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Competitive Categorization and Networks: Cognitive Strategic Groups

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Technological advancement compounds the complexity of competitor identification, making it increasingly multi-front and multi-dimensional. Strategic groups are an important unit for competition analysis, typically delineated by firms' characteristic similarities or cognitive maps. Both have inadequacies – the former produces methodological artefacts, and the latter is subject to scale limitations, replicability and managers' cognitive blind spots. Hence, the need for alternatives supplementing the existing approaches. We propose a novel grouping methodology based on news co-mentions, reflecting factual corporate events, executives' and journalists' views, and environmental changes. It yields three advantages. First, news depicts interorganizational relationships, alleviating the concern that strategic groups are statistical artefacts. Second, the approach supplements managers' cognition with that of journalists. Third, the public availability of data offers replicability. The proposed methodology is applied to a sample collected from the US high-tech sector. We document commonalities between the co-mention-based groups and the conventionally used characteristic-based approach. However, the similarity and groups yielded from news co-mentions go beyond characteristic similarities in explaining competitive inclination, suggesting that the co-mention-based approach offers a robust alternative to identifying competitors and strategic groups. Overall, by developing a novel methodology based on a strong theoretical foundation, this study sheds new light on strategic group research.

Introduction

The fourth industrial revolution is reshaping the market for competition through the emergence of platform firms, globalization, greater interdependencies and blurring traditional industry boundaries (Rietveld and Schilling, 2021; Schwab, 2017; Stallkamp and Schotter, 2021), unsurprisingly making the necessary but inherently challenging task of categorizing firms into competing groups more complex (Cattani, Porac and Thomas, 2017; Gur and Greckhamer, 2019; Yu and Cannella, 2013). Categorization enables competitor identification and assessment of competitive advantage (Cattani, Porac and Thomas, 2017; Gur and Greckhamer, 2019). The technology-driven changes add a layer of complexity to the simple but essential question of who competes with whom (Yu and Cannella, 2013). For example, does a camera manufacturer compete with other camera manufacturers or mobile phone manufacturers? A reliable answer is of significance to academics, practitioners, investors and policymakers (Barlow, Verhaal and Angus, 2019; Gur and Greckhamer, 2019).

Categorizing firms into comparable groups is of interest to several disciplines (Cattani, Porac and Thomas, 2017). We draw on the strategic

group concept because it offers a more promising root to understanding competition and market dynamics (Cattani, Porac and Thomas, 2017; Levine, Bernard and Nagel, 2017; Rebière and Mavoori, 2019). Two broad approaches are deployed for identifying strategic groups: characteristic-based and cognitive-based. Both have limitations exacerbated by changes in the marketplace for competition. The theoretical underpinning of characteristic-based approaches is criticized, grounded on the infinite dimensionalization of firm entities and the interorganizational nature of competition (Cattani, Porac and Thomas, 2017; Gur and Greckhamer, 2019). The weaknesses of cognitive-based approaches include the practical issue of scale, replicability and competitive blind spots (Levitt, 2017; Ng, Westgren and Sonka, 2009; Porac, Thomas and Baden-Fuller, 2011; Prahalad and Bettis, 1986). In sum, due to theoretical and methodological issues compounded by environmental change, the current methods for categorizing firms into strategic groups have notable shortcomings (see Cattani, Porac and Thomas, 2017 for a review), underscoring the need for an alternative complementary methodology based on a sound theory.

By adopting Hunt's (1972) definition of strategic groups – a group of competitors pursuing the same or similar strategies – we propose and test a novel methodology for categorizing firms into strategic groups. Network analysis, the foundation of our approach, directs attention to firms' structural positions, providing a promising alternative avenue (Gnyawali and Madhavan, 2001; Gulati, Nohria and Zaheer, 2000; Gur and Greckhamer, 2019; Thomas and Pollock, 2002). To move the discussion forward, we ask two interrelated questions: (a) How can the structural properties of interorganizational networks be used to identify strategic groups?[1] (b) How do strategic groups based on interorganizational networks compare with characteristics-based groups?

In resolving the first research question and in line with our strategic group definition, we extend Kennedy's (2008) proposition by using the networks formed by co-mentions of firms in the same news articles (so-called co-mention networks), along with the concept of structural equivalence to identify strategic groups. Different from the prior literature (see Ingram and Yue, 2008), we focus on the co-mention network shaped by actual corporate events – outcomes of managers' cognitive process (Kaplan, 2011; Nadkarni and Barr, 2008; Porac, Thomas and Baden-Fuller, 1989), expressed views of executives and changes in the operating environment, as well as journalists' cognitive embeddedness (Kennedy, 2008). The inclusion of journalists' cognitive interrelationships adds a layer of alternative cognition to that of managers extending collective cognitive boundaries. We reason that business strategies shape firms' actions, which determine their interactions with the external environment (Kald, Nilsson and Rapp, 2000), influencing public (including journalists') cognition regarding the related actors (Fombrun and Shanley, 1990; Kennedy, 2008; Shipilov, Greve and Rowley, 2019). In this reasoning, we argue that the structurally equivalent firms in co-mention networks are likely to be competitors and in line with Hunt's (1972) definition of pursuing similar strategies, providing the theoretical basis for using co-mentions to identify strategic groups.

To illustrate our proposed methodology and examine the group solution empirically, we use a sample of firms operating in the high-tech sector. Focusing on a sector rather than a specific industry reflects greater permeability of industry boundaries. The technology sector is particularly appropriate because its manifests industry boundary permeability (Duysters and Hagedoorn, 1995). Hence, if the methodology works for this sector it is likely to work for other sectors with lesser boundary permeability. In addressing our second research question, we conduct extensive empirical analyses to test and ascertain the level of overlap between the co-mention-based approach and the characteristic-based approach. The analysis points to some commonalities as well as observable differences. Additionally, we ascertain the validity of co-mention similarities and the group solution by its effectiveness in identifying corporate rivalry, as firms within a group are considered to be direct competitors (Carroll and Thomas, 2019; Harrigan, 1985; Hunt, 1972). We find that co-mention similarities and co-mention-based groups are positively and significantly correlated with competitive inclination. In contrast, characteristic similarities have a limited correlation with competitive inclination. As such, we suggest

[1]The question echoes Gur and Greckhamer's (2019) future agenda for competition research, where they ask: 'How are the structural properties of interorganizational networks related to the identification of competitors?'

that the co-mention-based approach outperforms the characteristic-based approach in identifying potential rivals from an exogenous stand.

Our contribution to the literature is fourfold. First, we make a significant methodological contribution to the strategic group and categorization literature by proposing a theoretically robust method incorporating a new perspective to supplement the characteristic-based approach. Our approach addresses the statistical artefact criticism levied at the characteristic-based approach by using news co-mention linkages forged by actual corporate events, executives' publicly expressed views and environmental shaping events, as well as the cognitively meaningful perceptions of journalists.

Second, we extend the conventional cognitive approach by simultaneously addressing its main limitations – replicability, scale and competitive blind spots. By drawing on commercially available news data focusing on three broad types of coverage – actual corporate events, executives' or journalists' publicly expressed views and changes to the operating environment and reaction to it – we construct an alternative measure of managerial cognition addressing the scale and replicability shortcomings. Managers may not comprehend fully their competitive interdependencies (Zajac and Bazerman, 1991), resulting in blind spots potentially exacerbated by the permeability of industry boundaries (Rietveld and Schilling, 2021; Stallkamp and Schotter, 2021). The inclusion of an informed third-party cognition (financial journalists) offers a counterweight to the competitive blind spot (e.g. Helfat and Peteraf, 2015; Levitt, 2017). Together, our proposed methodology is more robust, offering a systematic assessment of management cognition augmented by the cognition of knowledgeable journalists which potentially moderates managerial cognitive limitation and delineates the complexity of competitive dynamics.

Third, we contribute by providing a viable means to investigate the competition between firms operating in multiple industries of a sector. The extant literature mainly focuses on narrowly defined industries (e.g. Short *et al.*, 2007), leaving the call to expand strategic groups to multi-industries unanswered (Gur and Greckhamer, 2019; Harrigan, 1980; Oster, 1982; Thomas and Pollock, 2002; Thomas and Venkatraman, 1988). Changes in the market for competition add a greater imperative to addressing these calls. Yet research adopting this suggestion is scarce (for an exception, see Duysters and Hagedoorn, 1995). As co-mention networks are not constrained by industry divisions, our proposed methodology extends the boundary of strategic group research – important in the current environment.

Additionally, we make a broader methodological contribution to management research through the novel use of news addressing the call to reach beyond the surveys and interviews, the dominant management research methodologies (Andreou, Harris and Philip, 2020). News provides a promising alternative to understanding and addressing management issues because of its third-party role in offering alternative assessments, its availability and the potential for replicability (Gamache and McNamara, 2019; Sanou, Roy and Gnyawali, 2016; Shipilov, Greve and Rowley, 2019). To date, studies applying content analysis to news articles have rarely examined the firm connections inherent in the news (for exceptions, see e.g. Kennedy, 2008; Nohria and Garcia-Pont, 1991). In this paper, we demonstrate a novel use of news by analysing the structural equivalence of firms in news co-mentions. This could be illuminating for future research relying on news to address management issues.

