and grades 4–5), and for each bin, the mean and 90% confidence intervals are estimated using the bootstrap sample. Furthermore, we use the SHAP average values to assess the overall feature importance; that is, we respond to the question of which EF corporate culture values best predict business outcomes. Effective culture results from the alignment of and interactions between values, norms, and formal institutions (Graham et al., 2016). Accordingly, it is also essential to consider the interactions between different corporate culture values when interpreting the relative global importance of these features for corporate performance.

Our results confirm that employees possess valuable information related to the financial fundamentals of a firm and that employee-authored company reviews on social media provide a potentially fertile setting for uncovering firm corporate culture information. Our findings contribute to the previous accounting and finance research by introducing a novel explainable ML-based research approach to reveal which EF corporate culture values and practices are the most important predictors of Tobin's *Q* and ROA and how much these values can predict firms' value and performance.

Furthermore, we contribute to the previous research by revealing the importance of pride in working for the company (company image) as a driver of firm value. We find that it is the most important predictor of Tobin's *Q*. This effect is also closely linear and negative for the first two intervals (grades 1–2 and 2–3 of the employee ratings) and strongly positive for the last interval (grades 4–5 of the employee ratings). This finding complements the previous research findings in the field of corporate culture and studies related to SIT by showing that organisational pride is not only important at the individual level for work engagement, employee satisfaction, motivation, and work performance but also a major predictor of firm value. Our findings also suggest that it might be a vital feature revealing a strong and effective corporate culture that mirrors the alignment of individual and organisational values (Pratt, 1998) and the employees' internalisation of organisational goals as their own (Riketta, 2005). When employees experience pride in their company, they direct their energy towards what is best for the organisation instead of focusing on their individual goals (e.g., Riketta, 2005). This finding has practical relevance as well. Our results (SHAP values) show that an increase from a low score for company pride (employee ratings of grades 1–2) to a high score (employee ratings of grades 4–5) would result in approximately a 0.16 unit increase in Tobin's *Q*, which is approximately an 8% increase from the sample mean. As SIT suggests that the EF corporate culture values affect organisational pride through perceived respect and prestige, we examined these associations in our further analysis. Our findings (Table 9, see later) reveal that career prospects for growth and professional development and attitudes towards older employees are the two most important and strongest predictors of pride in the company.

Our findings show that employees' perceptions about their job stability (job security) are the best predictor of ROA and that job insecurity has a negative effect on ROA, whereas job security has a positive effect. In particular, the *Job security* variable has a significant negative effect for the first two intervals (employee ratings of grades 1–2 and 2–3) and a significant positive effect for the last two intervals (employee ratings of grades 3–4 and 4–5). This effect also makes a meaningful contribution from a practical point of view. The SHAP values reveal that

improvement from a low score for job security to a high score (change from employee ratings of grades 1–2 to 4–5) will increase a company's ROA by 0.9 units (i.e., an increase, for example, from 5% to 5.9%), which is approximately 16% from the sample mean. Our findings contribute to the previous corporate culture research by showing the high importance of an EF corporate culture in which employees know that their jobs are stable and valued by the management. It makes a difference whether employees experience a secure or insecure job relationship and is clearly associated with firm profitability. Our further analyses (Table 10, see later) show that career prospects for growth and professional development and attitudes towards older employees are the two most important predictors of job security.

2 | THEORETICAL BACKGROUND

In this study, following Bertomeu et al. (2020), the role of ML is understood as being primarily a descriptive tool for data exploration to expose relationships in data without strongly postulating about a particular theory. As such, while this ML-led approach is atheoretical by design, it can reveal associations that can help researchers identify important variables that should be added to theoretical causal models (Bertomeu et al., 2020). It can thus offer new views and understanding into which theories are likely to explain a sample (Bertomeu, 2020). Our aim is to use a novel explainable ML approach to explore which particular EF culture values are the most important predictors of corporate performance. It is possible that these corporate culture features have a positive, negative, or no effect on profitability and firm value. An increased understanding of these relationships and their relative importance will fill a gap in the corporate culture literature and has clear, practical implications. Our explainable ML research approach lets us study the relative importance of these corporate culture features and the strength of their effect and determine when these effects are meaningful. We are able to investigate whether some of these effects are nonlinear and statistically meaningful only at low or high values of a particular corporate culture feature. Next, we present theoretical explanations for why and how the features of an EF corporate culture can predict corporate performance and why the importance of different values might vary.

A crucial issue for organisations is to create an EF corporate culture that aligns employees' interests with shareholder value maximisation. This study focuses on corporate culture features as a potential tool for merging labour and shareholder interests. There are several theoretical explanations why EF corporate culture can influence firm performance. The good governance perspective suggests that companies engage with stakeholders for value-enhancing purposes (e.g., Deng et al., 2013; Edmans, 2011). Under this value-enhancing view of favourable employee treatment, managers adopt policies to create an employee-friendly corporate culture simply because such investments are deemed to have a positive net present value. Several prior studies have supported this view. The underlying reasoning for these positive associations is that happy employees will exert greater efforts in their jobs, resulting in higher productivity and output (e.g., Barrick et al., 2015; Chen et al., 2016; Edmans, 2011, 2012; Edmans et al., 2020; Huang et al., 2015).

Investments in creating an EF corporate culture can be expensive, resulting in unsatisfactory financial performance unless the productivity and other gains outweigh the costs (Faleye & Trahan, 2011; Fauver et al., 2018). In addition, labour-friendly programs can fail to motivate employees to increase their productivity when creating a sense of entitlement among them, reducing the company's operating flexibility and ability to adapt quickly to changing market conditions (Faleye & Trahan, 2011). In addition, the prior literature (e.g., Faleye & Trahan, 2011; Fauver et al., 2018) has discussed value-destroying effects based on the agency theory of the firm (Jensen & Meckling, 1976). According to that view, positive employee treatment is simply the manifestation of agency problems within the firm, and the management uses labour-friendly policies to meet its objectives at the expense of shareholders (e.g., Cennamo

et al., 2009; Hellwig, 2000). Under these conditions, the EF corporate culture may be guided by hidden motives due to the inadequate matching of managerial and shareholder incentives (Fauver et al., 2018; Pagano & Volpin, 2005). For example, labour-friendly policies may be used to increase management-friendliness among employees to overlook managerial surplus and promote management decisions in various corporate control situations (Faleye & Trahan, 2011).

2.1 | Social exchange theory

Social exchange theory (Blau, 1964; Levinson, 1965) posits that the positive link between EF corporate culture, favourable employee treatment, and financial performance can be understood through the principle of reciprocity (Gouldner, 1960). This principle means that employees, in response to beneficial treatment from their employers, feel a need to reciprocate with effort and loyalty (Eisenberger et al., 1997, 2001; Rhoades & Eisenberger, 2002; van Knippenberg et al., 2007). These exchanges include both tangible and intangible benefits such as respect, promotions, pay, support, and recognition (Rhoades & Eisenberger, 2002; van Knippenberg et al., 2007). Eisenberger et al. (2001) argued that employees reciprocate not only to receive positive treatment but also to maintain self-image and avoid social stigma related to violating reciprocity norms. Organisational support theory suggests that employees form beliefs about the organisation's interest in their well-being and respond to positive treatment with actions beneficial to the organisation (Eisenberger et al., 2001). Perceived organisational support (POS) contributes to employees feeling obligated to help the organisation succeed as a form of repayment (Eisenberger et al., 2001). The quality of this reciprocal relationship informs employee attitudes and behaviours (van Knippenberg et al., 2007). If the benefits received outweigh the inputs, employees are more likely to work harder and express commitment and loyalty to the organisation (Eisenberger et al., 2001; van Knippenberg et al., 2007).

