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Organizational cultural strength as the negative cross-entropy of mindshare: a measure based on descriptive text

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The strength of an organization's culture is an important property that may have implications for organizational structure, performance, diversity, and inclusion, independent of its content. However, progress on conceptualizing and measuring cultural strength has been restricted so far. We propose a novel measure of an organization's cultural strength as the negative average cross-entropy of its members' mindshare distributions, defined on a support comprising a set of firm-specific cultural elements. Using descriptive text data produced by 2.9 million individuals in about 95 thousand US firms from the employee review website Glassdoor.com, we calculate our measure of organizational cultural strength using topic modeling and show that it behaves as theoretically expected: older, smaller, and more geographically concentrated firms have stronger organizational cultures. We also note some intriguing associations between organizational cultural strength, role differentiation, and gender imbalance within firms. Finally, we discuss opportunities for using this new measure to understand how organizations work more generally.

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Introduction

It is an intuitive idea that whether organizational culture can produce social order should depend on its *strength*—the extent to which an organization's members think cohesively. Strong cultures may be expressed through a variety of mechanisms including focal points (Schelling, 1978), group identity (Barnard, 1968), and homophily (Lazarsfeld and Merton, 1954). The broad importance of organizational cultural strength as a theoretical construct for understanding how organizations function as social systems cannot be overestimated. Strong cultures may support self-organization, possibly as an alternative to hierarchically imposed order (e.g., Ostrom, 2005; Ouchi, 1980; Ouchi and Prince, 1978). Given current interest in non-hierarchical forms of organizing that are argued to better represent humanistic values and the preferences of Generation Z workers (Hamel, 2007; Laloux, 2014; Turco, 2016), understanding strong cultures as a basis for organizing non-hierarchically is critical. Organizational resilience to crises such as the COVID-19 pandemic is very likely to depend on organizational cultural strength, because restrictions on communication make pre-existing shared understanding ever more important (Clark, 1996). Of course, it is also possible that strong cultures produce forms of "groupthink" that inhibit organizational innovation or oppose explicit moves to increase diversity and inclusion (Corritore et al., 2020; Sorensen, 2002).

However, despite a promising start to measuring and assessing the impact of organizational cultural strength (e.g., Burt et al., 1994; Chatman et al., 2014; Gordon and DiTomaso, 1992; Kotter and Heskett, 1992; Sorensen, 2002),[1] progress has been limited in understanding the kind of topics we noted above. This is because of the difficulty of measuring the strength of organizational cultures in a reliable, valid, and scalable manner, which we trace to three separate challenges.

The first challenge lies in building a conceptual bridge between the intuitive notion of a strong culture and its operationalization. Saffold (1988) criticized the concept of strong culture for its lack of clarity, and noted that strong cultures have variously been described as homogeneous (Ouchi and Prince, 1978), stable and intense, fully articulated, highly differentiated (Schein, 2004), and coherent (Weick, 1985). Variance in the specific cultural elements that, by being widely prevalent, produce culture strength also exacerbates this diversity in conceptualization. Elements that can underlie cultural strength include norms (e.g., Chatman et al., 2014; Gelfand et al., 2011), artifacts (Schein, 2004), values, and behaviors (Balthazard et al., 2006; Cooke and Rousseau, 1988). We believe that Chatman and colleagues (e.g., Chatman et al., 2014; O'Reilly, 1989; O'Reilly and Chatman, 1996) offer a promising conceptualization of cultural strength that is in principle agnostic to the specific cultural element under consideration (though their focus is on norms), but nonetheless explicitly recognizes the twin dimensions of commonality and importance of those cultural elements to the group's members. We build on this conceptualization—which has distributional components at both the inter-individual (i.e., similarity across actors) and intra-individual (i.e., what is important to those actors) levels—and formalize it.

Specifically, to conceptualize cultural strength clearly, we propose a measure of the relational properties of the distributions of importance ("mindshare") that individuals assign to the cultural elements of their organization. Formally, we represent an organization's cultural strength as a joint function of the intensity and similarity of how its members allocate importance among the cultural attributes specific to their organization. Mindshare distributions can be measured from the descriptive text individuals produce about the organizations they inhabit, such as in employee reviews (e.g., Corritore et al., 2020), using inductive machine learning methods—specifically, topic modeling (Blei et al., 2003).

The second challenge has been to measure differences across organizational cultures in a reliable fashion while being sensitive to the fact that organizational cultures might have idiosyncratic, organization-specific elements, as recognized in an *emic* approach to culture (Malinowski, 1922). Surveys that use pre-defined items, which represent by and large the most common "large" data source for comparing organizational cultures to date, help benchmark firms along a pre-determined set of shared dimensions, according to the *etic* view (Harris, 1979). Nevertheless, an empirical approach that ignores idiosyncratic cultural dimensions is likely to produce biased measures of cultural strength. We formulate an approach that avoids this problem. To capture emic aspects of culture, we measure the cultural strength of each sampled organization separately based on the text produced by its own employees. This allows us to uncover firm-specific attributes that employees consider important in conceptualizing their organizational life, which could otherwise be neglected by the traditional etic approaches.

The third challenge is one of data: comparing cultural strength quantitatively across organizations requires substantial amounts of data within and between. Fortunately, new sources of data have become available in recent years that mitigate this challenge. Databases that aggregate descriptive text written by employees about their organizations, such as Glassdoor.com, have enabled access to large-scale data relating to culture both within and between organizations. Access to data at this scale about an organization's cultural attributes as perceived by its members has been effectively impossible in the past and only became feasible through the conjunction of digitalization and business models that incentivize employees to anonymously share descriptions of their organization. We follow the lead of researchers who have begun analyzing such data to derive the cultural properties of organizations (e.g., Corritore et al., 2020; Marchetti, 2020). Despite their potential, caution must be exercised in using such data because they also have an important limitation: assessing their representativeness is difficult. Since employees self-select into writing reviews, they do not constitute a random sample of the organizational population. With surveys, it is possible to assess the non-response bias more precisely, if the researchers start with a well-defined sampling frame.

We compute and validate our cross-entropy-based measure of cultural strength using a sample of 2,900,436 text reviews posted by employees across 94,868 companies in 68 industries over the period 2008–2020 on the website Glassdoor.com. Given the limitations of data representativeness, a conservative interpretation of our measure is that it captures the strength of the sub-cultures of those who write reviews on Glassdoor. To examine if we can legitimately broaden the interpretation, we conducted tests for response polarization and find no evidence for it. Further, to validate our measure, we provide correlations with covariates generally assumed, on theoretical grounds, to be related to the strength of organizational culture: organizational size, age (both measured at the organizational level, neither sourced from text reviews), average employees' tenure, and geographical dispersion. The results are promising, suggesting that the measure we propose is capturing organizational cultural level properties, and not only that of the respondents' sub-cultures. As prior theory predicts, we find that younger, larger, and geographically dispersed organizations and organizations in which employees have shorter average tenure exhibit weaker cultures (DelCampo, 2006; Van den Steen, 2010a).

To point to the potential uses of our measure of organizational cultural strength, we also describe exploratory analyses which are indicative rather than definitive. First, we find that organizations with a larger imbalance in employees' gender appear to have

stronger cultures. This has the potentially troubling implication that the culture and demographics of such organizations may be locked into a mutually reinforcing resistance to expanding diversity. Second, we also find that organizations with a lower degree of internal role differentiation appear to have stronger cultures. We stress that whether this simply reflects the selection of individuals who write about their organizations' culture, or points to the existence of cultural differentiation by roles remains to be investigated. Third, we also find that organizational cultural strength varies more between industries, geographies, and firm typologies than within them. This points to the need for care in identifying useful exemplars of strong cultures, a practice quite common in popular managerial writing. It also suggests interesting interactions between regional and organizational culture that bear further investigation.

Prior literature on cultural strength

Management scholars have shown a long-lasting fascination with organizations perceived to have strong cultures. The first wave of theoretical work focused mainly on defining cultural strength as a construct and linking it to a firm's collaboration and innovation. In this stream of literature, strong cultures have been variously defined as homogenous (Ouchi and Prince, 1978), thick and widely shared (Sathe, 1983), stable and intense (Schein, 1984), cohesive and tight (Deal and Kennedy, 1982), and displaying both consensus and intensity (O'Reilly, 1989). While these definitions shared the crucial feature that they were agnostic as to the specific cultural element or its content (i.e., strong cultures could arise just as easily based on norms of fairness as on beliefs in rewarding differential ability), they also differed significantly in their verbal formulations.

More recent literature has attempted precise mathematical formalizations of the cultural strength construct. For instance, Van den Steen (2010a, 2010b) considers strong cultures as characterized by "high homogeneity in their members' beliefs" and discusses how the shared beliefs lead to a host of outcomes, such as higher delegation, satisfaction, motivation, better coordination, more communication, lower monitoring, but also less experimentation (Van den Steen, 2010a). He also proposes that firm's age, size, performance, and employee composition should correlate with its cultural strength (Van den Steen, 2010b).

In parallel, a stream of empirical research has aimed to advance cultural strength measurement with organizational data. Kotter and Heskett (1992) provide one of the first and most remarkable efforts to measure cultural strengths in organizational settings. They collect survey data from the top six officers of 180 large, publicly traded firms in 19 markets, asked to report the cultural strength of their competitors. Based on the survey scales they develop, a firm's culture is measured as strong if its managers would commonly speak of the company's style, the firm has espoused its values clearly, makes an effort to socialize its managers accordingly, and is managed based on long-standing practices and policies. The authors find that, across industries, strong cultures display better financial performance. Using the same dataset, Burt et al. (1994) find that the benefits of strong cultures are contingent on the nature of the market and are more substantial in highly competitive industries, while Sorensen (2002) emphasizes the importance of environmental uncertainty as a contingency, with stronger cultures being less effective in highly volatile sectors.