Literature review

Categorizing firms into comparable groups is of interest to different disciplines. The economists are interested in the gradient of substitutability among products (Berry, Levinsohn and Pakes, 1995, 2004; Einav and Levin, 2010; Nevo, 2001; Petrin, 2002) and the classification of industries (Bhojraj, Lee and Oler, 2003; Clarke, 1989; Fertuck, 1975). Organization scholars are interested in identifying groups of firms with shared understanding (Bowker and Star, 1999; Hsu, 2006; Murphy, 2002; Ody-Brasier and Vermeulen, 2014; Osherson and Smith, 1982; Pontikes, 2012; Rosch, 1978; Zuckerman, 1999). Strategy scholars are interested in understanding with whom and how firms compete and competitive dynamics (DeSarbo, Grewal and Wang, 2009; DeSarbo, Grewal and Wind, 2006; Rumelt, Schendel and Teece, 1994).

The task of categorizing firms into comparable groups is complex (e.g. Barlow, Verhaal and Angus, 2019; Durand and Paolella, 2013; Goldstone, 1994), presenting two interrelated challenges: (a)

Table 1. Strategic group definitions

	Reference	Definition
Industrial–organizational (I-O) economics	Hunt (1972)	A group of competitors within an industry **pursuing similar strategies**.
	Porter (1979, 1980)	A group of firms in an industry **following the same or a similar strategy** along the strategic dimensions.
	Newman (1978)	Firms sharing the same basic business and having similar 'degrees of vertical integration with the market in question' (p. 419).
	Cool and Schendel (1987)	'A set of firms competing within an industry on the basis of **similar combination of scope and resource commitments**' (p. 1106).
	Nohria and Garcia-Pont (1991)	A group of firms possessing similar capabilities.
	Porter (1979)	'Firms following **similar strategies** in terms of the key decision variables' (p. 215).
	Thomas and Pollock (1999)	Firms with similar asset configurations pursuing **similar competitive strategies** with similar performance results.
	Ferguson, Deephouse and Ferguson (2000)	'Collections of firms that are similar on key strategic dimensions' (p. 1195).
	Desarbo, Grewal and Wang (2009)	Firms following **similar strategic** recipes.
Cognition	Peteraf and Shanley (1997)	'A strategic group identity is a set of mutual understandings, among members of a cognitive intra-industry group, regarding the central, enduring, and distinctive characteristics of the group' (p. 166).
	Reger and Huff (1993)	Competitors clustered by the shared 'perceptions about strategic commonalities among firms' (p. 103).
	Dranove, Peteraf and Shanley (1998)	The mutual recognition of member firms sharing similar strategic interests.

how to define comparability and (b) given a definition of comparability, how to classify firms into comparable groups (Cattani, Porac and Thomas, 2017; Durand and Khaire, 2017; Zhao *et al.*, 2017).

Strategic group definitions

The strategic management literature offers a more promising root to understanding competition and markets predicated on the concept of strategic groups (Cattani, Porac and Thomas, 2017; Levine, Bernard and Nagel, 2017). Drawing on this literature we summarize the principal definitions of strategic groups (see Table 1).

Hunt (1972) coins the term 'strategic group', defined as a group of firms within an industry pursuing similar strategies shared by the subsequent definition. We rely on Hunt's (1972) definition, given its parsimony. The inconclusive evidence in support of the intimated casual line between group membership and firm performance (Cool and Schendel, 1988; McGee and Thomas, 1986; Thomas and Venkatraman, 1988) raised questions concerning the specificity of definitions and particularly the appropriateness of methods deployed for mapping similarities and differences among firms (e.g. Ketchen and Shook, 1996; Nath and Gruca, 1997). These issues encouraged another group of scholars, drawing on a constructionist perspective, to propose that strategic groups are collective representations held to be valid by managers (e.g. DiMaggio and Powell, 2012). The socio-cognitive underpinning of constructionism opens the possibility of various stakeholders (e.g. competitors, media, etc.) each constructing different strategic groups, providing additional justification for alternative methods and inclusion of different stakeholders (e.g. Cattani, Porac and Thomas, 2017; DiMaggio and Powell, 2012).

Despite the differences, 'competitiveness and pursuing similar strategies' feature explicitly or implicitly in all definitions. The primary difference between the two groups of scholars is the operationalization of Hunt's (1972) definition. To reconcile the differences, we draw on Hunt's (1972) definition of strategic groups.[2]

[2]Several definitions used by different scholars, including Hunt (1972), suggest that strategic groups are 'within an industry'. In this study, as mentioned, we focus on a sector rather than an industry because of the fuzziness of industry boundaries – particularly in the high-tech sector. Moreover, the validity of existing measures of categorizing firms into industries, such as the SIC classification scheme, has been questioned due to the rapid development of technologies (e.g. Sampler, 1998). Hence, in

Approaches to categorizing firms into strategic groups

The second problem, related to definition, is devising a robust method for mapping comparability to categorize firms into strategic groups (Harrigan, 1985; Meilich, 2019; Reger and Huff, 1993; Thomas and Pollock, 2002). The two most widely used approaches are characteristic-based and conventional cognitive-based (see Table 2). We contend that the cognitive-based method is not limited to the conventional approach and the co-mentioned perspective offers an alternative. Table 2 provides a succinct summary for each method.

Characteristic-based perspective

Porter (1980, p. 129), building on Bain's (1952) proposition that firms' substitutability – in other words, their similarity – determines critically their competitive relationship and Hunt's (1972) empirical findings, theorized that strategic groups in an industry follow a same or similar strategy along strategic dimensions. Unsurprisingly, scholars have devoted significant efforts to categorizing firms based on the similarity of their strategic dimensions (Short *et al.*, 2007; Smith *et al.*, 1997; Thomas and Pollock, 2002). Although conceptually logical, difficulties arise when attempting to establish a practically sound approach (Cattani, Porac and Thomas, 2017).

A critical difficulty is the multi-dimensionality of firm entities and, henceforth, between-firm similarity (Cattani, Porac and Thomas, 2017). The resemblance between firms is not determined by one but by numerous characteristics (Cattani, Porac and Thomas, 2017).[3] Clustering variables chosen *a priori* by the researchers offers an intuitive approach to tackling multi-dimensionality. As an early example, Amel and Rhoades (1988) used 15 balance-sheet variables to develop groups. Later, Short *et al.* (2007) used a set of deductive and inductive clustering variables to develop groups. DeSarbo, Grewal and Wang (2009) adopt a more dynamic view of strategic groups, proposing a new multi-dimensional scaling model, through which they picture the longitudinal movement of strategic groups in evolutionary paths.

Despite its popularity and improvements, the approach is criticized for several reasons. First, it is fundamentally arbitrary since the results are not consistent when alternative criteria are applied (Barney and Hoskisson, 1990; Cattani, Porac and Thomas, 2017). Second, by using a limited set of firm characteristics, it is impossible to capture the infinite dimensions of firms, as every entity 'is an infinity, and infinity cannot be exhausted' (Durkheim, 1982, p. 110). Third, it is difficult to defend that the clustered strategic groups are not methodological artefacts, given the absence of analysis on firms' actual behavioural relations and interactions (Barney and Hoskisson, 1990; Hatten and Hatten, 1987; Mas-Ruiz, Ruiz-Moreno and Ladrón de Guevara Martínez, 2014). Fourth, analysis is limited to firms operating within a well-defined industry boundary; hence, less effective given boundary permeability.

A cognitive perspective

Motivated by the inadequacies of characteristic-based approaches, scholars switched to cognitively constructing strategic groups (Daniels, Johnson and Chernatony, 1994; Porac, Thomas and Baden-Fuller, 1989, 2011; Reger and Huff, 1993). In a seminal study, Porac, Thomas and Baden-Fuller (1989) theorizes that managers act upon their cognitive maps and narrow their responses to the primary competitors. Reger and Huff (1993) argue that industry participants have shared perceptions about strategic commonalities influencing managerial decision-making. Peteraf and Shanley (1997) introduce the notion of strategic group identity, describing the mutual understanding of group members of their group characteristics. Using more advanced techniques, Sonenshein, Nault and Obodaru (2017) explore the role of strategic group identities in shaping the competitive and cooperative behaviours of the members.

A cognitive perspective provides theoretical advantages, but it has limitations. First, there is a practical issue of scale – the difficulty of investigating industries with a large number of firms or multi-industries. Moreover, constructing cognitive strategic groups requires primary data

our strategic group definition, we drop the 'within an industry' constraint regarding strategic groups.

[3] Including – but not limited to – customer bases, firm size, profitability, liquidity and R&D capability (see e.g. DeSarbo and Grewal, 2008; DeSarbo, Grewal and Wang, 2009; Mas-Ruiz, Ruiz-Moreno and Ladrón de Guevara Martínez, 2014; Short *et al.*, 2007; Storbacka and Nenonen, 2012).