As such, employees who positively value organisations' EF corporate culture values and practices will respond by showing behaviours and attitudes valued by the organisation. Because employees' reactions to these EF practices depend on their perceptions of the organisation's commitment to them (Eisenberger et al., 1990, 2001; Wayne et al., 1997), it is expected that individuals will pay back positive treatment with favourable behaviours and attitudes. In addition, a study by Eisenberger et al. (1997) found that employees consider the organisation's discretion when evaluating their treatment by the organisation. Based on their results, EF culture practices and actions experienced as highly discretionary will have a greater influence on employees' felt obligations and produce a stronger motivation to reciprocate than positive employee treatment dictated by outside influences (Eisenberger et al., 1997).

Prior studies have supported the basic predictions of the social exchange theory. The social exchange analysis of the link between the employee and the organisation has been shown to be related to many important outcomes relevant to employees and organisations, such as job satisfaction, organisational commitment, in-role performance, extra-role behaviour, and withdrawal from the job (e.g., Rhoades & Eisenberger, 2002; Whitener, 2001). For example, the study by Bridges and Harrison (2003) showed that financial and non-financial benefits, as well as different services offered to employees, have a positive relationship with employee commitment, whereas committed employees have been shown to exhibit lower rates of absenteeism (Gellatly, 1995) and voluntary turnover (Somers, 1995). Similarly, Jones (2010) used the social exchange and organisational identification theories to explain the association between the company's volunteerism program and employees' positive responses. Their results suggested that favourable attitudes towards a volunteerism program predict employee responses (e.g., retention and OCB) that, in the end, may affect the firm's bottom line positively.

From a financial performance perspective, issues like absenteeism and turnover are costly, impacting productivity and profitability. Faleye and Trahan (2011) found that EF policies,

guided by social exchange theory, are tied to corporate performance through improved employee commitment and productivity and reduced absenteeism, turnover, and attrition. Similarly, Barrick et al. (2015) found that collective organisational engagement mediates the relationship between organisationally motivated practices and firm performance, suggesting a positive link between EF corporate culture and firms' value and performance.

However, labour-friendly programs can have potential drawbacks. Certain EF cultural values may not positively impact or could even detrimentally affect firms' performance and value (van Knippenberg et al., 2007). Discontent may arise if employees perceive the benefits of EF practices as insufficient compared to their efforts, or if these practices are seen as mandatory rather than discretionary. Such dissatisfaction may prompt employee withdrawal behaviours like lateness, absenteeism, or disengagement, potentially adversely affecting corporate performance (van Knippenberg et al., 2007). Evidence supporting these arguments has been provided in studies on organisational and supervisor support, and psychological contracts (Eisenberger et al., 1986; Griffeth et al., 2000; Guzzo et al., 1994; Wayne et al., 1997). Thus, certain EF culture features might negatively influence corporate performance due to decreased productivity or increased turnover, particularly in low-EF culture situations.

2.2 | Social identity theory

Social identity theory illuminates the impact of employees' feelings of unity with their organisation on both individual and organisational performance (Ashforth & Mael, 1989). Employees are more likely to identify with an organisation that bolsters their self-esteem and has distinctive, attractive EF corporate culture values and practices (Farooq et al., 2017; Jones, 2010). Organisations using discretionary actions for employee well-being, characteristic of EF corporate cultures, are predicted to foster positive behaviours leading to superior corporate performance. Such organisations are likely to be esteemed and seen as a source of pride and distinction, attracting new talent (Farooq et al., 2017). Employees, therefore, seek identification with companies boasting strong EF cultures, aligning with their self-enhancement desires.

Emerging research underscores the importance of organisational identification in aligning employee efforts with the organisation's interests. Organisational pride, an emotional response linked to organisational membership, is another facet closely associated with this identification (Jones, 2010; Riketta, 2005). Employees with company pride are motivated to enhance their self-worth through identification with their employer (Ashforth & Mael, 1989; Jones, 2010).

Previous academic research has shown the importance of organisational identification and pride for employees and organisations. When people experience pride in their company, they internalise the organisational goals as their own, and instead of focusing on their individual goals, they focus their energy towards what is valuable for the organisation (Jones, 2010; Riketta, 2005). Organisational identification has been shown to be related to such positive behaviours as cooperation with other employees, commitment to the organisation, motivation, higher work-performance, job satisfaction, organisational citizenship behaviours, such as helping co-workers and supporting the organisation to achieve its goals, act according to organisation's strategic interests, and contributions to the public good (Ashforth & Mael, 1989; Blader & Tyler, 2009; Dukerich et al., 2002; Dutton et al., 1994; Edwards, 2005; Elsbach, 1999; Jones, 2010; Riketta, 2005; Rousseau, 1998; Schuh et al., 2016; Van Dick, 2001; Van Dick et al., 2006; van Knippenberg et al., 2007; van Knippenberg & van Schie, 2000).

Prior literature has shown that an employee's identification with employing organisation is more likely if it has a positive and prestigious image, its values and goals are recognisable and distinctive from other organisations, and it has a strong and persistent identity (Edwards, 2005). Previous research points out that prestige and respect are two particularly

important but different ways an EF corporate culture can influence organisational identification and pride (e.g., Farooq et al., 2017). Prestigious company images and reputations are important predictors of organisational identification and organisational pride because they enhance employees' need for self-enhancement and self-worth (Bhattacharya & Sen, 2004; Tajfel & Turner, 1985). Another way in which individuals seek to identify with employing organisations is via contributions to the private self. That is, individuals judge to what extent they are respected by their employers and seen as valued members of the organisation (Fuller et al., 2006; Tyler & Blader, 2002). These internal respect perceptions provide employees with a basis for determining their organisation's distinctiveness in comparison with other organisations, therefore acting as a source of organisational identification (Farooq et al., 2017; Tyler & Blader, 2002).

As such, perceived prestige and respect create two distinct channels through which an EF corporate culture can positively affect corporate performance. That is, they involve the assumptions made by employees regarding the way in which external and internal stakeholders, respectively, perceive the organisational culture. We argue that the EF corporate culture, in which the values are focused on caring for employees' general well-being and development via positive employee treatment (e.g., career prospects for growth and professional development, work–life balance, ensuring job security, and maintaining a safe and compliant working environment) and respect (e.g., valuing diversity, hiring older employees, and appreciating them by giving equal opportunities), sends a positive signal that the organisation values employees, is respecting and caring, and distinctive from other companies. As such, we expect an EF corporate culture to be an important driver of organisational identification and pride, which ultimately facilitates firms' operating performance and value creation.

3 | DATA AND METHODOLOGY

The unresolved nature of the theory and the somewhat ambiguous concept of corporate culture have led to a variety of empirical approaches and raised various measurement concerns in empirical research; thus, the current literature has limited large-sample evidence (Graham et al., 2021; Li et al., 2020; Zingales, 2015). Prior studies exploring the relationship between corporate culture and firm performance have relied on survey and interview evidence (e.g., Graham et al., 2016, 2021; Guiso et al., 2015) or employed proxies to measure corporate culture (e.g., Biggerstaff et al., 2015; Davidson et al., 2015). More recently, text-based measures have also been used to quantify the definition of corporate culture (Grennan, 2019; Li et al., 2020).

3.1 | Employer review sample

We measure an employee-friendly corporate culture using a novel dataset of crowdsourced employee reviews from the Kununu social media-based recruitment website. Kununu is a recruitment website akin to Glassdoor.com, whose data have recently been used in research (e.g., Green et al., 2019; Hales et al., 2018; Huang et al., 2015, 2020). Social media provides academics with a new fruitful source of information to be exploited in applied research (e.g., Chen et al., 2021; Li et al., 2022; Marty et al., 2020; Nie & Jia, 2021). Social media can be seen as a two-way channel where the information flow from social media to companies has profound effects on company practices (Li et al., 2022; Nie & Jia, 2021) and, on the other hand, the flow of information from companies to social media reveals interesting knowledge of the inner workings of corporations previously hidden from outside researchers (Au et al., 2021; Green et al., 2019; Marty et al., 2020). This will create challenges on company disclosure practices as traditional disclosure channels are challenged by new rivals from

social media (Andrew & Baker, 2020; Linnenluecke et al., 2017). In 2019, Kununu stated that they had almost 4 million employer reviews for over 900,000 companies. We create a sample of 250,000 reviews from these data, which represents 493 of the S&P 1500 firms. To ensure the accuracy of the data, we only included firms with at least 20 reviews per year from 2014 to 2017. Table A1 contains detailed definitions of all the firm-level characteristics and other research variables. Our measure of corporate values aligns with those in the established literature. In particular, our 18 culture features parallel the categories of the employee-friendly corporate culture measure used by Fauver et al. (2018). Our employee-friendly cultural features also bear similarities to the employee treatment measures used by Landier et al. (2009) and Bae et al. (2011) and the cultural values established by Guiso et al. (2015) and Graham et al. (2021).