Gordon and DiTomaso (1992) similarly leverage survey data but define cultural strength as the sample standard deviation in employee responses to questions that verify the prevalence of some pre-selected cultural dimensions. They also provide an alternative operationalization of cultural strength, focused on the dimensions of stability. On a sample of 11 US insurance companies, with an average of 77 respondents per firm, they find that organizations that exhibit consensus around cultural values experience superior performance. Chatman et al. (2014) define strong cultures as those with both high consensus around a system of norms and intensity about the most valued norms and use survey items to measure the two dimensions around the specific cultural attribute of adaptability. On a sample of 39 firms, with 16 respondents per firm on average, they find that organizations displaying higher consensus and intensity around adaptability perform better than others.

Despite the advances made in this body of literature, significant limitations remain. The first pertains to the theoretical conceptualization of the cultural strength construct, which raises doubts about its usefulness as a concept. It is unclear whether a strong culture should exhibit high levels of consensus (Gordon and DiTomaso, 1992; Van den Steen, 2010a, 2010b), intensity (Burt et al., 1994; Kotter and Heskett, 1992; Sorensen, 2002), or both (Chatman et al., 2014; O'Reilly, 1989) around the cultural elements that matter in a context. Further, while most scholars have defined cultural strength independent of its underlying elements or their content (e.g., Burt et al., 1994; Carrillo and Gromb, 1999; DelCampo, 2006; Kotter and Heskett, 1992; Sorensen, 2002; Van den Steen, 2010a, 2010b), others anchor the definition of a strong culture to specific cultural elements and content relevant to the organization (e.g., Chatman et al., 2014; Gordon and DiTomaso, 1992). In many ways, Saffold's (1988) critique regarding the original stream of theoretical work on the topic still has force today: the definition of the construct often appears elusive, leading "to conclude that the concept of culture strength is an amorphous notion unlikely to provide a sound basis for theory or research" (p. 548).

Second, relying on surveys has meant a relatively small data scale (the largest studies on cultural strength noted above cover 180 firms with an average of 6 respondents per firm and 11 firms with an average of 77 respondents per firm). However, perhaps even more troublesome is the risk of biased inference about an organization's cultural strength incurred by comparing firms along pre-determined and shared sets of cultural dimensions in surveys, as imposed by the *etic* approach (e.g., Chatman et al., 1998, 2014; Harrison and Carroll, 2006; Lauver and Kristof-Brown, 2001; O'Reilly and Chatman, 1996). A preferable alternative is the *emic* approach, which argues that cultures rest on group-specific belief systems (e.g., Alvesson and Berg, 1992; Martin, 2002; Smircich, 1983) that can only be studied from the "native's point of view" (Malinowski, 1922). Using etic lists of organizational attributes could lead to potential biases in measuring cultural strength. It could be underestimated if organizational members exhibit homogenous mindshare distributions only on emic dimensions not included in the etic list (Chatman et al., 2014). It can, on the other hand, be overestimated if the members report high mindshare homogeneity over the etic attributes they are shown, but in fact, these are collectively unimportant to them. Without an emic approach to first uncovering the relevant firm-specific attributes of a culture, we have no way of even knowing which of these is the more severe problem.

In the next section, we describe how we re-conceptualize cultural strength from a theoretical standpoint and how we operationalize the construct in a way that avoids these limitations.

Re-conceptualizing cultural strength: definition and operationalization

A formal definition of cultural strength. We follow Chatman and colleagues, who have defined a strong organizational culture as one where the members reach *consensus* (i.e., agreement) on which cultural attributes have the greatest *intensity* (i.e., are highly important) to them (e.g., Chatman et al., 2014; O'Reilly, 1989; O'Reilly and Chatman, 1996; Schein, 1983). Thus,

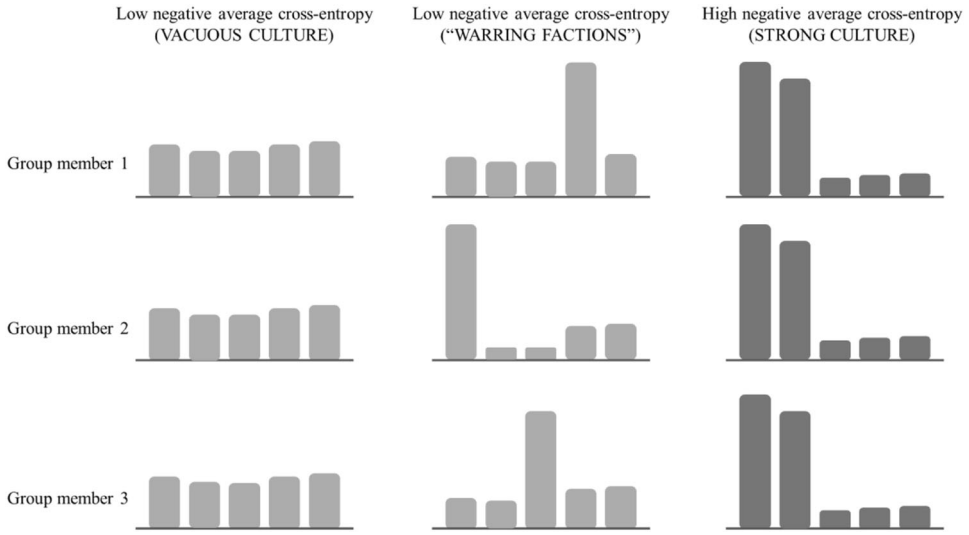

Fig. 1 Examples of cultural strength based on the negative average cross-entropy metric. In Fig. 1, we describe an organizational culture based on the relative levels of negative average cross-entropy displayed by its members' distribution of mindshare over cultural attributes and identify three possible culture typologies accordingly.

membership in a strong culture implies that individuals assign high importance to the same cultural attributes characterizing the organization. Note that this definition is agnostic to the specific cultural elements (e.g., belief vs. value) or their content (e.g., valuing fairness as "egalitarianism" or "just desserts") underlying the culture. Therefore, this definition of cultural strength can be generalized to consider the distribution of importance assigned by its members to elements such as values (what is considered desirable), norms (what is considered socially expected and acceptable), beliefs (what is considered to be true), or artifacts (what are considered as symbols that signify values, norms and beliefs) (Schein, 2004).

We formalize our definition of cultural strength as follows. An organization can be represented by a matrix $A \epsilon R^{NxK}$, which comprises the ϑ_r individual mindshare distributions for the $r = 1$ to N organizational members over K organizational-specific cultural attributes. We can then compute the cultural strength, S, of the organization as the negative average cross-entropy of A:

$$S = -\frac{2\sum_{i=1}^{N}\sum_{j=i}^{N}\overline{\mathrm{CE}}_{ij}, j \neq i}{N(N-1)} \quad (1)$$

where $\overline{\mathrm{CE}}_{\vartheta_p,\vartheta_q}$ is the average pairwise cross-entropy for the probability distributions ϑ_p, ϑ_q and can be expressed as

$$\overline{\mathrm{CE}}_{p,q} = \frac{[H(\vartheta_p) + D_{\mathrm{KL}}(\vartheta_p||\vartheta_q) + [H(\vartheta_q) + D_{\mathrm{KL}}(\vartheta_q||\vartheta_p)]}{2}. \quad (2)$$

$H(\vartheta_p)$ is the entropy of the probability distribution ϑ_p and $D_{\mathrm{KL}}(\vartheta_p||\vartheta_q)$ is the Kullback–Leibler (henceforth, KL) divergence between ϑ_p, ϑ_q. The negative sign ensures that higher values of S for a given organization correspond to greater cultural strength. Our proposed measure explicitly accounts for (a) the distribution of importance each individual assigns across attributes (ϑ_r), and (b) the extent to which individuals are similar in their importance distributions (the averaging of all pairwise $D_{\mathrm{KL}}(\vartheta_p||\vartheta_q)$), (c) over sets of attributes (K) that are firm-specific, according to the emic view of culture.

Research in natural language processing (e.g., Ghazvininejad et al., 2020; Teahan and Harper, 2003) uses cross-entropy as a standard metric of distributional differences. The metric has the advantage of simultaneously accounting for both the shared nature (i.e., the degree of consensus across individuals) and the differential importance (i.e., the degree of intensity within an individual) that employees assign to organizational attributes. In measuring the strength of organizational culture, accounting for both such dimensions is critical because both the properties of consensus and intensity are necessary for a strong organizational culture to arise. Chatman et al. (2014, p. 788) contrast a strong culture with "vacuous cultures", in which there is high consensus but low intensity on the cultural attributes of the organization its members deem important, and with "warring factions", where intensity is high, but consensus is low around the cultural attributes.

High values of S (close to zero) signify that the organizational members' mindshare distributions are focused on the same and few attributes of their culture, capturing both the dimensions of commonality and importance simultaneously. Low S indicates a weak culture and could be driven either by individuals' indifference (as in "vacuous" cultures) or conflict (as in "warring factions", to use the language from Chatman et al., 2014) in what matters to organizational members. Neither indicates a strong culture. In Fig. 1, we summarize the different distributional properties of mindshare across cultural elements that may lead to a range of values for S.

Measuring cultural strength

Data source and sample construction. To measure organizational cultural strength, the crucial ingredient is the matrix A of individual mindshare distributions for the N organizational members over K organizational-specific cultural attributes (see Eq. (1)). To compute the mindshare distributions that form A, we leverage employee-generated descriptive text data from Glassdoor.com. Glassdoor is a job search platform launched in 2008 that counts 55 million unique monthly visitors and 95 million reviews, salary information, and company insights posted online by over 1.7 million firms' employees covering a wide range of industries and geographies over the years.[2] Researchers have begun to use Glassdoor reviews (e.g., Corritore et al., 2020; Sull et al., 2019) to measure organizational cultures. Because employees also provide information about their demographic and employment, such as their gender, tenure, and job title at the firm, Glassdoor employer reviews represent a unique data source to get a picture of the internal workings of organizations.

The primary weakness of this data source is that it is prone to unquantifiable response biases. Our results are therefore limited

to the data produced by individuals who choose to write on Glassdoor. They may or may not be representative of their organizations. However, recent evidence produced by Wilmers et al. (2021) offers some basis for optimism. They performed a systematic analyses of potential selection biases in Glassdoor by conducting an online survey of 1000 participants asked whether they had ever reviewed their employer online. The authors find that the respondents who had previously contributed an online review are similar to the non-reviewers (conditional on responding to their survey). Nonetheless, we take further steps to examine the impact of response biases in our analysis below.