Table 2. A summary of strategic group streams and identification approaches

	I-O economics	Cognition	
Purpose of identifying strategic groups	Explaining performance differences among firms (Caves and Porter, 1977; Porter, 1979).	Understanding the drivers behind strategic choices and strategy formulation (Porac, Thomas and Baden-Fuller, 1989; Reger and Huff, 1993).	
View on the relationship between performance and strategic group membership	S–C–P paradigm suggests that industry structure affects firms' conducts, which in turn affect the performance. As such, there are performance differences between different groups due to the existence of mobility barriers (Caves and Porter, 1977; Porter, 1979, 1980).	Strategic groups may be unrelated to performance outcomes since competitors do not necessarily have similar performance (Carroll and Thomas, 2019; Reger & Huff, 1993).	
	Characteristic-based approaches	Conventional cognitive approaches	The co-mention-based (network) approach
Theoretical foundation	Firms in the same strategic groups are likely to pursue similar strategies along the strategic dimensions, which can be quantified by certain economic characteristics.	Managers have shared perceptions on their surrounding environments (so-called 'cognitive maps'), including competitors.	Firms mentioned in the same news articles because of corporate interactions or journalists' cognitive embeddedness, implying the firms used similar strategies. Structurally equivalent firms are likely to have access to the same resources. RDT suggests that competitive advantages critically depend upon the resources firms access from their interactions with the external environment. Thus, structurally equivalent firms are likely to compete for generic resources.
Data source	Accounting and financial data	Interviews and surveys obtained from managers	News articles
Advantages	The approach is replicable and can be applied in large-scale analysis.	(a) Competitors are identified based on the actual perception of managers who make strategic decisions. (b) The outcomes are not statistical artefacts.	(a) The approach is based on actual firm interactions, hence the outcomes are not statistical artefacts. (b) News co-mentions differing from surveys or interviews contain both objective elements – corporate interactions and subject elements – journalists' views. (c) News as a third party complements managerial views. (d) It is replicable and can be used in large-scale analysis.
Disadvantages	Likely to produce statistical artefacts.	(a) Managerial cognitive limitations (e.g. competitive blind spots). (b) The approach is not replicable and thus cannot be used in large-scale analysis.	(a) Journalist biases. (b) Journalists are not decision-makers of firms, thus the approach cannot replace the conventional approach based on managerial views.

collected using surveys or interviews. A uniqueness of data sources study creates replication obstacles. The alternative content analysis to analyse textual data – for example, presidents' letters to shareholders (Osborne, Stubbart and Ramaprasad, 2001) – requires significant human judgement because of the inability of machines to 'read' sophisticated scripts, constraining their applicability.[4]

Another concern is human rationality. Psychological studies suggest that mental models – once established – are difficult to revise (Prahalad and Bettis, 1986). Thus, individuals often ignore contradictory facts (Prahalad and Bettis, 1986). Additionally, decision-makers cannot attend to and interpret all informational cues, creating competitive blind spots (Levitt, 2017; Ng, 2009; Porac, Thomas and Baden-Fuller, 2011; Prahalad and Bettis, 1986).[5] Managers may thereby focus narrowly on 'recognized' competitors but dismiss covert threats made more likely by changes in the market for competition (Levitt, 2017; Porac, Thomas and Baden-Fuller, 2011) – a point demonstrated by the literature (e.g. Helfat and Peteraf, 2015; Levitt, 2017).

A network perspective

The approaches reviewed are motivated by distinct rationales and have their respective limitations. Scholars call for a deeper appreciation of the dynamics of interfirm relationships, triggering a growing interest in network analysis (Gulati, Nohria and Zaheer, 2000; Kennedy, 2008; Mische, 2011; Porac *et al.*, 1995; Thomas and Pollock, 2002; Whitford and Zirpoli, 2016). For instance, Thomas and Carroll (1994) assert that a 'strong' definition of strategic groups ought to incorporate between-firm interactions, neglected by the extant literature; we contend that our adopted definition of similarity addresses the relationship dimension. Caves and Porter (1977) stress the importance of cooperative relationships, suggesting that mutual dependencies may explain the formation of strategic groups. Gulati, Nohria and Zaheer (2000) put forward the concept of strategic networks, which by definition is inclusive as it consolidates both cooperative and competitive relationships. They argue that strategic networks, and particularly the concept of structural equivalence, provide a robust alternative approach to identifying strategic groups. Despite the recent developments in strategic networks (Rui and Bruyaka, 2021), to the best of our knowledge the concept has not been deployed to identify competitors or strategic groups. Gur and Greckhamer (2019), in their recent review of competition literature, restressed the importance of firm structural positions in identifying rivals. We concur and contend that network analysis, particularly the concept of structural equivalence, has the potential to move strategic group research forward.

Structural equivalence in competition research

Structurally equivalent actors are those who have a similar pattern of relations with the occupiers of other positions (Burt, 1997). Such actors are considered competitors (Burt, 1987; Galaskiewicz and Burt, 1991). The claim is rooted in a set of related arguments. First, structurally equivalent firms are dependent on the same resources obtained from the network (Burt, 1997; Ingram and Yue, 2008). Second, resource dependency theory (RDT) adds a layer to structural equivalence by suggesting that organizations depend on resources which originate from their environment and are ultimately held by other organizations (Drees and Heugens, 2013; Hillman, Withers and Collins, 2009; Pfeffer and Salancik, 1978). Hence, structurally equivalent firms are likely to compete with one another for similar generic resources. Third, structural equivalence leads to homogenous and competitive behaviours, based on two arguments. The *socialization* argument suggests that structurally equivalent actors would behave similarly since they interact with similar others (Burt

[4]Osborne, Stubbart and Ramaprasad (2001) use computer-assisted content analysis, specifically common factor analysis, to extract themes from presidents' letters to shareholders; and strategic groups are identified by the overlap of common themes. Although the approach is computer-assisted, thematizing the scripts still involves a considerable amount of manual work. Machines can only produce keywords, while human judgement is needed for deciding the themes. To the best of our knowledge, this issue has yet to be addressed by some of the most updated topic modelling techniques (e.g. latent Dirichlet allocation, normally referred to as LDA). In fact, Osborne, Stubbart and Ramaprasad (2001) only analyse 22 firms. To an extent, this indicates the limitation of scale.

[5]Limited managerial attention has been discussed extensively in managerial cognition research (see e.g. Eggers and Kaplan, 2013; Helfat and Peteraf, 2015; Ocasio, 1997).

and Minor, 1983). The *symbolic* argument suggests that such actors monitor and imitate each other – because when an actor adopts an advantageous position, its structurally equivalent counterpart is likely to make a similar move, to hedge against the economic and social risks of falling behind (Galaskiewicz and Burt, 1991).

The concept of structural equivalence is used by several competition-related studies. For example, Podolny, Stuart and Hannan (1996) investigate competition in the semiconductor sector using technological niches to identify structurally equivalent firms. Bothner (2003) explores the competition in the computer industry, where structural equivalence is determined by the sales network of computer vendors. However, the extant literature derives networks formulated by a single type of linkage – patent networks (Podolny, Stuart and Hannan, 1996) or sales networks (Bothner, 2003) – overlooking the complexity of firm relationships. We contend that Kennedy's (2008) news co-mention network is more robust in identifying competitors because it comprehensively captures a broad range of relationships.

News co-mention networks

Kennedy (2008) points to the central role of media in reflecting and shaping market formation. He argues that media coverage increases the visibility of 'not-yet-legitimate' firms and positions them in the appropriate market through cognitive embedding (Kennedy, 2008, p. 272). News co-mentions, he argues, help the public to 'connect the dots' to establish a view about the category members as well as what the category means, hence shaping public cognition in defining market categories (Kennedy, 2008, p. 273). Kennedy's (2008) research, despite its wide-ranging implications, is largely limited to new market formations – ignoring its potential for identifying competitors. We contend that by incorporating the concept of structural equivalence, news co-mentions provide a critical means for identifying competitors and strategic groups.

News articles reporting actual corporate events, the expressed views of executives and changes in the operating environment depict competitive and cooperative interaction – both useful informational cues for identifying competitors. Competitive interactions, for example corporate lawsuits, unequivocally manifest competitive relationships between firms. Cooperative interactions such as strategic alliances and joint ventures are more nuanced, however, we contend that they too point to competition and competitive dynamics. Our assertion is based on two arguments and practical observations. First, Gulati, Nohria and Zaheer (2000) extended Nohria and Garcia-Pont's (1991) proposition beyond strategic blocks, arguing that the more collaborative interactions two firms have, the higher their intensity of rivalry. Hence, cooperative interactions include an element of competition consistent with the structural equivalent theory that firms depend on the same resources obtained from the network (Burt, 1997; Ingram and Yue, 2008; Sinha and Cusumano, 1991). The point is amply demonstrated by the complex relationship between Microsoft and Apple.[6] Second, the literature points to the existence of simultaneous symbiotic relationships comprising elements of both competition and collaboration (coopetition) (Bengtsson and Kock, 1999; Bouncken et al., 2017; Chen, 2008; Ritala, 2012). A point supported by practice – for example, IBM had an agreement with every one of its major competitors on every major computer component (Krueger, 2001). These arguments are supported by empirical studies. Peng *et al.* (2012) conclude that cooperation with competitors is possible and leads to better performance. Pun and Ghamat (2016) conclude that forming an R&D joint venture (RJV) potentially intensifies the competition between partners.

Corporate interactions prompted by actual corporate events, the expressed views of executives or changes in the operating environment are the primary driver of co-mention linkages; augmented by journalists' cognitive perceptions, providing a critical and robust sense-making means (Kennedy, 2008) in two different ways.[7] First, journalists

[6]Various news sources (e.g. Dernbach, 2020) suggest that Steve Jobs, CEO of Apple, did not regard Microsoft as a competitor but as a reliable software supplier at the early stage of interactions between the two firms. Yet, precisely because of the collaborative relationship, Microsoft saw the potential of so-called 'graphics-based operating systems' and gained essential knowledge of developing its own operating system – Windows, resulting in a long-lasting competitive relationship between the two firms.

[7]In practice, a great majority of news articles (99%, see online Appendix 1) reported firm actions and some addressed changes in the operating environment (44.61%) and a small minority contained journalist commentaries and interviews with executives (5.29%) (a news article could be related to several topics, hence the sum of topic coverage is not 100%). On balance, we contend that

might *add* additional linkages reporting a focal event (i.e. firms that are indirectly related to a news event). Second, they might *strengthen* certain linkages by repeatedly reporting the news events that are regarded as important. In both scenarios, the rationales underpinning co-mention linkages are strengthened not impaired, because the co-mention networks are crystallized by numerous corporate events and respective writers' opinions, supplementing managerial cognition and moderating managerial competitive blind spots.