Our measure of crowdsourced employee opinions of corporate culture has four clear advantages. First, like Glassdoor, it is based on employee perceptions of companies and their management, not on management-proclaimed values. This is important because previous studies have shown that employee perceptions matter for firm performance (e.g., Green et al., 2019; Huang et al., 2015, 2020), while proclaimed values appear to be irrelevant (Guiso et al., 2015). Second, our data incorporate more than 250,000 employee assessments from a large number of firms and provide reasonable cross-sectional and time-series variations, which allow for an extensive exploration of EF corporate culture features. Third, compared with the previously used data from Glassdoor, which have nine review attributes, our dataset offers a more detailed and comprehensive set of features of employee opinions on various characteristics of corporate culture.

The employee review data are combined with the financial performance data of the companies. We use Tobin's Q as a measure of market performance, and ROA as a measure of operational performance. These performance measures have been widely used in related literature (e.g., Fauver et al., 2018; Guiso et al., 2015; Huang et al., 2015, 2020).[1] In the model, we control for company size, leverage, R&D intensity, ROA (for Tobin's Q), the market-to-book ratio (for ROA), implied volatility, and firm age (see Table A1 for details). Log and cubic-root transforms are implemented when necessary to achieve a stable, normal distribution of feature values. In addition, the control variables are transformed to the same interval range as the employee opinion variables (1–5). The same domain for all the variables makes the learning of the ML model more efficient because the parameters of each feature are approximately the same size. The year and industry effects are also controlled in the model. The industry effects are controlled using one-digit SIC dummies.

3.2 | Employer review descriptive statistics

Table 1 provides descriptive statistics for the employee opinion variables. The reviews are used to calculate yearly averages for each firm. The final sample has more than 1800 firm-year observations, except for the features *Challenging work* and *Inclusive/diverse*, for which the total number of observations is slightly below 1400 due to these questions being added to the web portal later than the other questions. There are no significant abnormalities in the statistics.

Table 2 provides the correlation matrix for the employee variables. As expected, some of the variables are highly correlated, thus justifying our use of gradient boosting, which can handle multicollinearity.

[1]We also tested Altman's Z as our performance measure. The results had many similarities with the Tobin's Q and ROA models. For example, Altman's Z had a strong positive association with *Company image* and *Job security*, which are strongly associated with Tobin's Q and ROA, respectively.

TABLE 1 Descriptive statistics for the employee opinion variables.

	Count	Mean	SD	25%	50%	75%
Company culture	1827	3.28	0.73	2.81	3.25	3.75
Support from management	1826	3.20	0.77	2.67	3.12	3.75
Teamwork	1827	3.51	0.66	3.08	3.50	4.00
Freedom to work independently	1826	3.40	0.71	2.99	3.38	3.88
Internal communication	1827	3.09	0.69	2.64	3.05	3.50
Gender equality	1827	3.45	0.68	3.00	3.47	3.91
Attitude towards older colleagues	1827	3.51	0.71	3.00	3.49	4.00
Career development	1827	3.21	0.77	2.67	3.15	3.75
Overall compensation for work	1827	3.36	0.71	2.89	3.33	3.85
Office/work environment	1827	3.39	0.66	3.00	3.39	3.82
Environmental friendliness	1827	3.43	0.70	2.96	3.43	3.96
Work–life balance	1827	3.30	0.74	2.79	3.25	3.83
Company image	1827	3.52	0.74	3.00	3.51	4.00
Job security	1827	3.18	0.78	2.61	3.14	3.75
Accessible for people with disabilities	1827	3.54	0.66	3.14	3.57	4.00
Workplace safety	1826	3.75	0.58	3.42	3.79	4.12
Challenging work	1389	3.20	0.62	2.87	3.24	3.60
Inclusive/diverse	1390	3.13	0.73	2.67	3.16	3.63

TABLE 2 Correlation matrix for the employee variables.

Company culture	Support from management	Teamwork	Freedom to work independently	Internal communication	Gender equality	Attitude towards older colleagues	Career development	Overall compensation for work
1.00	0.82	0.78	0.81	0.77	0.79	0.79	0.78	0.72
0.82	1.00	0.85	0.86	0.79	0.71	0.85	0.86	0.76
0.78	0.85	1.00	0.84	0.78	0.70	0.81	0.82	0.73
0.81	0.86	0.84	1.00	0.77	0.74	0.84	0.84	0.72
0.77	0.79	0.78	0.77	1.00	0.71	0.77	0.80	0.73
0.79	0.71	0.70	0.74	0.71	1.00	0.76	0.71	0.62
0.79	0.85	0.81	0.84	0.77	0.76	1.00	0.86	0.73
0.78	0.86	0.82	0.84	0.80	0.71	0.86	1.00	0.77
0.72	0.76	0.73	0.72	0.73	0.62	0.73	0.77	1.00
0.78	0.74	0.74	0.78	0.78	0.73	0.76	0.76	0.69
0.77	0.80	0.80	0.81	0.75	0.72	0.77	0.82	0.76
0.78	0.84	0.79	0.86	0.79	0.71	0.83	0.85	0.77
0.80	0.84	0.81	0.84	0.79	0.70	0.85	0.88	0.77
0.75	0.82	0.77	0.79	0.77	0.70	0.85	0.86	0.69
0.69	0.67	0.67	0.72	0.67	0.76	0.71	0.69	0.57
0.72	0.67	0.71	0.73	0.67	0.72	0.68	0.67	0.66
0.52	0.44	0.46	0.50	0.48	0.51	0.43	0.44	0.44
0.68	0.57	0.58	0.60	0.64	0.73	0.58	0.53	0.45

3.3 | A tree-based gradient-boosting model

Previous research on corporate culture has been more concerned with parameter estimation and, as such, has relied on parametric models, like OLS regression. In contrast to the existing empirical accounting and finance research approaches, we use an ML approach and select our model from a large set of different models (functional forms) instead of preselecting our model based on a hypothesis (Karolyi & Van Nieuwerburgh, 2020). Accordingly, compared to a linear statistical model, ML algorithms are most useful in research settings where the associations to outcomes are not theoretically evident (Bertomeu et al., 2020). This is an advantageous research approach for us because of the lack of strong theoretical and empirical research evidence, which could guide us to make arguments about the importance of one corporate culture value over another.

Our approach overcomes many limitations of traditional econometric methods such as potential multicollinearity and nonlinearity (Bertomeu, 2020; Karolyi & Van Nieuwerburgh, 2020). It provides efficient, flexible predictions, and handles correlated variables effectively (Bertomeu, 2020; Jones, 2017). Through gradient boosting, we can analyse various corporate culture features simultaneously, without compromising model stability. It is efficient in handling highly correlated predictors, reveals interaction effects, and employs a variable selection procedure similar to regularisation techniques (Bertomeu et al., 2020; Friedman, 2001). This approach also mitigates bias related to data snooping (Jones, 2017).