To build a sample of firms to measure their degree of cultural strength and validate our proposed metric, we started from the universe of US-based firms reviewed in Glassdoor during the observation period 2008–2018. This initial set comprised 388,412 companies. We then narrowed the sample to 10 macro-industrial domains[3] where the average firm-level Glassdoor coverage (i.e., the total number of reviews available on Glassdoor for a focal firm over the observation window, divided by its number of employees) is equal to 25% at least. This aims to weaken concerns about response bias in the Glassdoor data. This approach left us with a total of 140,726 firms from the original sample, for which we have higher confidence that the Glassdoor reviews are representative of the whole organizational population in drawing a picture of its culture. Further, we retained only those firms for which Glassdoor features at least two reviews, the minimum threshold to compute their degree of cultural strength (our conclusions are robust to raising this threshold to five reviews). This left us with 94,868 firms in the final sample, corresponding to 67% of the organizations in the selected industrial sectors and 24% of the original Glassdoor universe of US-based companies, and a total of 2,900,436 text reviews posted online by employees of the sampled firms.

Operationalizing cultural strength. To measure the mindshare distributions as an ingredient into our measure of organizational cultural strength, we follow Corritore et al. (2020) and use each employee's review posted on Glassdoor as an observation of the their mindshare, i.e., the attributes of the organization that the individual posting the review considers most important to them. Similar to prior research leveraging text analysis techniques (e.g., Blei et al., 2003; Corritore et al., 2020; Hannan et al., 2019; Huang et al., 2018; Kaplan and Vakili, 2015), we apply the latent Dirichlet allocation (henceforth, LDA) algorithm for unsupervised topic modeling to extract the set of organizational attributes employees discuss on Glassdoor when reviewing their companies.

The LDA analysis on firm-specific text corpora allows us to summarize each employee review as a probability distribution ϑ_r, which we treat as an empirical estimation of the individual distribution of importance (mindshare) over the cultural attributes used to describe the organizational context, under the assumptions that: (i) individuals are more likely to write about organizational aspects that matter more to them, and (ii) the topics estimated by LDA from the corpus of reviews correspond to organizational attributes (in the form of values, norms, beliefs, or artifacts) that employees use to understand and describe the organization they belong to.

LDA topic modeling is often used to uncover the hidden topical structure in large text corpora. It is widely enough used in organizations literature that we refer the interested readers to other sources (e.g., Hannigan et al., 2019) for a basic introduction. LDA allows us to extract the organization-specific set of topics that employees discuss when they write about their firm and summarize how important each of them is to the individual writer, thus offering a suitable methodology to measure mindshare distribution over organization-specific attributes. Critically, because of this empirical approach, we can measure cultural strength around firm-specific content (as per the emic view of culture), across different cultural elements, and at scale, while this was not possible for other forms of data collections (e.g., surveys, interviews, field studies).

Four features of our LDA implementation are worth highlighting. First, following prior literature (Balthazard et al., 2006; Chatman and O'Reilly, 2016; Cooke and Rousseau, 1988; Schein, 2004), we take a broad view on the meaning of such organizational elements, which could concern, for instance, the organization's emphasis on employees' performance (value), the nature of teamwork among colleagues (behavior), a clear and straightforward communication style (norm), or a focus on workers' health and benefits (artifact). We, therefore, run LDA on the corpus of Glassdoor reviews available for each sampled organization (i.e., we do not prune the corpus based on the reviews' content to isolate text that openly refers to cultural elements).

Second, we tune the optimal number of topics to be extracted by LDA on the principle of maximizing topical "coherence". In other words, the optimal topic number for a firm-specific text corpus is the one maximizing the semantic distance among the topics in the solution, where topics are probability distributions over the corpus vocabulary (Puranam et al., 2017). This approach to tuning the topic space size allows us to reduce the noise and possible bias that would otherwise affect our results if an arbitrary topic number were to be chosen (Wallach et al., 2009).

Third, we leverage a specific property of the Glassdoor reviews, where users are asked to separate the content they post in a "pros" and "cons" section about their organization. To compute an organization's cultural strength, we primarily rely on text from the "pros" section only. This is because in the "pros" section of Glassdoor reviews, employees are likely to describe actual attributes of their organization that matter to them. In contrast, in the "cons" section, they may refer to these, as well as to certain attributes that their organization lacks and that they would appreciate instead. Put simply, complaints expressed on Glassdoor reviews' "cons" are typically likely to be more heterogenous and less descriptive of the organization than compliments in the "pros". We therefore focus on the "pros" section of Glassdoor reviews in the baseline analysis, but also report the results from "cons".

Fourth, to measure corporate culture with an emic approach, which allows organizations to vary in their cultural content and show distinctive cultural dimensions (Malinowski, 1922), we run LDA on firm-specific corpora. If we were to aggregate all the Glassdoor reviews available across the sampled organizations in a unique corpus, we would constrain the topics estimated by LDA to be shared across firms, thus imposing the assumption that a universal list of cultural dimensions relevant to all the firms in the population exists (Harris, 1979). Crucially, since we do not have any theoretical reason to argue that the bias potentially induced by an etic measurement would be acting in the same direction across all the sample firms (i.e., generating either all conservative or aggressive measurements of cultural strength), we choose to implement an emic analysis.

Results

Summary statistics and sample description. Table 1 summarizes the characteristics of the individuals who post Glassdoor reviews and thus appear in our sample. Since we do not have equivalent data on those who did not post reviews on Glassdoor, we cannot accurately quantify the non-response bias. We do however have an average of 29 reviews per firm and an average firm coverage (computed as the ratio of reviews available on the website for the focal firm to the total number of employees in the firm assessed from independent sources) of 29% for 94,868 sampled firms.

Table 1 Summary statistics for Glassdoor reviewers.

Average age (std. dev.)	36.45 (12.08)
Gender	
Female	47.08%
Male	47.97%
Education	
High school	11.50%
Bachelors	69.97%
Associates	2.54%
JD	0.19%
MD	0.04%
MBA	1.29%
PhD	0.29%
Current employee when posting review	52.17%
Satisfaction with employer	
Average overall satisfaction (std. dev.)	3.31 (1.43)
Average career opportunities satisfaction (std. dev.)	3.11 (1.43)
Average comps & benefits satisfaction (std. dev.)	3.18 (1.34)
Average satisfaction with senior leadership (std. dev.)	2.96 (1.51)
Average work/life satisfaction (std. dev.)	3.25 (1.41)
Average cultural satisfaction (std. dev.)	3.29 (1.52)
Recommends employer	58.62%
Approves CEO	48.14%
Employment type	
Contract	4.59%
Freelance	1.04%
Intern	3.64%
Part-time	14.64%
Regular	76.09%
Average employee tenure (std. dev.)	2.17 (2.29)

Table 2 reports summary statistics and correlation coefficients among the variables we use in this study.

Figure 2 depicts the distribution of the cultural strength metric (computed on the Glassdoor reviews' "pros" section, left panel), which appears to be multi-modal, suggesting that it could also be approximated with a three-level ordinal variable (we test the robustness of our results to this alternative operationalization of cultural strength). The average number of coherence-maximizing topics estimated per firm is 10.

Validation of the cultural strength metric. Given the enormous scale of our data, there is no comparable publicly available data set to triangulate our new measure of cultural strength. Instead, we rely on indirect theoretical validation for the construct we propose. To do so, we draw on the fact that organizational cultures are known to be shaped through two primary mechanisms (Carroll and Harrison, 1998, 2002; Chatman and O'Reilly, 2016; Harrison and Carroll, 1991; Schein, 2004): (a) sorting, i.e., the selection of individuals into and out of the organization based on their fit (either by employees themselves, or managers, or both), and (b) socialization, i.e., the top-down and peer-to-peer influences among members of the organization that creates homogenization of beliefs and attitudes.

To validate the operationalization of the construct we propose, we show that it correlates with factors noted in prior research as related to cultural strength through the mechanisms of sorting and socialization. We first report bivariate associations (Pearson correlations) to maximize the use of data and in the next section test the same associations using Ordinary Least Squares (henceforth, OLS) regressions with control variables, which however significantly reduces the sample size because of missing data. Fig. 3 summarizes the relationship between cultural strength and the covariates for which theoretical expectations exist in the prior literature (and for which have data).

Table 2 Summary statistics and correlation table.

Variables	Obs	Avg	Std. dev.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Cultural strength ("pros")	94,868	−5.62	1.87	1.00												
(2) Cultural strength ("cons")	94,868	−5.58	1.92	0.55***	1.00											
(3) Firm Glassdoor reviews	94,850	28.86	209.62	−0.05***	−0.05***	1.00										
(4) Firm Glassdoor coverage	93,067	0.43	2.75	−0.08***	−0.07***	0.02***	1.00									
(5) Firm current employees (%)	94,868	0.47	0.28	−0.19***	−0.07***	0.03***	0.03***	1.00								
(6) Firm revenues (log)	66,655	16.01	2.38	−0.14***	−0.21***	0.23***	−0.16***	0.00	1.00							
(7) Firm size (log)	93,067	4.30	1.89	−0.14***	−0.22***	0.24***	−0.18***	0.01**	0.84***	1.00						
(8) Reviewers' average tenure	92,549	2.17	2.29	0.01*	−0.00	0.02***	−0.02***	0.06***	0.15***	0.13***	1.00					
(9) Glassdoor occupational codes	79,776	4.09	6.22	−0.25***	−0.30***	0.63***	0.04***	0.10***	0.46***	0.47***	0.05***	1.00				
(10) Gender imbalance	94,868	0.31	0.26	0.20***	0.21***	−0.06***	−0.03***	−0.05***	−0.12***	−0.11***	−0.01**	−0.18***	1.00			
(11) Number of cities	94,868	3.10	11.3	−0.08***	−0.08***	0.68***	0.05***	0.04***	0.29***	0.32***	0.03***	0.63***	−0.07***	1.00		
(12) Number of states	94,868	2.25	4.02	−0.16***	−0.19***	0.54***	0.06***	0.06***	0.37***	0.40***	0.05***	0.72***	−0.11***	0.87***	1.00	
(13) Firm age (years)	48,565	32.4	29.75	0.05***	−0.04***	0.9***	−0.04***	−0.14***	0.37***	0.39***	0.23***	0.18***	−0.05***	0.11***	0.14***	1.00