Furthermore, strategies shape firms' interactions with their external environment and henceforth influence stakeholders' perceptions regarding the related actors (Fombrun and Shanley, 1990; Kald, Nilsson and Rapp, 2000; Kennedy, 2008; Shipilov, Greve and Rowley, 2019). As mentioned, high co-mention similarities between firms lead to the adoption of similar actions including strategies. For instance, firms using a low-cost strategy would cut price to compete with their rivals, who may be forced to adopt a similar strategy in response (Kumar, 2006). Reporting such interactions leads to co-mention, in turn, and the comparability of such firms will be strengthened in public cognition, further increasing the probability of co-mentions in news articles. As such, we contend that co-mentions, in line with Hunt's (1972) definition, offer a robust route for identifying competitors pursuing similar strategies.

Methodology

Below, we summarize the computational process of co-mention similarity for a given firm pair, laying out the foundation for deriving strategic groups from news co-mention networks.

Co-mention similarity

We start by constructing a firm-to-news matrix, where the columns represent different news articles and the rows represent different firms. To elaborate the calculation, consider a hypothetical firm-to-news matrix X where there are three firms (F1, F2 and F3) connected by three news articles (N1, N2 and N3):

$$X = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 1 \end{bmatrix} \quad (1)$$

In the hypothetical firm-to-news matrix X, F1 is mentioned by N1 and N2, hence the vector for F1 is (1, 1, 0). F2 is mentioned by N1, N2 and N3, hence the vector for F2 is (1, 1, 1). F3 is mentioned by N2 and N3, hence the vector for F3 is (0, 1, 1).

We then calculate the structural equivalence of firms in the firm-to-news matrix using cosine similarity, a distance measure widely applied in network research (Newman, 2018). We define co-mention similarity based on cosine similarity as follows:

$$\text{co} - \text{mention similarity} = \frac{A \cdot B}{\| A \| \| B \|} \quad (2)$$

where, for the two firms under consideration, A and B are binary vectors indicating the citations of a firm in a given set of news articles. The value of co-mention similarity is bounded between 0 and 1. Thus, in the hypothetical matrix X, the co-mention similarity of (F2, F3) is:

$$\frac{(1, 1, 1) \cdot (0, 1, 1)}{\| (1, 1, 1)) \| \| (0, 1, 1) \|} \approx 0.82 \quad (3)$$

By calculating the co-mention similarity of all firm pairs, we obtain a firm-to-firm similarity matrix Y, as shown:

$$Y = \begin{bmatrix} 1 & 0.82 & 0.5 \\ 0.82 & 1 & 0.82 \\ 0.5 & 0.82 & 1 \end{bmatrix} \quad (4)$$

Co-mention-based strategic groups

We then derive strategic groups by co-mention similarity based on community detection, a technique for identifying the dense clusters, so-called 'communities' (i.e. groups), within a network (Fortunato and Hric, 2016). There are several community detection algorithms. One of the most popular is the Louvain algorithm, which maximizes a quality function called modularity, used to assess the quality of a cluster solution (Fortunato and Hric, 2016). However, recent research suggests that the Louvain algorithm may yield poorly connected communities (Traag, Waltman

including these articles will be helpful in capturing the set of relationships as comprehensively as possible.

and Van Eck, 2019). Moreover, modularity is constrained by resolution limits which lead to difficulties in detecting small communities (Fortunato and Barthélemy, 2007). Thus, we use the Leiden algorithm, an extension of the Louvain algorithm that yields communities with strong connections (Traag, Waltman and Van Eck, 2019). Further, we optimize the community partition by another quality function called 'surprise' which, compared to modularity, works better in detecting small communities (Traag, Aldecoa and Delvenne, 2015).[8] We rely on a Python library (CDLIB) to implement the community detection algorithms.

Illustrative application: The US high-tech sector

Sample and data

We provide an illustrative application using the US high-tech sector from 2001 to 2017. Guided by Kile and Phillips' (2009) review, we focus on the following high-tech industries: computer equipment (SIC: 357), software (SIC: 37), medical technologies (SIC: 38) and communication and electrical (SIC: 36).

To construct the co-mention networks, we collect news data from the Dow Jones Newswires Service (DJNS) archive.[9] For each news article, the DJNS provides stock tickers of cited firms, enabling us to construct the co-mention networks. Further, it provides subject identification codes, enabling us to select articles regarding specific news topics.

We use the following six steps to filter news articles. First, we retrieve all news articles for the sample period. Second, we select only co-mention news items, thus dropping single-firm news items. Third, we drop duplicated news articles with the same headlines published at the same time. Fourth, following Lee, Ma and Wang (2015), we use a simple heuristic cut-off by excluding news mentioning more than 10 firms (as 95% of the news items mention no more than 10 firms). Fifth, we exclude news with irrelevant topics by focusing on 65 out of 3080 topics that capture cooperative or competitive corporate interactions and journalists' perceptions (see online Appendix 1 for the selection of news topics). Finally, following Kennedy (2008), we exclude press release news to alleviate influence from the firms themselves. By taking these steps, we obtained 719,315 news articles.

Stock-level and firm-level accounting data are collected from the Centre for Research in Security Prices (CRSP) and Compustat databases.

Examination and verification: Strategic dimensions and competitive inclination

To assess the features of the co-mentioned groups, we compare them with those produced by the characteristic-based approach examining intra-group similarities and inter-group differences along key strategic dimensions. We then examine the validity of the co-mention-based similarity and group solution by testing the relationship with competitive inclination.

Strategic dimensions

Following prior literature (DeSarbo and Grewal, 2008; DeSarbo, Grewal and Wang, 2009; Ferguson, Deephouse and Ferguson, 2000; Short *et al.*, 2007), we consider five different strategic dimensions – scale, performance, liquidity, R&D capability and valuation – to examine the intra-group similarities and inter-group differences.

Scale. Mas-Ruiz and Ruiz-Moreno (2011) argue that firms with a larger scale have greater market power, wider scope and a higher level of efficiency and resource mobility; hence, an important strategic dimension. We measure scale by taking the natural log of a firm's total assets and its total number of employees.

Performance. Performance homogeneity is used as a key variable in efforts to construct strategic groups (Ketchen and Shook, 1996; Short *et al.*, 2007). We use the following indicators proxying for firm performance: Returns on assets (ROA), calculated by the total net income of a firm over its total assets; Asset turnover, calculated by the total sales of a firm over its total assets; Profit margin, calculated by the total net income of a firm over

[8]The number of groups is flexible and there is no best way to determine the optimal number of groups – 'surprise' is one of the possible ways. The number of groups and group sizes can be manually adjusted depending on the purpose of analysis.

[9]The DJNS includes the historical text of news items published in two news outlets: *Dow Jones Intra News Newswire* and *The Wall Street Journal*.

its total sales; Sales growth, calculated by the percentage change in the total sales of a firm.

Liquidity. Financial resources are critical to establishing strategic flexibility (Greenley and Oktemgil, 1998; Short *et al.*, 2007). Following Short *et al.* (2007) and DeSarbo and Grewal (2008), we use five variables proxying for firms' liquidity: Current ratio, calculated by the current assets of a firm over its current liability; Leverage, calculated by the total debt of a firm over its total equities; Cash-to-asset ratio, calculated by the cash and cash equivalents of a firm over its total assets (we use the natural log of the total amount of cash and cash equivalents); Total cash, calculated by the natural log of a firm's cash and cash equivalents; and Altman's Z which, according to Altman (1968), is calculated by the following equation:

$$Altman'sZ = 0.012 * X_1 + 0.014 * X_2 + 0.033 * X_3 + 0.006 * X_4 + 0.999 * X_5 \quad (5)$$

where X_1 = working capital/total assets, X_2 = retained earnings/total assets, X_3 = earnings before interest and taxes/total assets, X_4 = market value of equity/book value of total liabilities and X_5 = sales/total assets.

R&D capability. Short *et al.* (2007) highlight the importance of R&D capability as a key strategic dimension, suggesting that firms with high R&D intensity tend to pursue innovation, while firms with low R&D investment are likely to focus on existing opportunities. We measure R&D capability using two variables. One is R&D per sale – the R&D expenditure of a firm over its total sales. The other is the natural log value of a firm's total amount of R&D expenditure.

Valuation. Valuation represents investors' expectations regarding a firm's future growth opportunity (Geroski, Machin and Walters, 1997). We use two indicators proxying for market valuation: Price-to-earnings (P/E) ratio, calculated by the market capitalization of a firm over its total net income and Tobin's Q, calculated by the sum of a firm's market value of common equity and its total assets after deducting the book value of common equity, with the same deflated by the total assets.

We further calculate characteristic similarities by the following equation:

$$Characteristic\ similarity_{(i,j),k,t} = \frac{100 - \left| Percentile_{i,k,t} - Percentile_{j,k,t} \right|}{100} \quad (6)$$

where $Characteristic\ similarity_{(i,j),k,t}$ refers to the similarity of a given firm characteristic k between firm i and firm j at a given year t. $Percentile_{i,k,t}$ refers to the percentile of firm i's characteristic k among the values of the same characteristic of all firms at a given year t. The value of characteristic similarity ranges from 0 to 1. A value of 0 suggests the characteristic similarity between a firm pair is the highest among that of all possible firm pairs. And a value of 1 suggests the characteristic similarity between a firm pair is the lowest among that of all possible firm pairs.