'Ensemble methods' is an umbrella term for ML approaches that are based on the joint prediction of many simple predictors, and they have been the most popular ML architecture in the accounting and finance literature. The gradient-boosting algorithm (Friedman, 2001, 2002; Friedman et al., 2000) implements a gradient descent algorithm to the boosting model,

Office/work environment	Environmental friendliness	Work–life balance	Company image	Job security	Accessible for people with disabilities	Workplace safety	Challenging work	Inclusive/ diverse
0.78	0.77	0.78	0.80	0.75	0.69	0.72	0.52	0.68
0.74	0.80	0.84	0.84	0.82	0.67	0.67	0.44	0.57
0.74	0.80	0.79	0.81	0.77	0.67	0.71	0.46	0.58
0.78	0.81	0.86	0.84	0.79	0.72	0.73	0.50	0.60
0.78	0.75	0.79	0.79	0.77	0.67	0.67	0.48	0.64
0.73	0.72	0.71	0.70	0.70	0.76	0.72	0.51	0.73
0.76	0.77	0.83	0.85	0.85	0.71	0.68	0.43	0.58
0.76	0.82	0.85	0.88	0.86	0.69	0.67	0.44	0.53
0.69	0.76	0.77	0.77	0.69	0.57	0.66	0.44	0.45
1.00	0.78	0.79	0.78	0.74	0.70	0.75	0.51	0.60
0.78	1.00	0.80	0.82	0.75	0.73	0.75	0.47	0.57
0.79	0.80	1.00	0.84	0.81	0.70	0.72	0.43	0.55
0.78	0.82	0.84	1.00	0.83	0.72	0.73	0.46	0.56
0.74	0.75	0.81	0.83	1.00	0.69	0.68	0.37	0.51
0.70	0.73	0.70	0.72	0.69	1.00	0.72	0.49	0.65
0.75	0.75	0.72	0.73	0.68	0.72	1.00	0.51	0.63
0.51	0.47	0.43	0.46	0.37	0.49	0.51	1.00	0.69
0.60	0.57	0.55	0.56	0.51	0.65	0.63	0.69	1.00

significantly improving its efficiency for applications. In accounting and finance research, ensemble learning algorithms have been used, for example, to predict financial failure (Jiang & Jones, 2018; Jones, 2017), to identify and predict features that influence citation impacts (Jones & Alam, 2019), to detect fraud (Bao et al., 2020; Gepp et al., 2021), to model the conditional risk premium (Hoang & Faff, 2021), to improve managerial estimates in financial reports (Ding et al., 2020), to predict corporate bond default (Lu & Zhuo, 2021), and to examine the value and relative importance of various board and firm characteristics in predicting workplace diversity (Ranta & Ylinen, 2023).

The gradient boosting algorithm was introduced in the works of Friedman et al. (2000), Friedman (2001), and Friedman and Popescu (2003). We implement a recent iteration of this algorithm, the extreme gradient boosting algorithm (Chen & Guestrin, 2016). It improves the original algorithm by adding highly optimised code, scalability, and accuracy. Furthermore, it borrows innovations from other ensemble methods, like the feature subsampling of the random forest algorithms.

Boosting models, often utilising decision trees, iteratively increase accuracy by reweighting misclassified data (Friedman, 2001). Gradient descent, a machine learning technique introduced by Cauchy (1847), is used to train these models. Contrasting ordinary decision trees, regression trees in a tree ensemble model contain continuous scores on leaves. Modern gradient boosting models incorporate a regularisation term to prevent overfitting and favour simpler functions (Chen & Guestrin, 2016). The model's adjustable hyperparameters, including the number of trees, shrinkage parameter, subsampling parameters, depth of trees, and a gamma parameter, are optimised for the data. Shrinkage scales down new tree weights for model improvements (Friedman, 2002), while column and row subsampling improve performance and speed up computations by selecting subsets of features and data points, respectively. Optimising hyperparameters is data-dependent, often using the grid-search method, despite its computational intensity. We employed a two-step optimisation with fivefold cross-validation, first applying a grid-search algorithm to the model's structure and regularisation parameters, then to the number of decision trees. Multiple hyperparameter settings were tested for robustness, yielding similar results and minor feature importance changes (Table 3).

The analysis is conducted using the Python programming language version 3.7 (Rossum & Drake, 1995). The Pandas library version 1.03 (McKinney, 2010) is used to clean and pre-process the data. The extreme gradient-boosting algorithm is implemented using the Xgboost library version 0.9, which was developed by the inventors of the algorithm (Chen & Guestrin, 2016).

TABLE 3 Hyperparameters for the models.

Hyperparameter	Tobin's *Q*	ROA
Depth of trees	5	5
Shrinkage parameter	0.03	0.02
Row subsampling	0.8	0.8
Column subsampling	0.8	0.8
Gamma	0.6	0.02

Note: The depth of a tree is a parameter that determines the number of allowed splits in the tree-building process. The shrinkage parameter regulates the weights assigned to newly added trees by scaling them down by a predefined factor, thereby allowing future trees to improve the model. The row subsampling involves selecting a subset of data points for training the subsequent tree. Similarly, column subsampling involves selecting a subset of features for training the newly added tree. Finally, the gamma parameter determines the minimum reduction in loss required to split a leaf node further.

Abbreviation: ROA, return on assets.

4 | RESULTS

4.1 | Model validation

We compare the performance of our model with the LASSO and OLS models by splitting the data and using 80% of the observations for training and 20% of the observations for testing (e.g., Sarstedt & Danks, 2022). The regularisation parameter for the LASSO model and the hyperparameters for the boosting model are optimised using fivefold cross-validation. We test the performance with and without the control variables and calculate the out-of-sample coefficient of determination for each model. Table 4 provides the results of the test. Overall, the results justify using a boosting model in this setting. The extreme gradient-boosting model performs better, with a clear margin, and is able to explain nonlinear associations between variables that the linear models miss completely.

4.2 | Shapley additive explanations

To assess the importance of EF variables in our predictive models, we require suitable metrics. While weight, gain, and cover metrics are commonly used, they can provide inconsistent and contradictory results, as they undervalue binary features and overlook the significance of divisions without considering their impact on accuracy (Lundberg & Lee, 2017). As such, we do not use these metrics in our research

Instead, we utilise the SHAP model (Shapley additive exPlanations) to interpret the extreme gradient-boosting model's outcomes (Lundberg et al., 2020; Lundberg & Lee, 2017). The SHAP metric, based on game-theoretically optimal Shapley values, boasts several appealing qualities including local accuracy, consistency, efficiency, symmetry, and additivity. We use TreeSHAP, a SHAP variant for tree-based ML models, due to its speed, precise Shapley value computations, and capability to manage feature dependencies. It measures individual predictions, allowing us to examine the relationships between predictors and predicted outcomes in diverse ways. The SHAP model offers an intuitive interpretation by calculating a single feature's effect on a specific prediction. The total of these effects equates to the final prediction, in this case, for a particular company's Tobin's *Q* or ROA prediction

TABLE 4 The out-of-sample coefficient of determination R^2 for the models.

Model	All variables	Employee opinion variables
Tobin's *Q*		
Boosting model	0.801	0.066
Lasso regression	0.549	0.024
OLS regression	0.539	0.022
ROA		
Boosting model	0.354	0.073
Lasso regression	0.202	0.002
OLS regression	0.202	0.006

Note: The predictive power is calculated using a test set (20% of the total) that is not used to train the data. The parameters of the models are optimised using fivefold cross-validation within the training set (80% of the total).

4.3 | Tobin's *Q*

4.3.1 | Global importance

Table 5 provides the SHAP average values for the model variables. The results show that the control variables are the most important predictors. In addition, our results (SHAP values) also demonstrate that many employee review features are associated with Tobin's *Q*. For example, *Company image*, which is the most important employee feature, has a predictive value of approximately 11% relative to the most important predictor (ROA), being almost as important a predictor as *Leverage*. The five most important EF culture features are *Company image*, *Work–life balance*, *Inclusive/diverse, Attitude towards older colleagues*, and *Company*

TABLE 5 The importance of the features of the Tobin's *Q* model.