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

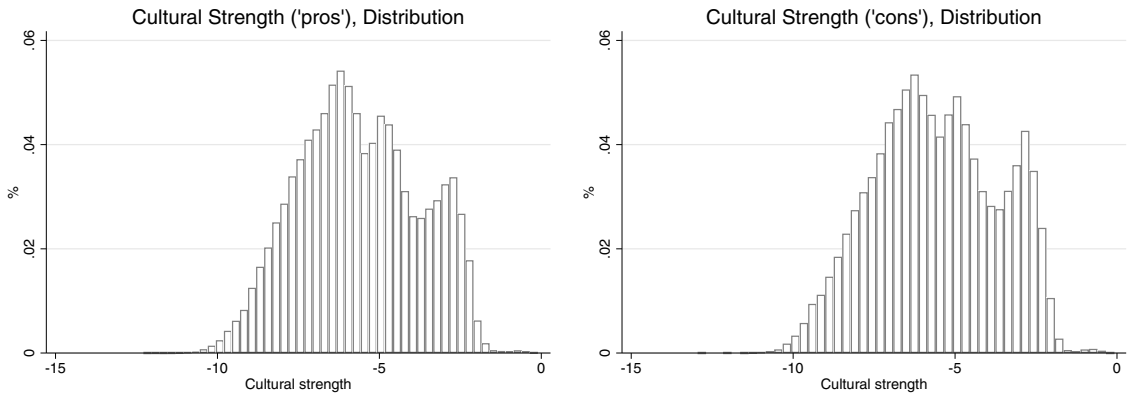

Fig. 2 Cultural strength distribution. In Fig. 2, we represent the distribution of the cultural strength metric, computed on "pros" in the left panel and on "cons" section of Glassdoor reviews in the right panel.

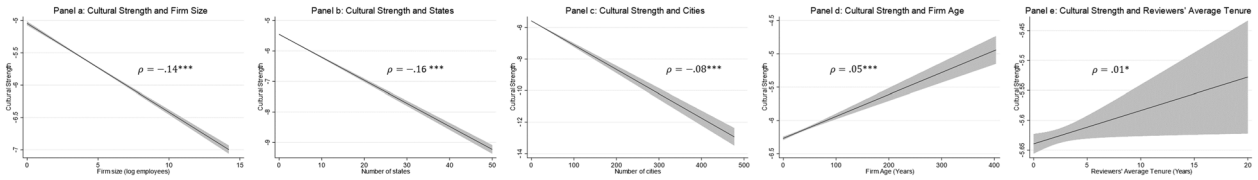

Fig. 3 Theory-driven covariates of cultural strength (computed on "pros"). In Fig. 3, we report results from bivariate analysis showing the correlation of cultural strength with theoretically relevant variables of interest. $^{+}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Firm size. Prior research has suggested that small organizations experience easier communication flows (since network linkages increase as a quadratic function of the number of nodes), which are essential to form shared beliefs, than larger organizations (Van den Steen, 2010a). We operationalize *Firm size* as the natural logarithm of a firm's employee number. This is a firm-level variable, and thus, although gathered from Glassdoor, is not prone to response bias since it does not depend on reviews. Consistent with the expectation we built from prior literature, we find a negative and significant association between *Cultural strength* and *Firm size* ($\rho = -0.14$, p value $= 0.000$), as shown in Fig. 3, panel a.

Geographic distribution. In geographically fragmented firms, employees are likely to be exposed to different cultural references, and different groups develop sub-cultures in silos, thus reducing the degree of cultural strength (e.g., Barkema et al., 1996; Hofstede, 1980; Kraut et al., 2002; Olson and Olson, 2000). Accordingly, we should expect firms active in multiple states to exhibit weaker cultures than those concentrated in fewer locations. This is also because, especially at the state level, different local cultures interact with the organizational culture, producing internal fragmentation. We have access to data for each firm on the number of states within the US from which its reviewers were drawn. To measure the *Number of states* a sampled firm is active in, we count the number of unique US states employees post reviews for a focal firm on Glassdoor from. As shown in Fig. 3, panel b, we find consistent evidence with these arguments, as *Cultural strength* exhibits a negative and statistically significant correlation with *Number of states* ($\rho = -0.16$, p value $= 0.000$).

Similarly, we can also proxy for the *Number of cities* a sampled firm is active in, by counting the unique cities from where employees post reviews on Glassdoor. For reasons analogous to the theoretical arguments presented with regards to the *Number of states*, we expect firms active in multiple metropolitan areas to display weaker cultures. Our results support this prediction as well, as shown in Fig. 3, panel c : the correlation between *Cultural strength* and the *Number of cities* is negative and statistically significant ($\rho = -0.08$, p value $= 0.000$). Is it also worth noticing that the barriers that geographic fragmentation posits to cultural strength should be expected to be stronger in the case of fragmentation across states rather than cities. Consistently, we observe that the negative correlation between *Cultural strength* and geographical fragmentation is stronger when we proxy it by the *Number of states* than by the *Number of cities*.

Firm age. Coherent, strong organizational cultures tend to emerge over time and only materialize if their members have had enough time to consolidate and institutionalize the relevant cultural dimensions (e.g., Ashforth, 1985; Cyert and March, 1963; Peters and Waterman, 1982; Schein, 1984; Van den Steen, 2010a). Thus, older organizations should exhibit stronger cultures. We measure *Firm age* as the number of years since the organization was founded. As in the case of *Firm size*, *Firm age* is a variable collected from Glassdoor at the firm level, thus not affected by response bias. Consistent with prior theory, we observe a positive and statistically significant correlation between *Cultural strength* and *Firm age* ($\rho = 0.05$, p value $= 0.000$), as reported in Fig. 3, panel d.

An alternative measure of the same mechanism is the reviewer's tenure at the time of writing the review. *Reviewers' average tenure* is measured in the Glassdoor dataset as the number of years each employee posting a review has spent at the focal organization. Since stronger cultures are more likely to emerge through socialization mechanisms when employees spend a long time in the organization, the higher the average employees' tenure, the higher the expected cultural strength of the focal firm. Our results point in the direction of such a relationship, as we find, in Fig. 3, panel e, a positive correlation between *Cultural strength* and *Reviewers' average tenure* ($\rho = 0.01$, p value $= 0.04$).

These bivariate associations cumulatively lend support to the validity of our measure of cultural strength.

Exploratory analysis of cultural strength covariates. In the spirit of exploration, we also report associations between *Cultural strength*

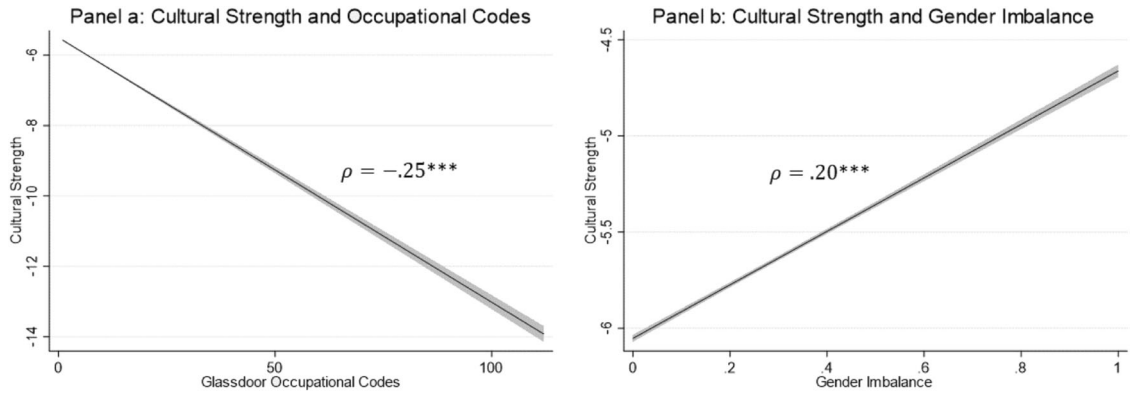

Fig. 4 Exploratory analysis of additional covariates of cultural strength (computed on "pros"). In Fig. 4, we report results from bivariate analysis showing the correlation of cultural strength with variables selected for exploratory purposes. $^{+}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

and other firm-level variables we have access to in Glassdoor. Fig. 4 summarizes the results of this analysis. Finally, we offer some theoretical speculations about these observed relationships, built on the premise that strong cultures must come ultimately from either sorting or socialization dynamics.

Glassdoor occupational codes. We can measure the internal variety of job titles for every sampled organization by counting the total number of unique Glassdoor occupational codes employees report when posting their reviews online. *Glassdoor occupational codes* may capture both the layers in an organizational hierarchy (e.g., CEO, vs. director, vs. manager, vs. individual contributor) and the extent of job description varieties within hierarchical layers (e.g., geographic, functional, or product diversification). We find that *Cultural strength* and *Glassdoor occupational codes* exhibit a negative and significant correlation, as reported in Fig. 4, panel a ($\rho = -0.25$, p value $= 0.000$).

Either as an indicator of vertical or horizontal structural differentiation (e.g., Lee, 2021), many *Glassdoor occupational codes* within a firm appear to provide a barrier to forming a strong culture. Employees likely develop sub-cultures specific to functions/divisions and/or organizational layers, being exposed to and reinforcing the value of different cultural codes. Further, formal organizational structure and culture have often been depicted as functionally equivalent towards achieving a host of organizational outcomes (e.g., Galbraith, 1977; Lee and Edmondson, 2017; Marchetti and Puranam, 2021; Nadler and Tushman, 1997; Ouchi, 1980). This suggests that firms investing in formal structure to organize their members are less likely to develop a strong culture as a control mechanism, and possibly vice versa.