Competitive inclination

Firms in the same strategic groups are competitors and they tend to compete more intensively (directly) than those outside of the group (Hunt, 1972; McGee, Thomas and Pruett, 1995; Reger and Huff, 1993). Hence, to verify the validity of our approach, we test if firms in the same strategic groups exhibit high competitive inclination. Competitive inclination is a continuous variable measuring the extent to which two firms are competitors as opposed to cooperators.[10] We use five steps to construct competitive inclination. First, we retrieve all articles that mention only two firms. Second, following Wei *et al.* (2015), we select competition-related articles using keywords including 'competition', 'compete', 'competing', 'competitors', 'rival', 'rivalry', 'war', 'win', 'beat' and 'defeat'. Third, we identify cooperation-related articles using the following keywords: 'cooperation', 'cooperating', 'co-

[10]We consider 'cooperative' relationships in constructing the dependent variable to mitigate the potential bias caused by the supposedly positive relationship between the frequency of two firms mentioned in the same news item and the chance that they are mentioned as 'competitors'. Adding the 'cooperative' factor and dropping firms without any competitive-related or cooperation-related news articles offsets the bias because, as the frequency of firms being mentioned increases, both the chance of being mentioned as 'competitors' and that of being mentioned as 'collaborators' would increase at the same rate.

Table 3. Number of firms, groups and SIC-4 industries

Year	No. firms	No. groups	Avg. no. firms in a group	Avg. no. SIC-4 industries in a group
2001	459	145	3.17	2.37
2002	481	139	3.46	2.54
2003	484	145	3.34	2.43
2004	604	175	3.45	2.62
2005	596	159	3.75	2.85
2006	577	169	3.41	2.65
2007	549	142	3.87	2.99
2008	540	158	3.42	2.67
2009	466	140	3.33	2.57
2010	384	113	3.40	2.49
2011	380	98	3.88	2.78
2012	370	105	3.52	2.41
2013	387	147	2.63	1.92
2014	365	131	2.79	1.94
2015	328	112	2.93	1.99
2016	274	109	2.51	1.83
2017	256	80	3.20	2.10

Note: This table presents the number of firms, number of groups, average number of firms in a group and average number of SIC-4 industries in a group for each year.

operator', 'collaboration', 'collaborator', 'friend' and 'partner'. Fourth, for each firm pair, we obtain the number of articles citing them as competitors or cooperators. Finally, we compute competitive inclination using the following equation:

$$Competitive\ intensity_{i,t} = \frac{Competition_{i.t} - Cooperation_{i,t}}{Competition_{i.t} + Cooperation_{i,t}} \quad (7)$$

where $Competition_{i.t}$ refers to the number of competition-related articles cited, for firm pair i in a given year t. $Cooperation_{i,t}$ refers to the number of cooperation-related articles cited, for firm pair i in a given year t. The value of this variable ranges from −1 to 1. A value of −1 indicates that the firm-pair relationship is entirely cooperative. A value of 1 indicates that the firm-pair relationship is entirely competitive. Firms without any competition-related or cooperation-related news articles in a given year are dropped from the sample.

Empirical results

Co-mention-based strategic groups in the high-tech sector

We take the following steps to derive the strategic groups in the high-tech sector. First, for each year from 2001 to 2017, we calculate the dyadic-level co-mention similarity of US high-tech firms. Second, we drop the observations without stock and financial data. Third, we construct strategic groups using community detection. The number of firms and groups is summarized in Table 3.

During the sample period, the number of firms included in our sample ranges from 256 to 596. The number of groups ranges from 80 to 175. On average, each group contains two to four firms across one to three, 4-digit SIC industries (denoted as SIC-4).

Descriptive statistics

In Table 4, we present the descriptive statistics of the firm characteristics studied.

In Tables 5 and 6, we present the descriptive statistics including the correlation matrices of the dyadic-level variables for running the probit regression testing intra-group similarity, and for running the OLS regression testing competitive inclination. We calculate variable variance inflation factors (VIFs) for the models where the value can be calculated. The average VIF value is 1.74 for the probit regression testing intra-group similarity, and 2.56 for OLS regression testing competitive inclination. No individual VIF value is higher than 4.74, which is below the recommended cut-off of 5 (Hair *et al.*, 2019). Thus, we find no multicollinearity problems in these models.

Table 4. Descriptive statistics for firm characteristics

	Mean	SD
Total assets (natural log)	6.40	1.85
Employees (natural log)	0.48	1.73
ROA	−0.03	0.23
Turnover	2.06	15.48
Profit margin	−0.08	0.87
Sales growth	0.12	0.45
Current ratio	3.42	2.59
Cash-to-assets	0.32	0.21
Leverage	0.32	1.14
Altman's Z	4.93	7.32
Total cash (natural log)	4.96	1.82
R&D per sale	0.73	25.94
R&D expenditure (natural log)	3.82	1.73
PE	20.35	130.55
Tobin's Q	2.39	1.58

Intra-group similarities

First, we test intra-group characteristic similarities by running a dyadic-level probit regression with the co-mention-based groups as the dependent variable – a dummy of 1 if the two firms fall into the same group, and 0 otherwise. We use characteristic similarities as the independent variables and control for industry classifications using two different schemes. One is SIC-4 conventionally used in the literature. Another is the 3-digit textual-based network industry classifications (denoted as TNIC-3).[11] Both industry classification variables in this regression are dummies (1 if the two firms fall into the same industry, and 0 otherwise). We add year fixed effects. Standard errors are clustered by dyadic-level firm pair and year.

Table 7 presents the empirical results for the test of intra-group similarity.

According to Table 7, firms in the same co-mention-based groups are significantly similar in relation to most strategic dimensions. Among 15 firm characteristics, 10 have positive and statistically significant coefficients ($p < 0.05$). Five coefficients are statistically insignificant from zero. Two coefficients are related to performance – ROA ($\beta = -0.02$, $p = 0.476$) and product margin ($\beta = -0.02$, $p = 0.476$). Three are related to liquidity – cash-to-assets ($\beta = -0.02$, $p = 0.476$), leverage ($\beta = -0.02$, $p = 0.476$) and Altman's Z ($\beta = -0.02$, $p = 0.476$). On the other hand, it is worth noting that the pseudo R-square, even after controlling for industry classifications and year fixed effects, is only 9%. This suggests that firms' characteristics play an important but not dominant role in determining the co-mention-based group membership, as the majority of variation remains unexplained by the regression model. Overall, the results demonstrate some commonalities between the co-mention-based approach and the characteristic-based approach, despite observable differences. Here, we carefully note that such differences do not necessarily undermine the validity of the co-mention-based approach in identifying 'real competitors'. The interplay between those concepts will be fully addressed in the 'Discussion and conclusion' section.

Inter-group differences

To examine the inter-group differences, we detect the separation of groups in terms of firm characteristics using the MANOVA analysis, used extensively in strategic group literature (Ferguson, Deephouse and Ferguson, 2000; Fiegenbaum and Thomas, 1990; Ketchen and Shook, 1996; Short *et al.*, 2007). Following Fiegenbaum and Thomas (1990), we separately examine the inter-group differences for different dimensions and different years. In line with Short *et al.* (2007), we use

[11]TNIC-3, proposed by Hoberg and Phillips (2016), is extracted from the product description in corporate annual reports (10-K filings). TNIC-3 compared to SIC-4 has several advantages, including for example its firm-centric feature and relatively high update frequency (annually), incorporating market changes. Hence, it has been increasingly used by scholars in identifying horizontal peers (Connelly *et al.*, 2020; Shi, Zhang and Hoskisson, 2017).

Table 5. Descriptive statistics for the regression testing intra-group similarity

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Strategic group	0.01	0.09																	
2. Total assets	0.72	0.20	0.04																
3. Employees	0.75	0.18	0.03	0.80															
4. ROA	0.67	0.24	0.01	0.19	0.16														
5. Turnover	0.78	0.17	0.02	0.09	0.05	0.05													
6. Profit margin	0.69	0.22	0.01	0.24	0.20	0.75	0.05												
7. Sales growth	0.71	0.21	0.01	0.02	0.02	0.11	0.06	0.11											
8. Current ratio	0.73	0.20	0.01	0.07	0.10	0.01	0.08	0.02	0.02										
9. Cash-to-assets	0.77	0.19	0.02	0.09	0.16	0.01	0.06	0.01	−0.01	0.19									
10. Leverage	0.73	0.21	0.01	0.12	0.15	0.00	0.02	0.00	0.00	0.13	0.20								
11. Altman's Z	0.71	0.22	0.01	0.09	0.05	0.29	0.06	0.24	0.11	0.23	0.02	0.19							
12. Total cash	0.73	0.20	0.04	0.66	0.43	0.15	0.14	0.16	0.02	0.06	0.15	0.04	0.10						
13. R&D per sale	0.89	0.09	0.03	0.08	0.18	0.11	0.21	0.10	0.05	0.04	0.26	0.09	0.04	0.07					
14. R&D	0.87	0.10	0.04	0.60	0.45	0.09	0.10	0.11	0.03	0.04	0.05	0.02	0.05	0.60	0.19				
15. PE	0.66	0.25	0.01	0.06	0.04	0.46	0.03	0.40	0.08	0.01	−0.01	0.00	0.17	0.05	0.04	0.02			
16. Tobin's Q	0.73	0.20	0.01	0.02	0.01	0.12	0.05	0.13	0.14	0.00	0.06	0.01	0.20	0.04	0.07	0.05	0.07		
17. TNIC-3	0.08	0.27	0.10	0.04	0.06	0.02	0.04	0.01	0.01	0.05	0.10	0.03	0.00	0.06	0.12	0.08	0.00	0.02	
18. SIC-4	0.08	0.27	0.07	0.02	0.04	0.01	0.03	−0.01	0.01	0.03	0.08	0.03	−0.01	0.03	0.10	0.04	−0.01	0.02	0.32