Feature	SHAP	Relative importance
ROA	0.5585	1.0000
R&D intensity	0.1987	0.3558
Implied vol.	0.1484	0.2656
Total assets	0.1259	0.2253
Leverage	0.1056	0.1891
Company image	0.0621	0.1112
Firm age	0.0578	0.1035
sic1dig	0.0444	0.0796
Work–life balance	0.0306	0.0549
Inclusive/diverse	0.0267	0.0479
Attitude towards older colleagues	0.0267	0.0478
Company culture	0.0237	0.0425
Office/work environment	0.0224	0.0400
Teamwork	0.0220	0.0394
Job security	0.0211	0.0378
Internal communication	0.0197	0.0353
Freedom to work independently	0.0189	0.0339
Gender equality	0.0188	0.0336
Challenging work	0.0186	0.0333
Overall compensation for your work	0.0167	0.0299
Career development	0.0165	0.0296
Accessible to people with disabilities	0.0157	0.0281
Workplace safety	0.0144	0.0257
Environmental friendliness	0.0139	0.0248
Support from management	0.0124	0.0222

Note: The SHAP values tell the contribution of each variable to individual predictions. The first column presents the aggregate importance, which is the mean of absolute SHAP values. In the second column, SHAP values are rescaled so that the most important variable gets a value of 1.

Abbreviation: ROA, return on assets; SHAP, shapley additive explanations values; sic1dig; Industry, measured by one-digit SIC (Standard Industrial Classification) code.

culture.[2] The least important variables are *Environmental friendliness* and *Support from management*.

4.3.2 | Nature of associations and statistical significance

We proceed by analysing the statistical significance of the associations. To assess the relevance of nonlinear structures in the data, we first divide the domain of each variable into four intervals. Then, using bootstrapping with 1000 samples, we estimate the mean effects at each interval, along with their statistical significance (10% threshold), separately for each variable. The results, provided in Table 6, verify the statistical significance of the associations for the most important variables. For *Company image* and *Company culture*, the effects on the market performance are negative for the first two intervals and positive for the last interval. The nonlinear positive association of *Inclusive/diverse* with Tobin's *Q* is significant, the positive effect being substantial for the fourth interval and negative or insignificant for the rest of the intervals. There are also indications that the u-shaped association between *Attitude towards older colleagues* and company value is statistically significant. For *Work–life balance*, the results show that the effect is positive and significant for the first two intervals and insignificant for the last two intervals, thus verifying the negative association.

The SHAP values possess a highly intuitive interpretation. For example, they show that an increase from a low score for company pride (employee ratings of grades 1–2) to a high score (employee ratings of grades 4–5) would result, on average, approximately a 0.16 unit increase in Tobin's *Q*, which is an 8% increase from the sample mean. These effects are comparable in size to those reported in the previous studies using employee reviews from Glassdoor (e.g., Hales et al., 2018; Huang et al., 2020) and ASSET4 (e.g., Fauver et al., 2018).

4.4 | ROA

4.4.1 | Global importance

We proceed by undertaking a similar analysis for ROA. Table 7 provides the importance comparison using the SHAP values. The control variables are, again, the most important features. The most important EF culture variables are *Job security*, *Workplace safety, Freedom to work independently, Gender equality*, *Workplace safety*, *Inclusive/diverse,* and *Company image*.[3] Our analyses show that *Job security* is the most important employee feature and has, on average, a 0.26 unit effect on the ROA, which is approximately 11% relative to the model's most

[2]To verify the robustness of our results, we built several alternative ML models and compared their results to the initial model. For example, we built an Xgboost model, which was trained using time splitting for training and testing sets (last year as a test set). Furthermore, we built models where, instead of gradient boosting, we used random forest and decision tree architectures. The results were more or less the same for all models, especially for the random forest and decision tree models. For example, the top three most important employee opinion variables were always the same. We also created a model where we excluded all control variables. The main results remain almost identical as the same five features are among the six most important employee review variables. Company image also remains clearly the most important employee feature. The only notable difference is that the predictive value of job security increases. One possible explanation is that job security and ROA partly share the same information as our results (Table 7) show that job security is associated with ROA and ROA is clearly the most important predictor of Tobin's *Q*.

[3]We did similar robustness analyses for the ROA model as we did with the Tobin's *Q* model (random forest, time splitting). The results were very similar between the models. Similarly, we created an additional model without the control variables to see whether missing interactions between employee features and control variables will change the importance of employee rating information. Our analyses show that the exclusion of control variables does not cause any significant changes to our main findings. In particular, the same five employee features are still among the six most important predictors and *Job security* and *Workplace safety* are still the two most important predictors. The only minor change is that the importance of *Freedom to work independently* decreases slightly relatively to other most important employee features.

TABLE 6 Significance analysis of the features of the Tobin's *Q* model.

Features	Grades 1–2	Grades 2–3	Grades 3–4	Grades 4–5
Company culture	−0.0148	−0.0154*	0.0003	0.04*
Support from management	0.0227	−0.0028	0.0007	−0.0144
Teamwork	−0.0095	0.0149	0.0048	−0.0202*
Freedom to work independently	0.0365*	0.0136*	−0.0048	−0.0144
Internal communication	−0.0117	−0.0123*	0.0088	0.0212
Gender equality	0.0497	−0.0028	−0.0079*	0.0144
Attitude towards older colleagues	0.069*	0.0038	−0.0133*	0.0131
Career development	−0.0088	−0.0036	0.0089*	−0.0051
Overall compensation for your work	−0.0204	−0.015*	0.0052	0.0107
Office/work environment	0.0012	−0.0011	−0.0142*	0.0423*
Environmental friendliness	−0.0265	−0.0114	0.0037	0.0104
Work–life balance	0.0482*	0.015*	−0.0092*	−0.0204*
Company image	−0.0852*	−0.0691*	−0.0052	0.073*
Job security	0.0177	−0.0073	0.0066	−0.0186
Accessible to people with disabilities	−0.0054	0.0011	−0.0051	0.0114
Workplace safety	−0.0484	0.0122	0.0035	−0.0093
Challenging work	0.0008	−0.0089	0.0071	−0.0284
Inclusive/diverse	−0.0146	−0.0237*	−0.0079	0.0813*

Note: The SHAP values are the mean effects of the bootstrap samples for the four intervals. The domain of each variable is divided into four intervals, and the average contribution to the prediction is calculated for each variable and interval. The average effect and the statistical significance are estimated using a bootstrap sample of 1000 sub-samples. * indicates statistical significance at least at the 10% level.

important predictor (market to book). The least important employee review features are *Teamwork* and *Internal communication*.

The significant role of *Job Security* is intriguing. The prior literature review by Posthuma et al. (2013) about high-performance work systems suggested that organisations that are finding ways to increase their performance and maintain their competitiveness should adopt human resource practices that stress the importance of job security and focus attention on increasing employees' feelings about their job security. Our results support these arguments as job security is clearly the most strongly associated EF corporate culture feature. An additional explanation for the importance of job security as a predictor of ROA is that, because employees possess value-relevant and fundamental inside information about a firm's operating performance, their opinions about job security can also reflect their expectations of and knowledge about the firm's future profitability. As such, this information might capture at least some of the same firm fundamentals as the *business outlook* measure of the Glassdoor data used in previous research (e.g., Green et al., 2019; Hales et al., 2018; Huang et al., 2020; Sheng, 2021).

4.4.2 | Nature of associations and statistical significance

Table 8 provides the SHAP values and verifies the associations' statistical significance. *Job security* has a significant negative effect for the first two intervals and a significant positive effect for the last two intervals. Prior research has postulated positive effects of job security on employee work attitudes and behaviours based on social exchange theory (Blau, 1964). Job security refers to employees' expectations about the stability and longevity of their job in an organisation (Greenhalgh & Rosenblatt, 1984; Kraimer et al., 2005). When employers satisfy

TABLE 7 The importance of the features of the ROA model.