Gender imbalance. Through the Glassdoor dataset, we know the gender of the reviewer, which we leverage, at the aggregate firm level, to proxy for the degree of gender imbalance that characterizes an organization. We operationalize *Gender imbalance* as the absolute value of the difference in the percentage of reviews posted by female vs. male employees for the focal firm. The variable is bounded in [0–1], with larger values representing a higher imbalance between the two genders. As reported in Fig. 4, panel b, we find a positive and statistically significant association between *Cultural strength* and *Gender imbalance* ($\rho = 0.20$, p value $= 0.000$). If a firm hires in a manner that creates a pronounced gender imbalance, that also implies a greater homogeneity among employees on the gender dimension. This homogeneity, accomplished through sorting, might serve as a basis for stronger cultures to emerge (possibly amplified by homophily and within-group socialization).

Multi-variate analysis of cultural strength and the identified covariates. We replicate the results about the relationship between *Cultural strength* and the covariates of interest by running an OLS model in which we regress *Cultural strength* on all the variables we discussed above, further controlling for *Firm revenues*; *Firm Glassdoor coverage*, computed as the ratio of Glassdoor reviews to the total number of employees at the focal firm, to account for the representativeness of the Glassdoor corpora compared to the total size of the employee base at a firm; *Firm Glassdoor reviews*, to account for the fact that firms with more reviews may likely cover more topics, thus mechanically reducing the degree of cultural strength; and *Firm current employees*, computed as the fraction of employees' reviews posted on Glassdoor by current workers, to account for the fact that a firm's culture may be portrayed in a more accurate manner the higher the fraction of current employees (vs. former ones) reviewing it on Glassdoor. We also include *Firm industrial sector*, *Firm state*, and *Firm type* fixed effects and robust standard errors. The sample size for the regression analysis is significantly smaller than in the bivariate analysis (about 24,000 vs. 95,000 in the bivariate analysis) because of missing data on individual variables among controls and fixed effects.

Results are reported in Table 3. Model 1 shows the effect of the control variables only on *Cultural strength*. *Firm revenues* exhibit a negative and significant effect on *Cultural strength* ($\beta = -0.151$, p value $= 0.000$), which is consistent with our expectations, as we can think of *Firm revenues* as an alternative proxy for firm size. *Firm Glassdoor coverage* has a negative and significant relationship with *Cultural strength* ($\beta = -0.044$, p value $= 0.027$), similar to that exhibited by *Firm Glassdoor reviews* ($\beta = 0.000$, p value $= 0.000$). Finally, *Firm current employees* exhibits a negative and significant relationship with *Cultural strength* ($\beta = -1.219$, p value $= 0.000$).

In model 2, we include the covariates of interest. Results are largely consistent with the bivariate correlational evidence reported in Fig. 3. *Firm size* ($\beta = -0.058$, p value $= 0.000$), *Firm age* ($\beta = 0.003$, p value $= 0.000$), *Reviewers' average tenure* ($\beta = 0.068$, p value $= 0.000$), *Glassdoor occupational codes* ($\beta = -0.047$, p value $= 0.000$), and *Gender imbalance* ($\beta = 1.419$, p value $= 0.000$) show significant relationships with *Cultural strength*, which are directionally consistent with what we described above in terms of correlations (Fig. 3).

In the full model (model 2), *Number of states* loses statistical significance, in its relationship with *Cultural strength* ($\beta = 0.010$, p value $= 0.187$). *Number of cities* is the only variable for which we observe a change in direction in its relationship with *Cultural strength*. It shows a positive and significant coefficient in predicting *Cultural strength* ($\beta = 0.006$, p value $= 0.065$), while,

Table 3 Linear regression analysis of the relationship between *Cultural strength* and the covariates of interest: multivariate analysis.

Dependent variable	Cultural strength ("pros")		Cultural strength ("cons")	
	(1)	(2)	(3)	(4)
Firm size		−0.058***		−0.111***
		(0.013)		(0.014)
Number of cities		0.006+		0.019***
		(0.003)		(0.004)
Number of states		0.010		0.004
		(0.008)		(0.010)
Firm age		0.003***		0.002***
		(0.000)		(0.000)
Reviewers' average tenure		0.068***		0.061***
		(0.006)		(0.006)
Glassdoor occupational codes		−0.047***		−0.074***
		(0.004)		(0.005)
Gender imbalance		1.419***		1.473***
		(0.054)		(0.056)
Firm revenues	−0.151***	−0.019*	−0.223***	−0.061***
	(0.006)	(0.008)	(0.007)	(0.009)
Firm Glassdoor coverage	−0.044*	−0.035*	−0.052*	−0.049**
	(0.020)	(0.015)	(0.023)	(0.017)
Firm Glassdoor reviews	0.000***	0.001***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Firm current employees (%)	−1.219***	−1.120***	−0.470***	−0.198***
	(0.035)	(0.054)	(0.035)	(0.054)
Constant	−2.635***	−5.402***	−2.533***	−5.446***
	(0.517)	(0.610)	(0.544)	(0.480)
Firm industry	Included	Included	Included	Included
Firm state	Included	Included	Included	Included
Firm type	Included	Included	Included	Included
Observations	46,025	24,265	46,025	24,265
R-squared	0.088	0.119	0.093	0.167

Standard errors in parentheses are robust.
$^{+}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

in Fig. 3, panel c, we observe a negative and significant relationship, which was consistent with our theoretical expectations.

We also highlight that the *Firm industry*, *Firm state*, and *Firm type* fixed effects are statistically significant in the OLS analysis reported in Table 3, implying that the three factors of interest explain the variations in *Cultural strength* observed in the sample. Organizational cultures formed through sorting and socialization (Carroll and Harrison, 1998, 2002) result from isomorphic pressures that are likely to mark the boundaries of competitive fields, geographies, and institutional types (Dimaggio and Powell, 1983). Thus, our result is consistent with the theoretical expectation that firms are more homogeneous in their degree of cultural strength within such domains rather than across those, because of these isomorphic tendencies.

It should be noticed that this multi-variate analysis provides better control for confounding effects on the associations of interests, but also impose a possible sampling bias. When we perform the analysis reported in Table 3, we lose a relatively high number of observations (75%) compared to the correlational analyses reported in Figs. 3 and 4, because of the inclusion of industry, state, and firm type fixed effects. Such a drop in the number of observations may also account for the slight differences between the correlation and regression analysis, besides the effect of control variables.

We note that the results reported in both Figs. 3, 4 and Table 3 are robust to bootstrapping over 1000 repetitions, with replacement, to account for potential sources of sampling errors that may be driving the observed results. Results are also robust to replacing the *Cultural strength* continuous variable with a discrete one used to address the multi-modal distribution of the variable, observed in Fig. 2 (left panel).

We further summarize the relationship between *Cultural strength* and the factor variables *Firm industry*, *Firm state*, and *Firm type* by displaying the number of firms per factor level, as well as the average *Cultural strength* in Tables 4–6, respectively. The cultural strength metric used in this table is the residual obtained from regressing *Cultural strength* on *Firm Glassdoor reviews* to account for possible correlations between the two variables, as noted in Table 2. Figure 5 offers a visual representation of the US states by the average degree of cultural strength and is built from the summary data presented in Table 4.

Results from the "cons" section of Glassdoor reviews. For the same set of reviews used above, we replicated the analyses with culture metrics computed on the "cons" section of the Glassdoor reviews. The two metrics of cultural strength computed on the reviews' "pros" and "cons" show a positive and statistically significant correlation, though it is not very high (0.55, p value = 0.000), indicating that they capture different information. As shown in Figs. 6, 7, and Table 3, models 3 and 4, overall, the results are generally consistent with what we found when computing cultural strength on the Glassdoor reviews' "pros". Two differences are noteworthy: when using reviews' "cons," older firms show lesser cultural strength as do firms with greater reviewers' average tenure, although the latter is not statistically significant at conventional levels (Fig. 6, panel d and e).

We have focused on cultural strength computed on the "pros" section of reviews in the baseline analysis because it is more likely to give an accurate account of current organizational features, as opposed to what employees describe in the "cons" section, which might involve more heterogeneity because it likely describes expectations about desired (but missing) elements of organizational life. In line with this expectation, we find that reviewers are likely over time and in older firms to be similar in what they like but diverge more on what they dislike. The results suggest a corollary to the "Anna Karenina principle" (Bornmann and Marx, 2012)[4]: time magnifies differences among individuals in what causes discontent, as well as similarity in what they appreciate.

Polarization concerns in review data. Data generated via online review processes is often suspected of polarization (Matakos and Tsaparas, 2016). It is, in fact, common that the most satisfied or disgruntled users are more likely to post reviews online about products or services than those with average satisfaction ratings. If true, such evidence may raise concerns about the extent to which the employees' text reviews posted on Glassdoor are representative of the actual organizational population.

To address this potential issue, we first notice that, since its launch, Glassdoor has implemented a "give to get" policy aimed at reducing data polarization. When users browse the Glassdoor dataset, typically to search for a job or acquire information about available positions in other organizations, Glassdoor solicits their reviews to grant them full access to the data contained in the database. Marinescu et al. (2018) show that the "give to get" policy significantly reduces the polarization of Glassdoor reviews compared to trends observed on other websites.

Second, if reviews' polarization is present, we should observe this in the satisfaction rating employees share about their organizations when posting a review on Glassdoor. In particular, the satisfaction scores (collected by Glassdoor across the five organizational dimensions of overall satisfaction, culture and values, senior management, career opportunities, compensation and benefits, and work–life balance) should exhibit fat tails, manifesting in positive excess kurtosis. However, as we report in

Table 4 Average cultural strength (computed on "pros") by industry.