Table 6. Descriptive statistics for the regression testing competitive inclination

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Competitive intensity	0.22	0.88																			
2. Co-mention similarity	0.11	0.13	0.27																		
3. Strategic group	0.47	0.50	0.21	0.57																	
4. Total assets	0.84	0.16	0.02	0.24	0.33																
5. Employees	0.82	0.16	0.02	0.28	0.35	0.89															
6. ROA	0.73	0.24	−0.06	0.01	0.07	0.36	0.31														
7. Turnover	0.84	0.12	−0.02	0.10	0.08	0.07	0.05	0.15													
8. Profit margin	0.75	0.23	0.00	0.07	0.07	0.42	0.35	0.77	0.15												
9. Sales growth	0.76	0.18	0.03	0.09	0.09	0.10	0.12	0.16	0.04	0.15											
10. Current ratio	0.76	0.17	0.05	0.08	0.05	0.06	0.11	−0.01	0.07	0.01	0.07										
11. Cash-to-assets	0.82	0.13	0.05	0.05	−0.01	−0.02	0.01	−0.03	0.03	−0.01	0.04	0.48									
12. Leverage	0.75	0.20	0.03	0.06	0.03	0.08	0.09	0.06	0.13	0.08	0.11	0.12	0.16								
13. Altman's Z	0.78	0.18	0.07	0.02	0.04	0.15	0.14	0.43	0.11	0.39	0.17	0.13	0.09	0.31							
14. Total cash	0.90	0.13	0.03	0.11	0.25	0.83	0.67	0.36	0.05	0.37	0.06	0.04	0.04	0.06	0.16						
15. R&D per sale	0.93	0.06	0.02	0.11	0.05	0.09	0.11	0.09	0.35	0.11	0.12	0.15	0.22	0.13	0.09	0.06					
16. R&D expenditure	0.95	0.06	0.05	0.15	0.26	0.80	0.71	0.28	0.09	0.32	0.09	0.08	0.03	0.09	0.14	0.77	0.12				
17. PE	0.75	0.21	0.03	0.06	0.09	0.26	0.25	0.56	0.10	0.42	0.15	0.05	0.02	0.11	0.25	0.23	0.06	0.22			
18. Tobin's Q	0.79	0.18	−0.01	0.00	0.03	0.09	0.08	0.38	0.16	0.35	0.19	0.01	0.14	0.06	0.46	0.09	0.14	0.07	0.23		
19. TNIC-3	0.58	0.49	0.13	0.30	0.22	−0.03	0.00	−0.05	0.12	−0.04	0.10	0.18	0.19	0.13	0.03	−0.05	0.30	0.01	−0.09	0.03	
20. SIC-4	0.37	0.48	0.11	0.24	0.12	−0.12	−0.10	−0.11	0.08	−0.09	0.07	0.09	0.13	0.08	0.02	−0.12	0.26	−0.10	−0.10	0.06	0.39

Table 7. Probit regression testing intra-group firm characteristic similarities

DV:	Strategic group
Intercept	−4.47*** (<0.001)
Total assets	0.25*** (<0.001)
Employees	0.09* (0.016)
ROA	−0.02 (0.476)
Asset turnover	0.12*** (<0.001)
Product margin	0.03 (0.221)
Sales growth	0.14*** (<0.001)
Current ratio	0.06*** (0.001)
Cash-to-assets	0.00 (0.965)
Leverage	0.00 (0.817)
Altman's Z	0.01 (0.476)
Total cash	0.33*** (<0.001)
R&D per sale	0.33*** (<0.001)
R&D expenditure	0.76*** (<0.001)
PE	0.08*** (<0.001)
Tobin's Q	0.05** (0.005)
TNIC-3	0.59*** (<0.001)
SIC-4	0.34*** (<0.001)
No. observations	1,418,825
Pseudo R-squared	0.092

Note: Year fixed effects are included but not reported in the table. Standard errors are clustered by year. Figures in parentheses are p-values. Significance levels are indicated by +, *, ** and *** for 10%, 5%, 1% and 0.1%, respectively.

Table 8. MANOVA analysis testing inter-group firm characteristic differences

Year	Scale	Performance	Liquidity	R&D capability	Valuation
2001	15.17***	4.11**	15.53***	17.28***	0.1
2002	21.66***	4.85***	11.16***	14.16***	0.37
2003	19.79***	5.19***	11.93***	22.64***	3.8*
2004	32.73***	1.68	26.18***	47.79***	0.49
2005	11.6***	0.28	7.82***	16.72***	0.46
2006	4.91**	1.38	5.96***	7.74***	6.62**
2007	9.1***	0.83	7.76***	9.73***	2.38+
2008	10.76***	2.78*	10.05***	10.57***	0.33
2009	11.46***	2.03+	7.61***	12.58***	1.38
2010	12.28***	1.14	10.08***	19.1***	1.7
2011	4.89**	2.6*	5.97***	7.53***	0.3
2012	8.33***	0.98	10.57***	6.95**	1.41
2013	1.88	0.65	3.19*	6.55**	1.06
2014	2.16	0.71	2.26+	8.02***	1.17
2015	3.12*	1.16	3.41*	10.01***	0.33
2016	9.42***	2.89*	12.24***	21.55***	1.53
2017	3.48*	2.09+	9.95***	11.44***	1.13

Note: The table presents the results of MANOVA analysis. We run separately the MANOVA analysis based on years and five strategic dimensions. F-values are presented in the table. Significance levels are indicated by +, *, ** and *** for 10%, 5%, 1% and 0.1%, respectively.

the F-tests from Wilks' lambda, provided by the MANOVA analysis, to demonstrate the differences in the five strategic dimensions. Table 8 reports the results.

The MANOVA analysis shows strong inter-group differences in terms of scale, liquidity and R&D capability, and weaker differences in terms of performance and valuation (see Table 8). Specifically, the coefficients of inter-group differences in R&D capability are statistically significant across the entire sample period ($p < 0.05$). As for scale and liquidity, the coefficient is only insignificant

from zero in 2013 and 2014 ($p > 0.10$). The statistical differences in valuation are insignificant in most of the years, and significant only in 2003, 2006 and 2007 ($p < 0.10$). The statistic of performance is comparatively weak, given that the coefficients are statistically significant only in 8 out of 17 years. The results shown in Table 8 complement the findings presented in Table 7, suggesting that characteristic similarity is an important but not a determinant feature in the co-mention-based groups. Similar to the explanation in the previous section, we contend that the weak separation in performance and valuation does not weaken the reliability of the co-mention-based approach, since a valid strategic group solution uncovering rivalry structure may not result in firm characteristic differences between groups (Carroll and Thomas, 2019; Hatten and Hatten, 1987) (see 'Discussion and conclusion' section for a more detailed explanation).

Competitive inclination

In this section, we construct dyadic-level OLS regressions testing the co-mention-based approach in explaining competitive inclination. We use two sets of independent variables. One set is the co-mention similarity and co-mention-based groups derived from the news. The other set contains the similarity of 15 firm characteristics. We add year fixed effects. Standard errors are clustered by dyadic-level firm pair and year. To alleviate the potential risk of endogeneity, we take a 1-year lag between the dependent and explanatory variables.

Additionally, for robustness, we follow Chen, Su and Tsai (2007), Kim and Tsai (2012) and Tsai, Su and Chen (2011), using MRQAP analysis to address the autocorrelation issue caused by the dependent nature of dyadic data.[12] The results of the OLS regression analysis and MRQAP analysis are presented in Table 9.

In Models 1 and 3, we test firm characteristic similarities alone and their relationships with competitive inclination. Although some firm characteristics have positive and significant coefficients in one of the models (e.g. total assets, employees, sales growth and cash-to-assets in Model 1; profit margin, Altman's Z and PE in Model 3), no characteristic has positive and significant coefficients across both models, suggesting that firm characteristics are poor indicators of competitors. Contrastingly, in Models 2 and 5, the coefficients of co-mention similarity are positive and highly statistically significant ($p < 0.001$). Similarly, in Models 3 and 6, co-mention-based groups are positively and significantly correlated with competitive inclination ($p < 0.001$). Further, adding co-mention similarity or a co-mention-based group into the regression results in a notable increase of adjusted R-squares (a 3–5% increase in OLS regressions; a 4–6% increase in the MRQAP analysis). Overall, the results suggest that the co-mention-based approach is more robust in identifying competitors.

Discussion and conclusion

Porter (1980), building on Bain's (1952) and Hunt's (1972) insights, proposed the strategic group as a theoretical construct straddling the two extremes of pure monopoly and perfect competition (Cattani, Porac and Thomas, 2017; Dranove, Peteraf and Shanley, 1998; Peteraf, 1993). Other scholars point to the limitation of treating all organizations as alike or unique, stressing the need for a meso-level categorization of organizations (McKelvey and Aldrich, 1983). Hence, strategic groups are valuable beyond a theoretical concept as a meso-level unit of analysis affording an alternative and valuable insight into markets and competition.

To categorize firms into comparable groups, two interdependent questions need addressing: (a) how to define comparability; and (b) for an assumed definition, how to classify firms into comparable groups (Cattani, Porac and Thomas, 2017). Given the theoretical significance of the concept and its potential for enhancing our nascent understanding of markets and competition, a variety of definitions emerged (see Table 1). Similarity of strategies is the common-denominator binding definition. Scholars taking their lead from industrial–organizational economics developed a range of methods using firm characteristics for identifying

[12]Two regression analyses in this paper involve dyadic-level data: one testing intra-group similarity, the other testing competitive inclination. However, we cannot apply MRQAP to test intra-group similarity, because the number of observations (N = 1,418,825) is exceedingly large and MRQAP has a computational limit when dealing with large network size. Thus, we apply MRQAP only in testing competitive inclination where there are fewer observations (N = 1110) as we dropped firm pairs without any competition-related or cooperation-related articles.