Feature	SHAP	Relative importance
Market to book	2.3407	1.0000
Leverage	1.5330	0.6549
sic1dig	0.6218	0.2657
Implied vol.	0.6035	0.2578
R&D intensity	0.4243	0.1813
Total assets	0.4193	0.1791
Job security	0.2640	0.1128
Workplace safety	0.2556	0.1092
Firm age	0.2247	0.0960
Freedom to work independently	0.2230	0.0953
Gender equality	0.2177	0.0930
Inclusive/diverse	0.2121	0.0906
Company image	0.2098	0.0896
Support from management	0.2034	0.0869
Environmental friendliness	0.1794	0.0766
Work–life balance	0.1741	0.0744
Accessible to people with disabilities	0.1734	0.0741
Challenging work	0.1713	0.0732
Attitude towards older colleagues	0.1598	0.0683
Company culture	0.1568	0.0670
Overall compensation for your work	0.1509	0.0645
Career development	0.1493	0.0638
Office/work environment	0.1369	0.0585
Teamwork	0.1328	0.0567
Internal communication	0.1206	0.0515

Note: The SHAP values tell the contribution of each variable to individual predictions. The first column presents the aggregate importance, which is the mean of absolute SHAP values. In the second column, SHAP values are rescaled so that the most important variable gets a value of 1.

Abbreviation: SHAP, shapley additive explanations values; sic1dig; Industry, measured by one-digit SIC (Standard Industrial Classification) code.

their employees' expectations and create feelings that their jobs are secure, equal exchange relationships between organisations and employees are formed (Conway & Coyle-Shapiro, 2012; Lu et al., 2017). Job security has been found to be associated with higher job satisfaction (Krausez et al., 1995; Miller & Terborg, 1979) and higher levels of organisational commitment (Lee & Johnson, 1991; Morrow et al., 1994; Van Dyne & Ang, 1998). This evidence suggests a positive effect on financial performance. On the other hand, job insecurity, which refers to 'the anticipation of this stressful event in such a way that the nature and continued existence of one's job are perceived to be at risk' (Sverke & Hellgren, 2002), has been suggested as one of the most significant and common causes for job-related stress (e.g., Wang et al., 2015) and has been found to be negatively related with employees' job satisfaction, organisational commitment, job involvement, trust in the organisation, and health (Cheng & Chan, 2008; Sverke et al., 2002). As such, job insecurity has been proposed to have a negative association with firm performance. Our results support these arguments.

The effect of the *Freedom to work independently* is negative for the first two intervals and positive for the last two intervals, but the effect for the fourth interval is not statistically

TABLE 8 Significance analysis of the features of the ROA model.

	Grades 1–2	Grades 2–3	Grades 3–4	Grades 4–5
Company culture	−0.2305	−0.0926	0.0507	0.0439
Support from management	0.0982	0.1171*	−0.0122	−0.2142*
Teamwork	0.0878	−0.071	0.0097	0.0383
Freedom to work independently	−0.3489*	−0.1337*	0.0312	0.1438
Internal communication	0.1394	0.0038	−0.0096	−0.1211
Gender equality	0.0082	0.0071	0.079*	−0.2828*
Attitude towards older colleagues	−0.088	−0.0662	0.007	0.1084
Career development	−0.1505	−0.0719	0.0509	−0.0441
Overall compensation for your work	−0.4115*	−0.0533	−0.0054	0.1516
Office/work environment	−0.2355	−0.0075	0.0269	−0.0631
Environmental friendliness	0.2783	−0.0331	−0.0382	0.084
Work–life balance	0.2832	0.0022	−0.0228	−0.0337
Company image	0.3168	−0.0518	−0.0913*	0.2142*
Job security	−0.5686*	−0.1281*	0.1404*	0.3095*
Accessible to people with disabilities	0.3747	0.0387	−0.0081	−0.0514
Workplace safety	0.3571*	0.2596*	−0.0525*	−0.056
Challenging work	0.0432	0.0615	−0.0066	−0.1311
Inclusive/diverse	−0.0884	0.0184	0.1409*	−0.3509*

Note: The SHAP values are the mean effects of the bootstrap samples for the four intervals. The domain of each variable is divided into four intervals, and the average contribution to the prediction is calculated for each variable and interval. The average effect and the statistical significance are estimated using a bootstrap sample of 1000 sub-samples. * indicates statistical significance at least at the 10% level.

significant. For *Company image*, the results indicate a u-shaped association. However, the effects are statistically significant only for the first and the last intervals. The effects for *Gender equality* reveal a slight indication of a positive association from the first interval to the third interval, but the effect for the last interval is negative and substantial. *Inclusive/diverse* has a similar structure, where the positive effect for the third interval and the negative effect for the fourth interval are significant. The results also verify the negative association of *Workplace safety* with significant positive effects for the first two intervals and a significant negative effect for the last interval. In addition, SHAP values indicate that employee reviews have practically relevant predictive power, which corresponds to prior research evidence (e.g., Fauver et al., 2018; Hales et al., 2018; Huang et al., 2020). For example, an increase from a low score for job security (employee ratings of grades 1–2) to a high score (employee ratings of grades 4–5) will increase a company's ROA by 0.9 units (i.e., an increase, for example, from 4% to 4.9%), which is approximately 16% from the sample mean.[4]

[4]We also employed factor analysis with promax (oblique) rotation to collapse the 18 attributes of employees' responses into a smaller set of variables. This was done to identify which factor most likely reflects the employees' opinions of the firm's corporate culture, and to examine whether it could improve the prediction of companies' performance. The analysis revealed three basic dimensions, with eigen values greater than 1. The most significant factor captured the employees' general feelings about the future, including stable work, supportive management, equal opportunities for senior employees, and career prospects, which related positively to most of the review attributes. The second factor, although less significant than the first, reflected the employees' latent beliefs about the firm's concern for the well-being of the employees and the environment, which related most strongly to opinions of fair compensation, environmental friendliness, and work-life balance. Finally, the analysis identified a third significant factor, which was interpreted as opinions about how firms value diversity in the workplace. This factor related most strongly to the employees' assessments of inclusiveness/diversity, challenging work, and gender equality.

All association related to three factors are positive on Tobin's *Q* and ROA, and the most important factor is the one that relates to diversity issues in a company. Thus, we can conclude that these findings are in line with our baseline models.

TABLE 9 Relative importance and statistical significance for the model predicting a company's image.

	Relative importance	Grades 1–2	Grades 2–3	Grades 3–4	Grades 4–5
Career development	1	−0.3245*	−0.1238*	0.0897*	0.2261*
Attitude towards older colleagues	0.5182	−0.1442*	−0.107*	−0.0318*	0.1519*
Work–life balance	0.4172	−0.1408*	−0.0635*	0.0326*	0.076*
Job security	0.3511	−0.141*	−0.0432*	0.0359*	0.0912*
Environmental friendliness	0.3406	−0.128*	−0.0682*	0.0054	0.0735*
Company culture	0.3044	−0.116*	−0.0415*	0.0323*	0.0899*
Workplace safety	0.2783	−0.1123*	−0.0897*	−0.0109*	0.0508*
Overall compensation for work	0.2364	−0.1118*	−0.0452*	0.017*	0.0578*
Freedom to work independently	0.2316	−0.0788*	−0.0418*	0.0078	0.0417
Inclusive/diverse	0.1863	0.0291	−0.008	−0.0246*	0.0096
Tobin's *Q*	0.1798	−0.0151*	0.0316*	0.0639*	0.0897*
Support from management	0.1726	−0.0653*	−0.025	0.0177	0.0503*
Accessible to people with disabilities	0.1593	−0.1019*	−0.046*	0.005	0.022*
Implied vol.	0.1361	−0.0034	0.0168*	0.041*	0.0094
Teamwork	0.1277	−0.0764*	−0.0399*	0.0128*	0.0193
Internal communication	0.1189	−0.0188	0.0018	0.0086	0.0298*
Leverage	0.1166	−0.0211	−0.0095	0.002	−0.0005
Office/work environment	0.115	−0.0017	−0.0093	−0.0103*	0.0473*
Challenging work	0.0989	−0.0226	−0.0139	−1.00E-04	0.0057
Total assets	0.0876	−0.0107	−0.005	0.009	0.0188
Industry	0.0799				
Gender equality	0.068	0.0283	0.0097	−0.009*	−0.0082
ROA	0.0479	−0.0083	−0.0074	0.0024	0.0053
Firm age	0.0424	−0.0117*	0.0007	0.0039	0.0067
R&D intensity	0.0418	−0.0005	−0.0031	0.0108	−0.0159

Note: The importance of the features are calculated as averages of the absolute SHAP values. Here the SHAP values are rescaled so that the most important variable gets value 1. The SHAP values are the mean effects of the bootstrap samples for the four intervals. * indicates statistical significance at least at the 10% level. Company image is measured here by the review question, which assesses how proud the employees are of working for the company.