Industry	Cultural strength (adjusted for review no.)		
	Average	Std. dev.	Obs.
Bars & Nightclubs	1.06	1.56	104
Vehicle Dealers	0.63	1.65	1,988
Laundry & Dry Cleaning	0.63	1.81	55
Veterinary Services	0.60	1.80	246
Audiovisual	0.58	1.71	172
Commercial Printing	0.57	1.69	508
Home Centers & Hardware Stores	0.52	1.78	271
Performing Arts	0.51	1.75	245
Adult Entertainment	0.51	2.01	58
Gas Stations	0.46	1.71	86
Sports & Recreation	0.39	1.70	2361
Gift, Novelty & Souvenir Stores	0.36	1.89	216
General Merchandise & Superstores	0.34	1.86	138
Health, Beauty, & Fitness	0.34	1.74	1840
Wholesale	0.34	1.71	2418
Sporting Goods Stores	0.33	1.87	318
TV Broadcast & Cable Networks	0.32	1.94	61
Drug & Health Stores	0.32	1.74	189
Accounting	0.31	1.73	4049
Building & Personnel Services	0.30	1.77	1298
Food & Beverage Stores	0.29	1.80	282
Radio	0.29	1.76	138
Funeral Services	0.27	2.19	34
Home Furniture & Housewares Stores	0.27	1.81	568
Media & Entertainment Retail Stores	0.27	1.85	181
Department, Clothing, & Shoe Stores	0.23	1.78	2938
Telecommunications Services	0.22	1.75	365
Cable, Internet & Telephone Providers	0.21	1.83	922
Office Supply Stores	0.17	1.82	144
Security Services	0.17	1.80	919
Membership Organizations	0.17	1.72	1171
Legal	0.15	1.80	2184
Architectural & Engineering Services	0.14	1.76	2246
Movie Theaters	0.14	1.79	105
Talent & Modeling Agencies	0.14	1.82	540
Health Care Services & Hospitals	0.14	1.77	12,430
Consumer Electronics & Appliances Stores	0.13	1.84	377
Other Retail Stores	0.11	1.92	711
Commercial Equipment Rental	0.10	2.02	96
Automotive Parts & Accessories Stores	0.10	1.75	244
Real Estate	0.09	1.87	3099
Photography	0.09	1.83	150
Ticket Sales	0.09	1.85	892
Gambling	0.08	1.80	336
News Outlet	0.07	1.88	326
Research & Development	0.07	1.85	904
Motion Picture Production & Distribution	0.06	1.76	1199
Museums, Zoos & Amusement Parks	0.01	1.71	541
Grocery Stores & Supermarkets	0.01	1.81	269
Self-Storage Services	0.00	1.83	46
Music Production & Distribution	−0.01	1.90	129
Toy & Hobby Stores	−0.06	1.82	47
Telecommunications Manufacturing	−0.07	1.80	82
Beauty & Personal Accessories Stores	−0.08	1.85	405
Insurance Agencies & Brokerages	−0.09	1.89	5625
Video Games	−0.11	2.01	334
Internet	−0.11	1.87	1541
Publishing	−0.15	1.88	1583
Consumer Product Rental	−0.16	1.98	163
Insurance Carriers	−0.18	1.84	785
Staffing & Outsourcing	−0.18	1.91	3516
Consulting	−0.19	1.92	5109
Auctions & Galleries	−0.22	1.73	58
Computer Hardware & Software	−0.26	1.98	7864
Business Service Centers & Copy Shops	−0.27	1.92	156
Advertising & Marketing	−0.30	1.90	11,093
Pet & Pet Supplies Stores	−0.45	1.86	74
IT Services	−0.59	2.07	2042
Enterprise Software & Network Solutions	−0.59	1.96	3284

The cultural strength metric used in this table is the residual obtained from regressing *Cultural strength* on *Firm Glassdoor reviews* to remove the mechanical correlation existing between the two variables.

Table 7, all the satisfaction variables exhibit negative excess kurtosis instead, making it unlikely that polarization is a concern.

Finally, in a recent study conducted by Sull et al. (2019) to address the concern that Glassdoor oversamples positive reviews because of HR departments soliciting posts from satisfied employees as a form of PR (Winkler and Fuller, 2019), the authors find that positive polarization (manifested in a sudden and temporally limited surge in positive reviews for a firm on Glassdoor) is very unlikely to occur, and does not represent a concern generalizable to the whole dataset.

Discussion and conclusions

Organizational cultural strength is a promising concept with a long heritage. Numerous authors have remarked on the importance of such a construct, which, independent of the specific content of the culture in an organization, might explain the cohesive nature of what people believe and value and, therefore, how they act. However, the construct has also been criticized for its lack of clarity, and progress on studying it has been limited by differences in how it is conceptualized and challenges in obtaining data that allows for cultural strength to be measured in a way that is mindful of inter-organizational cultural differences.

In this paper, we have offered one solution to these problems. It involves conceptualizing the cultural strength of an organization in a manner that considers both the intensity or high importance accorded to some cultural elements versus others by individuals and the extent to which organizational members resemble each other in this allocation of their mindshare. Formalizing cultural strength as the negative average cross-entropy of mindshare distributions of the individuals in a group, we show how this measure can be constructed using descriptive text produced by the members of an organization writing about the attributes of the firm. While we settled on negative average cross-entropy to measure cultural strength, we also considered other possible candidates that we eventually discarded for the reasons we discuss in Appendix.

The approach we propose to theorize and measure organizational cultural strength offers several advantages over prior art. First, it allows us to adopt a clear operationalization consistent with influential prior work (e.g., Chatman et al., 2014) while being agnostic about the specific cultural elements or their content that form the basis of the organizational culture. The formalization of our measure rules out any ambiguity about how cultural strength is conceptualized, a risk with a purely verbal description. Thus, we can capture whether an individual assigns significant mindshare not

Table 5 Average cultural strength (computed on "pros") by US state.

State	Cultural strength (adjusted for review no.)		
	Average	Std. dev.	Obs.
AK	0.09	1.98	70
AL	0.32	1.70	474
AR	0.35	1.77	212
AZ	0.05	1.88	1239
CA	−0.23	1.93	11,208
CO	−0.16	1.88	1532
CT	0.04	1.83	715
DC	−0.39	1.81	924
DE	0.13	1.82	116
FL	0.09	1.86	3666
GA	−0.03	1.89	2160
HI	0.10	1.52	144
IA	0.02	1.80	324
ID	0.16	1.77	229
IL	−0.15	1.89	3,433
IN	−0.11	1.79	875
KS	0.01	1.83	400
KY	0.17	1.78	375
LA	0.37	1.78	492
MA	−0.26	1.96	2217
MD	−0.07	1.82	1406
ME	0.21	1.92	154
MI	−0.04	1.87	1571
MN	−0.23	1.78	1095
MO	−0.01	1.84	1012
MS	0.36	1.66	159
MT	0.12	1.59	93
NC	−0.04	1.85	1551
ND	0.17	1.67	69
NE	−0.02	1.90	279
NH	−0.03	1.86	275
NJ	0.12	1.84	1835
NM	0.33	1.77	176
NV	0.07	1.82	511
NY	−0.19	1.89	6229
OH	0.01	1.84	1874
OK	0.17	1.80	423
OR	−0.33	1.82	857
PA	−0.05	1.84	2280
RI	0.17	1.74	175
SC	0.19	1.81	507
SD	−0.35	1.81	59
TN	0.12	1.84	889
TX	−0.01	1.84	5370
UT	−0.35	1.93	850
VA	−0.12	1.86	2098
VT	−0.01	1.82	101
WA	−0.31	1.88	1890
WI	−0.11	1.82	884
WV	0.27	1.66	121
WY	0.35	1.66	43

The cultural strength metric used in this table is the residual obtained from regressing *Cultural strength* on *Firm Glassdoor reviews* to remove the mechanical correlation existing between the two variables.

Table 6 Average cultural strength (computed on "pros") by firm type.

Firm type	Cultural strength (adjusted for review no.)		
	Average	Std. dev.	Obs.
Self employed	0.79	1.68	243
Contractor	0.38	1.66	927
School	0.37	1.96	50
Private practice	0.35	1.76	2608
Government	0.28	1.74	349
Franchise	0.28	1.80	719
College	0.17	1.72	92
Public company	0.15	1.87	6500
Hospital	0.05	1.60	2127
Private company	−0.02	1.89	70,873
Non-for-profit	−0.10	1.72	4067
Subsidiary	−0.43	1.85	4062

The cultural strength metric used in this table is the residual obtained from regressing Cultural strength on Firm Glassdoor reviews to remove the mechanical correlation existing between the two variables.

only to particular norms but also to values, beliefs, or artifacts—each of which is an independently legitimate component of culture (Schein, 2004)—without focusing on one of these to the exclusion of others (Chatman and O'Reilly, 2016). Our measure thus allows us to test whether cultural strength has utility as a construct independent of the specific cultural elements (values, beliefs, norms, artifacts) or its contents (e.g., the artifact "employee benefits", the norm of "maintaining a friendly work environment", or the belief that "technology can solve anything") that enjoy high mindshare among most members of an organization.

Second, the negative average cross-entropy of mindshare distributions among all the individuals in a group gives a simple and intuitive metric of cultural strength. Crucially, consensus, i.e., commonality in how the cultural attributes of an organization are viewed in terms of importance, is not enough to summarize a strong culture. A high value of the measure indicates that the same attributes are viewed as highly important across members, thus capturing commonality and high importance simultaneously. Low values, indicating weak cultures, could either arise from indifference—leading to "bland" cultures (as no one dimension is particularly important to the organizational members and they are equally indifferent to all), or conflict—leading to "fragmented" cultures—in which members hold different aspects to be highly important to them. With our approach, we can analytically and empirically distinguish these two forms of weak cultures.

Third, we can compute cultural strength on emic dimensions without making etic assumptions that could generate measurement biases. Since cultural strength is a relational property between distributions held by individuals within a group, using the correct group-specific support of the individual's mindshare distribution is crucial. If the cultural strength of one organization arises from a shared high importance given to "adaptability" and in another organization to "fairness", measuring cultural strength in both by assessing the importance that members assign to "adaptability" only (as the etic approach would do) would be misleading about their relative strengths.

Finally, the measure of cultural strength we propose can be constructed potentially at scale, as large corpora of descriptive text about organizational cultural attributes are becoming increasingly available to researchers. However, since the writers of reviews are not a random sample, representativeness of the responses remains in doubt. We took several measures to mitigate this bias, such as using data from firms with a high Glassdoor coverage, checking for review polarization, and testing theoretically expected correlations with data that do not suffer from response bias (e.g., organizational size and age). Nonetheless, caution is appropriate in interpreting the results as representative of the culture of the sampled companies, as opposed to the culture of their sub-groups that choose to write Glassdoor reviews. We also note that the promise of the approach to capturing cultural strength itself is independent of the representativeness of our particular sample.