Table 9. OLS regression and MRQAP analysis testing the relationship between network-based similarity/groups and competitive inclination

	DV: Competitive inclination					
	OLS regression			MRQAP analysis		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	−0.62 (0.416)	−0.81 (0.23)	−0.66 (0.353)	−0.60 (0.352)	−0.78 (0.231)	−0.65 (0.293)
Co-mention similarity		1.80*** (<0.001)			1.83*** (<0.001)	
Co-mention-based group			0.36*** (<0.001)			0.37*** (<0.001)
Total assets	0.18* (0.011)	0.06 (0.393)	0.09 (0.175)	−0.08 (0.882)	−0.46 (0.381)	−0.32 (0.524)
Employees	0.13+ (0.094)	0.04 (0.539)	0.10 (0.179)	−0.15 (0.703)	−0.50 (0.202)	−0.40 (0.310)
ROA	−0.20 (0.729)	−0.57 (0.296)	−0.40 (0.482)	−0.82*** (<0.001)	−0.668*** (<0.001)	−0.78*** (<0.001)
Asset turnover	−0.13 (0.768)	−0.47 (0.274)	−0.40 (0.358)	−0.17 (0.460)	−0.31 (0.173)	−0.26 (0.258)
Product margin	−0.85*** (<0.001)	−0.69*** (0.001)	−0.81*** (<0.001)	0.41* (0.028)	0.33+ (0.070)	0.47* (0.011)
Sales growth	0.52* (0.014)	0.52** (0.007)	0.52** (0.01)	0.05 (0.750)	0.01 (0.959)	0.01 (0.959)
Current ratio	−0.19 (0.448)	−0.33 (0.167)	−0.28 (0.24)	−0.00 (0.974)	0.02 (0.920)	−0.00 (0.996)
Cash-to-assets	0.46* (0.027)	0.38* (0.047)	0.51* (0.012)	0.12 (0.625)	0.11 (0.652)	0.18 (0.571)
Leverage	0.07 (0.689)	0.03 (0.859)	0.03 (0.864)	−0.12 (0.387)	−0.09 (0.468)	−0.09 (0.571)
Total cash	−0.01 (0.951)	0.00 (0.992)	−0.00 (0.995)	0.18 (0.687)	0.48 (0.249)	0.18 (0.441)
Altman's Z	0.19 (0.481)	0.17 (0.502)	0.25 (0.346)	0.53** (0.002)	0.53** (0.002)	0.53** (0.006)
R&D per sale	−0.11 (0.519)	−0.09 (0.6)	−0.08 (0.622)	−0.44 (0.369)	−0.21 (0.674)	−0.18 (0.719)
R&D expenditure	0.30 (0.499)	0.60 (0.166)	0.23 (0.592)	0.95 (0.211)	1.27+ (0.080)	1.07 (0.144)
PE	−0.46 (0.477)	−0.22 (0.717)	−0.21 (0.731)	0.41** (0.008)	0.32* (0.031)	0.36* (0.024)
Tobin's Q	1.00 (0.248)	1.27+ (0.094)	1.18 (0.143)	−0.19 (0.265)	−0.147 (0.410)	−0.21 (0.262)
TNIC	0.41** (0.007)	0.32* (0.043)	0.37* (0.013)	0.19** (0.001)	0.08 (0.193)	0.11* (0.078)
SIC	−0.17 (0.399)	−0.12 (0.516)	−0.17 (0.369)	0.14* (0.016)	0.05 (0.415)	0.11+ (0.064)
No. observations	1110	1110	1110	1110	1110	1110
Adj. R-squared	0.05	0.08	0.10	0.03	0.09	0.07

Note: Year fixed effects are included but not reported in the table. A 1-year lag is taken between the dependent variable and independent variables. Figures in parentheses are p-values. Significance levels are indicated by +, *, ** and *** for 10%, 5%, 1% and 0.1%, respectively.

strategic groups within an industry – referred to as the characteristics-based approach. Caves and Porter (1977) and Porter (1980) further argued that strategic groups possess mobility barriers accounting for within-industry performance differences. The empirical evidence for this proposition is mixed. Inadequacies and criticism of characteristic-based endeavours encouraged cognitive scholars to construct strategic groups from a cognitive perspective, suggesting that managers act upon their cognitive map to identify their primary competitors. The outcome was cognitive-based approaches to identifying strategic groups.

Despite the significant effort and progress, Table 2 highlights the weaknesses of the conventional methods used to derive strategic groups. Additionally, the fourth industrial revolution exacerbates these weaknesses, pointing to the need for further theorizing and development of supplementary methods to augment the conventional approaches.[13]

One may question why characteristic similarities, given their poor effectiveness in identifying rivals, have been used extensively in strategic group research. We contend that this is due to a focus on narrowly defined industries such as SIC-4 industries (e.g. DeSarbo and Grewal, 2008; DeSarbo, Grewal and Wang, 2009; Short *et al.*, 2007). For example, it is possible to identify competitors in the automotive industry based on characteristics such as relative size (e.g. Nohria and Garcia-Pont, 1991) because firms in this industry often serve the same market, offering homogenous products or services. On the other hand, it is significantly more difficult to apply the characteristic-based method to an industry with a sizable number of firms or multiple industries of a sector (e.g. the high-tech sector) where multi-front competition is common and competitors are not necessarily similar in characteristics. For example, consider Microsoft and Facebook. The two firms provide very different products or services. The featured products of Microsoft include software (Windows operating system, Office, Microsoft 365), computer devices (Surface series) and gaming devices (XBOX).[14] In contrast, Facebook does not provide any of these products but instead mainly profits from advertising.[15] Additionally, Microsoft and Facebook have very different financial characteristics. According to the Compustat database, in 2017, Microsoft hired nearly five times as many employees as Facebook; Microsoft's total assets are more than double those of Facebook; Microsoft's ROA was 6.27%, whereas Facebook's ROA was 27%. Given the profound differences, it would be very difficult to categorize the two firms as competitors based on characteristic similarities. This contrasts with a cognitive consensus that Microsoft and Facebook are close competitors on multiple fronts (Tweh and Riley, 2021). Such competitive dynamics are critical but are dismissed by the characteristic-based method.

To address the shortcomings of the conventional methods, we propose a methodologically novel approach to identifying competitors and strategic groups using news co-mention networks. The proposed methodology extends Kennedy's (2008) propositions regarding co-mention networks by incorporating the concept of structural equivalence to identify competitors. Importantly, we use actual corporate events (outcome of executives' cognitive process), expressed views of executives or journalists and reported changes in the operating environment. We test the validity and robustness of our proposed methodology using a sample of the US high-tech sector.

A comparison between characteristic-based approach and co-mention-based approach

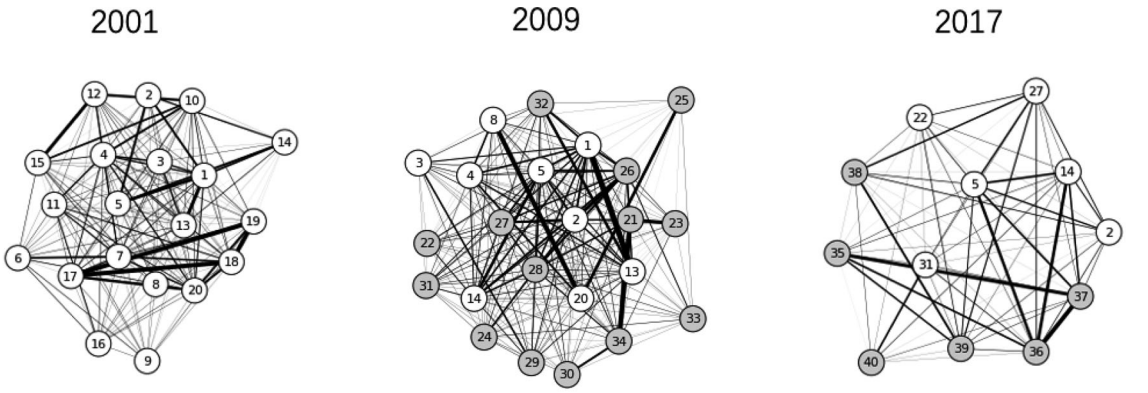
Our empirical tests yield three significant findings. First, the co-mention-based strategic group solution exhibits intra-group similarities and inter-group differences in five key strategic dimensions; however, the differences are weaker in terms of valuation and performance. Second, the co-mention similarities and the co-mention-based groups are strongly correlated with the competitive inclination between the two firms. Third, characteristic similarities have very limited explanatory power regarding competitive inclination.

Recent research raises doubts concerning the validity of characteristic-based approaches (Carroll and Thomas, 2019; Cattani, Porac and Thomas,

[13]See online Appendix 2 for further analysis presenting the features of the news co-mention-based approach in capturing cross-industry competition and time-variant competitive dynamics.

[14]See Microsoft official website: https://support.microsoft.com/en-gb/allproducts

[15]In 2019, 98% of Facebook's total revenue was from advertising (Iyengar, 2020).