4.5 | Additional tests

4.5.1 | Models for employee opinion variables

SIT suggests that an employee-friendly corporate culture can influence organisational identification and pride through perceived prestige (Ashforth & Mael, 1989; Dutton et al., 1994) and perceived respect (Farooq et al., 2017; Fuller et al., 2006). To understand better the nature of the relationship between corporate culture features and pride in the company, we conduct an additional analysis to determine which features are the most important predictors of pride in the company. The SHAP values (Table 9) reveal that career prospects for growth and professional development and attitudes towards older employees are clearly the most important predictors of pride in a company. These associations are positive and linear, suggesting that employee caring and respectful cultural values, which Graham et al. (2021) called cultural values of

TABLE 10 Relative importance and statistical significance for the model predicting job security.

	Relative importance	Grades 1–2	Grades 2–3	Grades 3–4	Grades 4–5
Career development	1.0000	−0.3808*	−0.2018*	0.1384*	0.3887*
Attitude towards older colleagues	0.5559	−0.2404*	−0.1772*	0.0119	0.2292*
Company image	0.3426	−0.1865*	−0.1067*	0.0026	0.1375*
Support from management	0.2677	−0.1349*	−0.0525*	0.0609*	0.1128*
Work–life balance	0.1910	−0.1078*	−0.0299*	−0.0131	0.0932*
Internal communication	0.1287	−0.1074*	−0.0213*	0.031*	0.0399*
R&D intensity	0.1284	0.0485*	0.0068	−0.0463*	−0.1114*
Gender equality	0.1056	−0.0702*	−0.0354*	−0.0073	0.0471*
Workplace safety	0.0929	−0.0897*	−0.0655*	−0.0224*	0.0292*
Challenging work	0.0898	0.0266	0.0116	−0.0221*	−0.0386
Office/work environment	0.0577	−0.033	−0.0194*	−0.004	0.0311*
Environmental friendliness	0.0566	0.0404	−0.0012	−0.0165*	0.0045
Accessible to people with disabilities	0.0537	−0.1093*	−0.0281*	0.0033	0.0153
ROA	0.0531	−0.0159	−0.0126*	0.0027	0.0233
Implied vol.	0.0531	0.0153*	−0.0153*	−0.0314*	−0.0156
Inclusive/diverse	0.0478	0.021	−0.0039	−0.0122*	−0.0199
Total assets	0.0434	0.0206	−0.0022	−0.0057	−0.0174
Freedom to work independently	0.0432	−0.0413	−0.017	0.002	−0.0037
Company culture	0.0366	−0.0328	−0.0098	0.0038	0.0183
Leverage	0.0361	0.0243	0.0267*	−0.0036*	0.0086
Tobin's *Q*	0.0354	−0.0015	−0.0013	0.0054	0.0294
Overall compensation for work	0.0347	−0.0004	0.0138	−0.007	−0.0138
Teamwork	0.0257	−0.0169	0.0015	0.0021	−0.0172
Industry	0.0127				
Firm age	0.0118	−0.0091	0.0084*	−0.0044	−0.0003

Note: The importance of the features are calculated as averages of the absolute SHAP values. Here the SHAP values are rescaled so that the most important variable gets value 1. The SHAP values are the mean effects of the bootstrap samples for the four intervals. * indicates statistical significance at least at the 10% level. Job security is measured here by the review question, which assesses how stable the employees experience their jobs.

community, are what cause employees to experience pride in their employer. However, according to SIT, it is possible that pride in the company is also affected by crowds' opinions about company fundamentals and other external aspects relating to firms' prestige that are not included in our model. In this case, employee evaluations might incorporate, for example, more externally oriented CSR activities and might indicate employees' prospects about the firm's future business outlook in a longer time horizon and, as such, mirror their perceptions of the company's future. This might be one reason why organisational pride is not among the most important predictors of ROA.

As employees' behavioural reactions to job insecurity are determined not only by individual features but also by organisations' treatment of their employees (e.g., Sverke & Hellgren, 2002), we conduct a further analysis to identify the most meaningful predictors of job security. The results of the model predicting *Job security* are provided in Table 10. Our analyses reveal that career prospects for growth and professional development and attitudes towards older

employees are clearly the two most important predictors of experienced job security. These relationships are strongly positive and closely linear. The SHAP values show that the effects of these features are negative for low employee ratings and strongly positive for high employee reviews. Previous research has argued that the perception of fairness would help employees to manage uncertainty as part of their job and stay engaged and productive in these demanding working environments (Wang et al., 2015). Similarly, an employee-friendly corporate culture with values of caring and respect may help employees to overcome these uncertainties and cope with job insecurity. These actions may enhance employee commitment, enhancing the organisation's performance in the long run (Posthuma et al., 2013).

5 | DISCUSSION AND CONCLUSIONS

This study presents an application of explainable ML methods in accounting research, demonstrating the value of ML in efficiently exploiting large data volumes (Bertomeu, 2020; Mullainathan & Spiess, 2017; Ranta et al., 2022; Storm et al., 2020). We contribute to the growing literature by using the SHAP method to analyse the impact of 18 EF corporate culture characteristics on financial performance. We find that crowdsourced employer reviews on social media provide useful corporate culture information, corroborating previous findings by Hales et al. (2018) and Miller and Skinner (2015) regarding the influence of social media on firms' information environments. Unlike prior studies, we identify specific employee review information related to firm EF corporate culture characteristics, provided by social media platforms, that associate with firm operating and market performance. We further highlight the distinctive relationships between different employee ratings and market versus operating performance.

Our results reveal the particularly important role of organisational pride and job security. *Job security* has a strong positive association with operating performance (ROA). Interestingly, it is not associated with Tobin's *Q*. Similarly, *Company image* (pride in company) clearly has the strongest association with market performance, but its role is substantially less important with ROA. These findings might also indicate that markets value the company fundamentals over a longer time horizon. It might be that *Job security* indicates stable and good financial performance in a shorter period of time compared to *Company image*, which might capture a wider range of different characteristics of company culture values and fundamentals, and as such, could indicate firms' future financial performance over a longer period of time. For example, an experienced, stable, and safe job might bring financial safety and continuity to individuals, and positive ratings might indicate that employees perceive their employers' financial fundamentals as being in a steady condition. However, this stability might send a different and less growth-oriented signal to markets in a longer time horizon. Green et al. (2019) suggested that changes in employee satisfaction are influenced by fundamental changes at the firm, with markets being slow to incorporate this information. This can be one explanation for our findings as well.

These findings suggest that employee opinions related to *Job security* best reflect their expectations and knowledge about firms' future financial performance. Employees' ratings about job security might reflect their insider view of the business, because they can possess valuable information about existing problems in purchasing, production processes, R&D, sales, etc. This information is also more feed-forward in nature, at least over a short period, and as such, it is different from many other employee ratings concerning corporate culture and employee treatment. Instead, a positive review about *Company image* might reflect more stable characteristics over a longer period of time, like pride in the company as a whole – its culture, values, history, and meaning – that, based on our findings, can translate into a good future market performance without being closely tied to timely information about operating performance,

like future sales demand and shortages in production capacity, or other more general information. In addition, *Company image* seems to reflect crowds' opinions about company fundamentals and other aspects in a more comprehensive manner, and as such, it might indicate employee prospects about the business outlook over a longer time horizon.