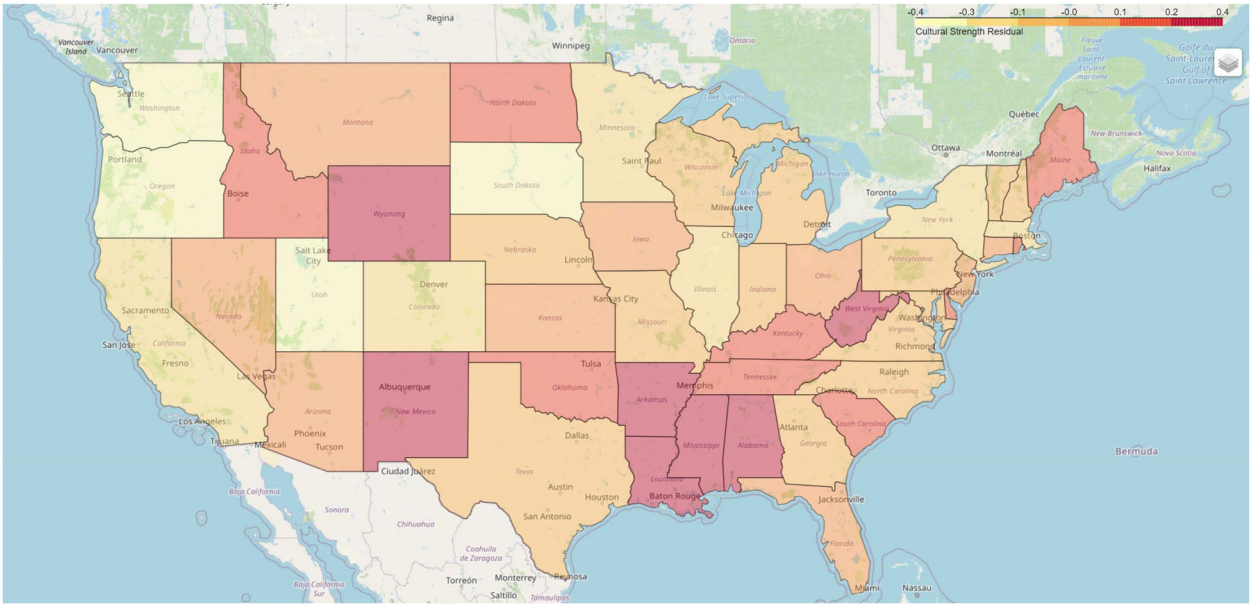

Fig. 5 US states by degree of cultural strength (computed on "pros"). The cultural strength metric used in this figure is the residual obtained from regressing *Cultural strength* on *Firm Glassdoor reviews* to remove the mechanical correlation existing between the two variables.

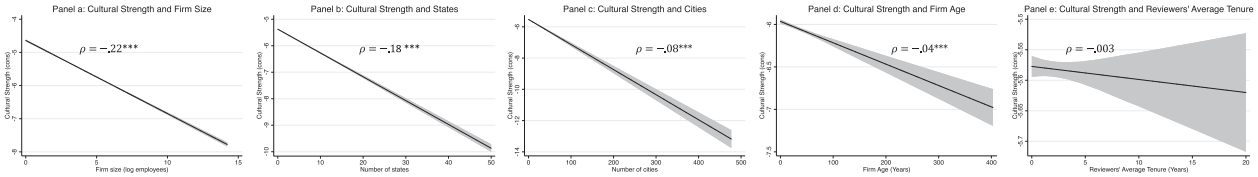

Fig. 6 Theory-driven covariates of cultural strength (computed on "cons"). In Fig. 6, we report results from bivariate analysis showing the correlation of cultural strength with theoretically relevant variables of interest. $^{+}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

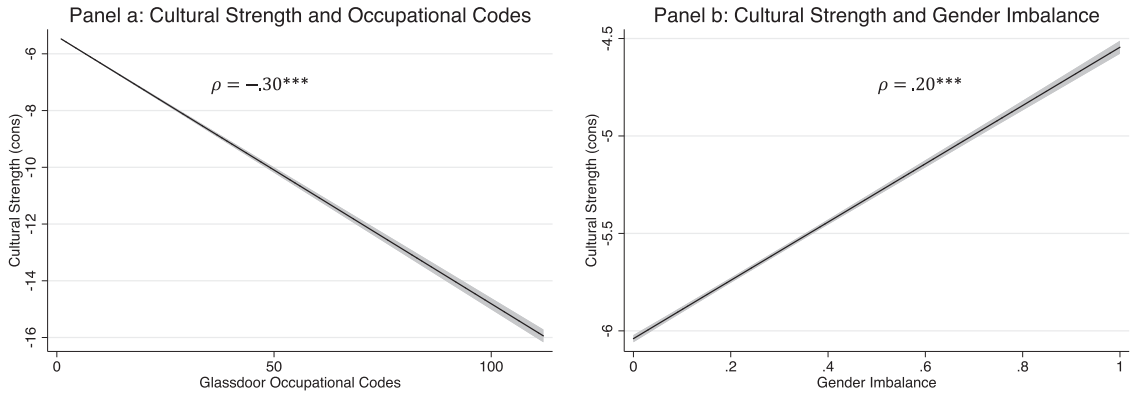

Fig. 7 Exploratory analysis of additional covariates of cultural strength (computed on "cons"). In Fig. 7, we report results from bivariate analysis showing the correlation of cultural strength with variables selected for exploratory purposes. $^{+}p < 0.1$; $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

Table 7 Excess kurtosis of Glassdoor employee satisfaction numerical ratings to address reviews' polarization concerns.

Satisfaction variable	Excess kurtosis
Overall rating	−1.14
Culture & Values	−1.35
Senior Management	−1.45
Career Opportunities	−1.29
Compensation & Benefits	−1.10
Work-life Balance	−1.19

Contributions. In this paper, we present results on organizational cultural strength for nearly 100,000 firms based on their employee reviews from Glassdoor. We also show that our measure of cultural strength behaves as theoretical expectations suggest it should: smaller, older, and geographically concentrated organizations have stronger cultures than firms with fewer employees, younger, and dispersed over broader geographies. These results offer optimism that our measure of cultural strength has validity and reliability.

Our conceptual definition and formalization help to address prior critiques about the ambiguity of cultural strength as a concept (e.g., Saffold, 1988). They also show how big data can be used for an *emic* (i.e., firm-specific) approach to cultural analysis (see Morris

et al., 1999). Finally, we offer refinements on previous studies that have also used large-scale open-ended text for measuring culture (e.g., Corritore et al., 2020), specifically in terms of LDA model estimation (i.e., using coherence maximization) and measurement of cultural strength (i.e., using average cross-entropy). We also report results from an exploratory analysis that suggest that gender composition and role differentiation may have reliable effects on cultural strength. As the evidence in the current study is purely correlational, it remains for future work to investigate the theoretical mechanisms behind these associations.

Future research opportunities. The construct of organizational cultural strength can be quite generative, in our opinion. Researchers can use the approach we propose to measure the strength of cultures known to revolve around specific values and norms (e.g., culture of adaptability as in Chatman et al. (2014), or knowledge-friendly cultures as in Liu et al. (2021)). When the underlying content of a culture is not known ex ante, interpreting the topics estimated by the LDA algorithm and used to compute cultural strength as we do in this paper is also possible and can generate insights about cultural dimensions that strengthen a culture.

Further, to the extent that formal structure and organizational culture are functionally equivalent, our measure of cultural strength allows an opportunity to test whether strong organizational cultures tend to rely less on formal structure to organize themselves. Inter-organizational phenomena such as M&A and strategic alliances are often depicted as relying on the extent to which cultural compatibility exists between the partners. We may use a measure of cultural strength defined on the aggregate cultures of two partners to assess the extent to which such cultural compatibility exists. As organizations worldwide are adjusting to distributed working in the light of the COVID-19 pandemic, strong cultures can be expected to play a role in how resilient organizations are to this disruption to their coordination processes. Our approach to measuring cultural strength offers the promise of dealing with such questions using large-scale data.

Managerial implications. The theoretical and methodological approach we propose to conceptualize and measure cultural strength has important implications for the world of practice. Managers may want to assess the extent to which socialization dynamics are effective in altering the strength of an organizational culture. They can use the same toolkit also to understand the cultural fit of employees that join the organization and leave it due to turnover or assess how sorting changes the degree of cultural strength. Managers can also deploy the approach we described in this paper to assess the cultural strength characterizing other competitor organizations. For instance, if we think of culture as a resource (Barney, 1986), a unique degree of cultural strength in the competitive landscape could provide competitive advantage.

Data availability

The datasets analyzed during the current study are not publicly available due to a non-disclosure agreement regulating the data access and sharing between the authors and Glassdoor.com (the data provider). However, the corresponding author can make anonymized versions of the data available to the reviewers on reasonable request.

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Notes

1 Cultural strength is distinct from cultural tightness (Gelfand et al., 2011). Tight cultures have "strong norms and low tolerance for deviant behavior" (Gelfand et al., 2011, p. 1100). Tightness therefore pertains to the enforcement of behavioral norms. On the other hand, cultural strength pertains to the intensity and homogeneity of beliefs. The two may diverge, for instance in the case of a strong culture where tolerance for behavioral diversity may be a very important value.

2 Updated statistics about Glassdoor.com: https://www.glassdoor.com/about-us/ (accessed 25 Sept 2021).

3 Arts, Entertainment and Recreation, Business Services, Consumer Services, Health Care, Information Technology, Insurance, Media, Real Estate, Retail, Telecommunications.

4 This references the first sentence of Leo Tolstoy's novel Anna Karenina: "Happy families are all alike; every unhappy family is unhappy in its own way."