Label	Company name	SIC	Label	Company name	SIC	Label	Company name	SIC
1	INTEL CORP	3674	15	MAXIM INTEGRATED PRODUCTS	3674	29	SANDISK CORP	3572
2	INTL BUSINESS MACHINES CORP	7370	16	ATMEL CORP	3674	30	CITRIX SYSTEMS INC	7372
3	MICRON TECHNOLOGY INC	3674	17	PMC-SIERRA INC	3674	31	EBAY INC	7370
4	TEXAS INSTRUMENTS INC	3674	18	VITESSE SEMICONDUCTOR CORP	3674	32	NVIDIA CORP	3674
5	MICROSOFT CORP	7372	19	APPLIED MICRO CIRCUITS CORP	3674	33	BROCADE COMMUNICATIONS SYS	3576
6	LATTICE SEMICONDUCTOR CORP	3674	20	BROADCOM CORP	3674	34	VMWARE INC -CL A	7373
7	XILINX INC	3674	21	EMC CORP/MA	3572	35	TWITTER INC	7370
8	QUALCOMM INC	3674	22	ADOBE SYSTEMS INC	7372	36	ALPHABET INC	7370
9	TRIQUINT SEMICONDUCTOR INC	3674	23	NETAPP INC	3572	37	FACEBOOK INC	7370
10	ANALOG DEVICES	3674	24	JUNIPER NETWORKS INC	3576	38	WORKDAY INC	7372
11	CYPRESS SEMICONDUCTOR CORP	3674	25	EMULEX CORP	3576	39	SALESFORCE.COM INC	7372
12	LINEAR TECHNOLOGY CORP	3674	26	HP INC	3570	40	PAYPAL HOLDINGS INC	7374
13	ADVANCED MICRO DEVICES	3674	27	ORACLE CORP	7372			
14	APPLE INC	3663	28	CISCO SYSTEMS INC	3576			

Figure 1. The evolutionary path of Microsoft-centred co-mention-based strategic groups from 2001 to 2017. Note*: The figure plots the changes of Microsoft-centred strategic groups where firms are connected by co-mention similarity from 2001 to 2017. The nodes represent firms. The width of edges represents the co-mention similarity between two firms – a wider edge suggests a greater similarity between the firms. New firms appearing in the groups are marked in grey. For example, EMC CORP/MA was not in the 2001 group, yet it appeared in the 2009 group. Hence, it is marked in grey in the latter group.*

2017). As Carroll and Thomas (2019, p. 507) note: 'strategic groups are supposed to capture the structure of rivalry in the industry, and the structure of some industries simply would not generate differences in performance'. Our findings support and extend this argument by demonstrating that it applies more broadly as the co-mention-based groups display weak differences in between-group performance but demonstrate a strong correlation with competitive inclination.

A comparison between conventional cognitive approach and co-mention-based approach

To illustrate the difference between the co-mention-based approach and the conventional managerial cognition-based approach, we further elaborate with the Microsoft example. In Figure 1, we demonstrate Microsoft-centric groups based on the co-mention-based approach in three different years (2001, 2009 and 2017). And Table 10 compares the competitors identified by co-mentions and those that are identified in the 'Competition' section of the company's annual reports (i.e. 10-K filings), representing the views solely from a managerial perspective.[16]

We have two observations. First, as shown in Figure 1, the Microsoft-centred strategic groups experienced dramatic changes from 2001 to 2017, in terms of group size and group membership, showing that our group solution captures the dynamism of firms' competitive environment. This

[16]In online Appendix 3, we provide a further analysis on the difference between the co-mentioned-based competitors and competitors identified from the 10-K filings.

Table 10. Comparison between the conventional cognitive approach (10-K competitors) and the news co-mention-based approach

	10-K competitors only	News co-mention-based competitors only	Overlap
2001	Sun Microsystems, Oracle, AOL, Corel, Qualcomm, Hewlett-Packard, Computer Associates, Sybase, Informix, Yahoo!, Excite, Lycos, Infoseek, AltaVista, CNN, Fox, Vivendi (Havas), Intuit, Electronic Arts, The Leaning Company, Infogrammes, Logitech, Disney, LucasArts, Nintendo, Sony, Electronic Arts, Namco, Midway, Activision, Konami, THQ, Palm, Nokia, Openwave, Wind River, Red Hat, Lineo, Monta Vista, Travelocity.com, Hotel Reservations Network, Priceline.com, CheapTickets.com, Biztravel.com, Worldres.com, Trip.com, United.com, Delta.com, Marriott.com, Orbitz, Hotwire, Autobytel, CarsDirect, Pearson, WROX, Sybex, Wiley, Smartforce, NetG	Intel, Micron Technology, Texas Instruments Inc., Lattice Semiconductor Corp., Xilinx Inc., Qualcomm Inc., Triquint Semiconductor Inc., Analog Devices, Cypress Semiconductor Corp., Linear Technology Corp., Advanced Micro Devices, Maxim Integrated Products, Atmel Corp., PMC-Sierpa Inc., Vitesse Semiconductor Corp., Applied Micro Circuits Corp., Broadcom Corp.	IBM, Apple
2009	Canonical, Red Hat, Google, Mozilla, Opera Software Company, Sun Microsystems, Novell, Red Hat, Oracle, CA, Inc., BMC, McAfee, Symantec, Trend Micro, Borland, SAP, AOL, Yahoo!, Corel, Zoho, 37Signals, AjaxWrite, gOffice, ShareOffice, Socialtext, ThinkFree, Salesforce.com, Autonomy, Endeca, Nintendo, Sony, Nokia, Openwave Systems, Palm, Research in Motion, Metrowerks, MontaVista Software	Micron Technology, Texas Instruments, Advanced Micro Devices, Broadcom, EMC, NetApp, Juniper Networks, Emulex, Oracle, Sandisk, Citrix Systems, eBay, NVIDIA, Brocade Communications Systems	Apple, HP, Intel, IBM, VMware, Adobe, Cisco
2017	Cisco, SAP, Infor, The Sage Group, NetSuite, HP, CA Technologies, Oracle, BMC, VMware, Amazon, Sony, Nintendo, Electronic Arts, Activision Blizzard	eBay, Twitter, Workday, PayPal	Adobe, IBM, Apple, Oracle, Alphabet, Facebook, Salesforce.com

is in line with the recent developments in strategic group research that adopt a more dynamic view (e.g. Combe *et al.*, 2012; DeSarbo, Grewal and Wind, 2006; DeSarbo, Grewal and Wang, 2009; Lee, Lee and Rho, 2002; Shelegia, 2012; Wu and Olk, 2014). Second, as shown in Table 10, while some competitors are identified by both approaches (e.g. IBM and Apple), there are also notable differences. One example is Intel, which in 2001 was identified as a competitor to Microsoft by the co-mention-based approach but was neglected in Microsoft's annual report in the same year. Then, Intel appears in Microsoft's 2009 annual report, confirming their competitive relationship. Such examples show that our approach (including third-party cognition) supplements the conventional cognitive method, potentially moderating managers' cognitive limitations.

Contribution and implications

In several ways our research contributes to the literature. First, we yield a significant methodological contribution by using relational similarities rather than characteristic similarities in identifying competitors and strategic groups, addressing the theoretical concerns that strategic groups are statistical artefacts. Second, our methodology extends cognitive strategic groups beyond their current confines. The proposed approach provides an alternative, combining outcomes of managers' cognitive processes in the shape of actual corporate events, expressed views of executives or journalists and reported changes in the operating environment. The proposed methodology addresses the key criticism ascribed to conventional cognitive approaches including scale, replicability and to a degree cognitive blind spots. Third, by analysing competitions across different industries within a sector, we widen the conventional scope where strategic groups are analysed within a narrowly defined industry, providing a viable means to investigate competition in largely populated industries or multiple industries within a sector. Finally, yet importantly, our novel use of news – incorporating the concepts of structural equivalence and news co-mentions in identifying competitors and strategic groups – arguably has implications beyond strategic group research and addresses the over-reliance of management research on surveys and interviews.

This study also has important implications for practitioners. A firm's competitive strategy is profoundly shaped by its understanding of its competitive environment. Managers failing to recognize real competitors could formulate inappropriate strategies, leading to unattractive outcomes. The co-mention-based approach provides managers with a methodology that they can readily deploy as part of their environmental scanning routine, to continuously and comprehensively evaluate their firms' competitive environment. This in turn is likely to aid managerial decision-making, resulting in better strategy formulation.

Limitations and future research

The proposed approach provides an alternative avenue to explore competitors and strategic groups; nevertheless, it has limitations. First, like managers, journalists are subject to their own biases, such as sensationalism, which could produce pseudo connections between weakly linked firms.[17] It can be intriguing for future studies to investigate the differences and interplays between managers' and journalists' cognitions. Second, using stock tickers provided by DJNS to identify firms mentioned in the news inevitably limits our research scope to public firms and firms with news coverage. Future research could apply textual analysis to the news for company identification, thus extending the analysis to private firms. Third, in this study we focus on 'fixed' strategic groups as we aim to identify 'comparable' firms. In other words, a firm can appear only in one strategic group. Future research could explore 'flexible' strategic groups, allowing overlaps between groups by using the similarity score provided in this research (for possible approaches, see online Appendix 4). Lastly, although we focus on a set of selected news topics, the specific relationships between the co-mentioned firms

[17]Here we carefully note the differences between personal biases (e.g. managers' competitive blind spots) and systemic biases (journalists' biases) resulting from social, cultural or institutional differences (Degravel, 2015). The conventional cognitive literature relying on surveys or interviews is subject to managers' personal biases driven by their idiosyncraticcognitive processes and psychological characteristics, whereas this paper infers firm connections from numerous news articles; hence, the results are less likely to be affected by personal biases but systemic biases due to reasons such as social categorization (Park and Westphal, 2013).

are not clear. Further research may use techniques such as knowledge graphs to decode the relationships between firms, drawing a more accurate picture of firms' competitive landscapes.

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Supporting Information

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