Other less important but significant predictors of Tobin's *Q* are *Work-life balance* (company values, considering families, and no pressure to work long hours), diversity in terms of *Inclusive/diverse workplace values* and *Attitudes towards older colleagues, Company culture,* and *Functional office/work environment*. Furthermore, our findings show that other important and significant predictors for ROA are *Workplace safety*, *Freedom to work independently*, diversity in terms of *Gender equality* and *Inclusive/diverse* workplace values, and *Company image*.

In addition, it seems that many EF corporate culture values might be more strongly related to performance measures other than firm value and profitability. Our additional analysis revealed that career prospects for growth and professional development and attitudes towards older colleagues are clearly the two most important predictors of pride in a company and job security. Similarly, there are other possible channels through which EF corporate culture values might affect, for example, retention and company attractiveness when recruiting new talents, as shown in the study by Guiso et al. (2015). Previous research has supported these arguments; for example, Sheng (2021) suggested that, even if the employee outlook (one measure in the Glassdoor data) is correlated with the corporate culture and employee satisfaction, their impacts on firms' future performance differ in terms of economic channels. Similarly, Hales et al. (2018) suggested that employee sentiment might be more strongly related to other aspects of corporate performance.

Our evidence provides interesting findings, and as such, opens new avenues for future research, However, the conclusions of this study need to be interpreted in the context of potential limitations. First, although the extreme gradient-boosting algorithm is a highly efficient predictor, its interpretation is more complicated. This challenge reflects the unavoidable trade-off between flexibility and interpretability faced by any method. While outputs such as SHAP values remedy the interpretability issue somewhat, traditional linear models are still significantly easier to interpret. The machine learning models, like gradient boosting, need to be analysed carefully using multiple metrics that evaluate features' importance from different perspectives. Also, using controls, especially fixed effects, is more complicated with nonlinear models. Nevertheless, restricting the modelling to linear structures would obscure many of the interesting nonlinear relationships found in this research. Second, employee reviews are submitted voluntarily, and we are unable to observe the motivations behind individual respondents' reviews. This issue might raise a concern about omitted variable bias if such events occur, which cause employees to leave reviews. However, our model includes many controls related to the types of events likely to drive employees to leave reviews.

Finally, we are fully aware that reverse causality is an issue, as it could be stated that better-performing companies can invest more in their employees and thus create a more EF corporate culture. However, as our research aims to reveal patterns in the complex social media data, the issue is not critical. The only way to convincingly prove a causal effect of employee-friendly corporate culture values on performance is through a field experiment. However, given the complexity and costs involved in setting up these experiments, the first crucial step is understanding the associations between different EF corporate culture features and performance and showing whether they appear to be present in the data (Guiso et al., 2015). One aspect of our study that may reduce such a concern is the economic theories arguing that a firm's culture is largely fixed over long periods and specific to the firm (e.g., Kreps, 1990; Lazear, 1995). In addition, the social exchange theory (Blau, 1964; Levinson, 1965), SIT (e.g., Ashforth & Mael, 1989; Hogg & Terry, 2000), and the theory of collective organisational engagement

(Barrick et al., 2015) provide strong theoretical arguments to explain the value-enhancing effects of EF treatments on corporate performance.

Our results provide managers with practically relevant information and new insights about the most meaningful features of EF corporate culture and also a starting point for other researchers to advance theory and develop new hypotheses. One such avenue is to study the multiple aspects of workplace diversity values more carefully. Our finding contributes to previous diversity literature by showing that employee social media ratings about different dimensions of diversity are associated with firms' financial success. Our results show that inclusive/diverse workplace values (to what extent the company values diversity in the workplace and supports diverse ideas and opinions) have a positive effect on Tobin's *Q*. However, our results also indicate that attitudes towards older colleagues (hiring older employees; appreciation, support, and equal opportunities for senior colleagues) and work-life balance (company values, considering families, and no pressure to work long hours) have negative associations with Tobin's *Q*. In addition, our results reveal interesting non-linear associations between gender equality, inclusive/diverse values, and ROA. These effects are mostly insignificant for companies with a low grade between 1 and 3. However, the positive effect is significant for grades 3–4. For companies with grades 4–5, the effect drops significantly and is negative and statistically significant. Studies focusing on the relationship between the company diversity dimension and financial performance are still scarce. Financial benefits of diversity are praised, but very little research has shown real empirical evidence as to whether this is true (e.g., Filbeck et al., 2017; Kirch, 2018). Ellis and Keys (2015) argued that companies are unwilling to share diversity information about company demographics, even if institutional investors are increasingly requesting that information to understand companies' diversity efforts. Our results suggest that the associations between workplace diversity and company performance are complicated, and employee ratings on social media might reveal important new insights about company policies that are not included in CSR disclosures. Future research can also study whether inconsistencies exist between crowdsourced employee opinions about workplace diversity in social media and those values reported publicly through CSR disclosures.

Finally, notable progress has been made in the field of machine learning (ML) for causal inference (Athey et al., 2019; Wager & Athey, 2018). The predictive capacity of ML algorithms in complex and high-dimensional environments can be utilised to enhance the accuracy of causal estimations. Several promising approaches have emerged, such as causal forests, counterfactual simulation, double machine learning, and machine learning for matching (Athey, 2019). Employing causal analysis can uncover the actual direction of associations and mitigate issues such as reverse causality, which can reveal intriguing new insights about the relationship between corporate culture and company performance.

DATA AVAILABILITY STATEMENT

Data is not available due to commercial restrictions. A Python code of this study is available on request from the authors.

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APPENDIX

TABLE A1 Employees' rating of their employer ranked on a 5-point scale, with five (one) being the most favourable (least favourable).

Company culture	How is the overall company culture?
Internal communication	How is the internal communication? To what extent are you informed about company results, successes, and challenges through regular communication?
Teamwork	How are co-workers at working together and interacting in an honest, direct manner?
Work–life balance	How does the company value work–life balance? Are families considered? Is there pressure to work long hours?
Support from management	Does the leadership set realistic expectations, communicate clear goals, and involve employees in the decision-making process?
Freedom to work independently	To what extent are you trusted to work independently?
Inclusive/diverse	To what extent does the company value diversity in the workplace? Are diverse ideas and opinions supported?
Gender equality	Are women treated equally and given the same career opportunities?
Attitude towards older colleagues	Does the company hire older workers? Are senior colleagues appreciated, supported, and given equal opportunities?
Office/work environment	Is the work environment comfortable and suited to do the work you are doing? Is there proper ventilation, lighting, temperature control, and technology available?
Environmental friendliness	To what extent does the company demonstrate concern for or awareness of the environment (e.g., having recycling program in place)?
Accessible to people with disabilities	Does the company have facilities that are handicapped accessible to support people with disabilities?
Workplace safety	Does the company maintain a safe and compliant working environment?
Overall compensation for work	Overall, do you feel that you are fairly compensated for your work?
Job security	How stable do you feel your job is?
Company image	Are you proud to work for your company?
Career development	How are your career prospects for growth and professional development?
Challenging work	How challenging is your work? Are you proud of the work that you produce?
Control variables	
Total assets	Total assets of a company
Leverage	Sum of the total long-term debt and debt in current liabilities divided by the stockholder's equity
Market-to-book	Market value of a company divided by the sum of total common equity and deferred taxes
R&D intensity	Research and development expenses divided by the total assets of a company
ROA	Net income divided by the total assets of a company
Implied volatility	Volatility assumption percentage
Firm age	Firm age computed from the first Compustat observation