References

Alvesson M, Berg PO (1992) Corporate culture and organizational symbolism. Walter de Gruyter, Berlin

Ashforth BE (1985) Climate formation: Issues and extensions. Acad Manag Rev 10:837–847

Balthazard PA, Cooke RA, Potter RE (2006) Dysfunctional culture, dysfunctional organization: capturing the behavioral norms that form organizational culture and drive performance. J Manag Psychol 21(8):709–732

Barkema HG, Bell JHJ, Pennings JM (1996) Foreign entry, cultural barriers, and learning. Strateg Manag J 17(2):151–166

Barnard C (1968) The functions of the executives, 30th anniversary. Harvard, Cambridge, MA

Blei DM, Ng AY, Jordan MI (2003) Latent Dirichlet allocation. J Mach Learn Res 3:993–1022

Bornmann L, Marx W (2012) The Anna K. Arenina principle: a way of thinking about success in science. J Am Soc Inf Sci Technol 63(10):2037–2051

Burt RS, Gabbay SM, Holt G, Moran P (1994) Contingent organization as a network theory: the culture-performance contingency function. Acta Sociol 37(4):345–370

Carrillo JD, Gromb D (1999) On the strength of corporate cultures. Eur Econ Rev 43:1021–1037

Carroll GR, Harrison JR (1998) Organizational demography and culture: insights from a formal model and simulation. Adm Sci Q 43(3):637–667

Carroll GR, Harrison JR (2002) Come together? The organizational dynamics of post-merger cultural integration. Simul Model Pract Theory 10:349–368

Chatman JA, Caldwell DF, O'Reilly CA, Doerr B (2014) Parsing organizational culture: how the norm for adaptability influences the relationship between culture consensus and financial performance in high-technology firms. J Organ Behav 35:785–808

Chatman JA, O'Reilly CA (2016) Paradigm lost: reinvigorating the study of organizational culture. Res Organ Behav 36:199–224

Chatman JA, Polzer JT, Barsade SG, Neale MA (1998) Being different yet feeling similar: the influence of demographic composition and organizational culture on work processes and outcomes. Adm Sci Q 43(4):749–780

Clark H (1996) Using language. Cambridge University Press, Cambridge, UK

Cooke RA, Rousseau DM (1988) Behavioral norms and expectations: a quantitative approach to the assessment of culture. Group Organ Manag 13:245–273

Corritore M, Goldberg A, Srivastava SB (2020) Duality in diversity: how intrapersonal and interpersonal cultural heterogeneity relate to firm performance. Adm Sci Q 65(2):359–394

Cyert RM, March JG (1963) A behavioral theory of the firm. Englewood Cliffs, NJ

Deal T, Kennedy A (1982) Corporate cultures. Addison Wesley, Reading, MA

DelCampo RG (2006) The influence of culture strength on person-organization fit and turnover. Int J Manag Rev 23(3):465–469

Dimaggio PJ, Powell WW (1983) The Iron Cage revisited: institutional isomorphism and collective rationality in organizational fields. Am Sociol Rev 48(2):147–160

Galbraith J (1977) Organization design. Addison Wesley

Gelfand MJ et al. (2011) Differences between tight and loos cultures: a 33-nation study. Science 332(6033):1100–1104

Ghazvininejad M, Karpukhin V, Zettlemoyer L, Levy O (2020) Aligned cross entropy for non-autoregressive machine translation. In: *Proceedings of the 37th international conference on machine learning*. Editors: Hal Daumé III, Aarti Singh. pp. 3515–3523

Gordon GG, DiTomaso N (1992) Predicting corporate performance from organizational culture. J Manag Stud 29(6):783–798

Hamel G (2007) The future of management. Harvard Business School Press

Hannan MT et al (2019) Concepts and categories: foundations for sociological and cultural analysis. Columbia University Press, New York, NY

Hannigan T et al. (2019) Topic modeling in management research: rendering new theory from textual data. Acad Manag Ann 13(2):586–632

Harris M (1979) Cultural materialism: the struggle for a science of culture. Vintage, New York, NY

Harrison JR, Carroll GR (1991) Keeping the faith: a model of cultural transmission in formal organizations. Adm Sci Q 36(4):552–582
Harrison JR, Carroll GR (2006) Culture and demography in organizations. Princeton University Press, Princeton, NJ
Hofstede G (1980) Culture's consequences: international differences in work-related valies. Sage, Beverly Hills, CA
Huang AH, Lehavy R, Zang AY, Zheng R (2018) Analyst information discovery and interpretation roles: a topic modeling approach. Manag Sci 64(6):2833–2855
Kaplan S, Vakili K (2015) The double-edged sword of recombination in breakthrough innovation. Strateg Manag J 36:1435–1457
Kotter J, Heskett J (1992) Corporate culture and performance. Free Press, New York, NY
Kraut R, Fussell S, Brennan S, Siegel J (2002) Understanding effects of proximity on collaboration: implications for technologies to support remote collaborative work. In: Hinds PJ, Kiesler S (eds) Distributed work. MIT Press, Cambridge, MA, pp. 137–162
Laloux F (2014) Reinventing organizations: a guide to creating organizations inspired by the next stage in human consciousness. Nelson Parker, Brussels
Lauver KJ, Kristof-Brown S (2001) Distinguishing between employees' perceptions of person-job and person-organization fit. J Vocat Behav 59(3):454–470
Lazarsfeld PF, Merton RK (1954) Friendship as a social process: A substantive and methodological analysis. In: Berger M, Abel T, Page CH (eds.) Freedom and control in modern society, vol 18. Van Nostrand, New York, NY, pp. 18–66
Lee MY, Edmondson AC (2017) Self-managing organizations: exploring the limits of less-hierarchical organizing. Res Organ Behav 37:35–58
Lee S (2021) The myth of the flat start-up: reconsidering the organizational structure of start-ups. Strateg Manag J 43(1):58–92.
Liu G, Tsui E, Kianto A (2021) Knowledge-friendly organisational culture and performance: a meta-analysis. J Bus Res 134:738–753
Malinowski B (1922) Argonauts of the western Pacific. Routledge, London, UK
Marchetti A (2020) Taking cultural heterogeneity seriously: the distinct forms of cultural distinctiveness in organizations. Working paper
Marchetti A, Puranam P (2021) Functional equivalence between culture and hierarchy: peering through the glass door. Working paper
Marinescu I et al. (2018) Incentives can reduce bias in online review. Working paper
Martin J (2002) Organizational culture: mapping the terrain. Sage publications
Matakos A, Tsaparas P (2016) Temporal mechanisms of polarization in online reviews. In: *2016 IEEE/ACM international conference on Advances in Social Networks Analysis and Mining (ASONAM)*. Editors: Ravi Kumar, James Caverlee, Hanghang Tong. ASONAM
Morris M, Leung K, Ames D, Lickel B (1999) Views from inside and outside: Integrating emic and etic insights about culture and justice judgment. Acad Manag Rev 24(4):781–796
Nadler D, Tushman M (1997) Competing by design: the power of organizational architecture. Oxford University Press, Oxford, UK
Olson GM, Olson JS (2000) Distance matters. Hum–comput Interact 15:139–178
O'Reilly C (1989) Corporations, culture, and commitment: Motivation and social control in organizations. Calif Manag Rev 31(4):9–25
O'Reilly CA, Chatman JA (1996) Culture as social control: corporations, cults, and commitment. In: Staw B, Cummings L (eds.) Research in organizational behavior: an annual series of analytical essays and critical reviews. Elsevier Science/JAI Press, pp.157–200
Ostrom E (2005) Understanding institutional diversity. Princeton University Press, Princeton, NJ
Ouchi WG (1980) Markets, bureaucracies, and clans. Adm Sci Q 25(1):129–141
Ouchi WG, Prince R (1978) Hierarchies, clans, and theory Z: a new perspective on organizational development. Organ Dyn 7(2):25–55
Peters TJ, Waterman RH jr (1982) In search of excellence: lessons from America's best-run companies. Harper & Row, New York, NY
Puranam D, Narayan V, Kadiyali V (2017) The effect of calorie posting regulation on consumer opinion: a flexible Latent Dirichlet Allocation model with informative priors. Mark Sci 36(5):726–746
Saffold GS (1988) Culture traits, strength, and organizational performance: moving beyond 'strong' culture. Acad Manag Rev 13(4):546–558
Sathe V (1983) Implications of corporate culture: a manager's guide to action. Organ Dyn 12(2):5–23
Schein EH (1983) The role of the founder in creating organizational culture. Organ Dyn 12(1):13–28
Schein EH (1984) Coming to a new awareness of organizational culture. Sloan Manag Rev 25(2):3–16
Schein EH (2004) Organizational Culture and Leadership. John Wiley & Sons
Schelling TC (1978) Micromotives and macrobehavior. Norton
Smircich L (1983) Concepts of culture and organizational analysis. Adm Sci Q 28(3):358
Sorensen JB (2002) The strength of corporate culture and the reliability of firm performance. Adm Sci Q 47:70–91
Sull D, Sull C, Chamberlin A (2019) Measuring culture in leading companies. MIT Sloan Manag Rev https://sloanreview.mit.edu/projects/measuring-culture-in-leading-companies/
Teahan W, Harper D (2003) Using compression-based language models for text categorization. In: Language modeling for information retrieval. Editors: W. Bruce Croft, John Lafferty. Springer, Dordrecht, pp. 141–165
Turco C (2016) The conversational firm: rethinking bureaucracy in the age of social media. Columbia University Press, New York, NY
Van den Steen E (2010a) Culture clash: the costs and benefits of homogeneity. Manag Sci 56(10):1718–1738
Van den Steen E (2010b) On the origin of shared beliefs (and corporate culture). RAND J Econ 41(4):617–648
Wallach H, Mimno D, McCallum A (2009) Rethinking LDA: Why Priors Matter. Adv Neural Inf Process Syst 22:1973–1981
Weick K (1985) The significance of corporate culture. In: Frost L, Moore M, Lundberg LC, Martin J (eds.) Organizational culture. Sage, Beverly Hills, CA, pp. 381–389
Wilmers N, Tong D, Zhang V (2021) Between-firm inequality and informal social relations. Working paper
Winkler R, Fuller A (2019) How companies secretly boost their Glassdoor ratings. Wall Street J https://www.wsj.com/articles/companies-manipulate-glassdoor-by-inflating-rankings-and-pressuring-employees-11548171977
Barney JB (1986) Organizational culture: can it be a source of sustained competitive advantage?. Academy of management review 11(3):656–665

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Competing interests

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Ethical approval

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