

The International Journal of Human Resource Management

ISSN: 0958-5192 (Print) 1466-4399 (Online) Journal homepage: <http://www.tandfonline.com/loi/rjih20>

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To cite this article: Jana Oehmichen, Mariano L. M. Heyden, Dimitrios Georgakakis & Henk W. Volberda (2016): Boards of directors and organizational ambidexterity in knowledge-intensive firms, *The International Journal of Human Resource Management*, DOI: 10.1080/09585192.2016.1244904

To link to this article: <http://dx.doi.org/10.1080/09585192.2016.1244904>



Published online: 26 Oct 2016.



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Boards of directors and organizational ambidexterity in knowledge-intensive firms

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ABSTRACT

We examine the relation between boards of directors' knowledge heterogeneity and organizational ambidexterity (OA) (i.e. simultaneous exploration and exploitation) in knowledge-intensive firms (KIFs). Although the literature on OA has started to emphasize its antecedents, the role of the board remains unaddressed. This is an important omission, as boards have become increasingly involved in strategy-making. In turn, studies on boards have looked at their influence on either exploration- or exploitation-type strategies. Yet, KIFs particularly need to balance both exploration and exploitation to renew their knowledge base. We draw on knowledge-based perspectives to disentangle the benefits and costs of board knowledge heterogeneity for driving OA in KIFs. Our empirical analysis based on a longitudinal panel of UK pharmaceutical firms provides support for our hypothesized U-shaped relation. Our findings suggest that the benefits of knowledge heterogeneity only outweigh the costs beyond a particular threshold. Overall, our theoretical approach and allied findings advance the literature by introducing boundary conditions to the resource provision role of boards in KIFs. We discuss contributions for organizational learning, strategic leadership, and human resource management. We conclude with implications for theory and practice, as well as key opportunities for future research.

KEYWORDS

Ambidexterity; boards of directors; content analysis; heterogeneity; knowledge-intensive firms; pharmaceutical industry

Introduction

Knowledge is considered the defining source of competitive prowess of our generation (Grant, 1996). Accordingly, knowledge-intensive firms (KIFs) have featured as key drivers of global economic growth (Alvesson, 1993; Von Nordenflycht,

2010). Yet, intensifying global competition has diminished the returns to the established knowledge base of KIFs. Increasingly, profitable product lines are reverse-engineered and replicated at lower cost (Lieberman & Asaba, 2006), high-skilled/low-cost global players capture fast-emerging markets (Luo et al., 2011) and variable intellectual property regulations in global markets impair KIF's ability to secure returns on their proprietary knowledge (Cohen & Kaimenakis, 2007). To compete in today's global business arena, KIFs need to renew their knowledge base by continuously exploring new knowledge for developing innovative products and services, while simultaneously exploiting their established competencies to improve current offerings.

Exploration and exploitation are two fundamental organizational learning strategies to renew the knowledge base of the firm (March, 1991). Exploration strategies are supported by behaviors such as risk-taking, opportunity-seeking, experimentation, and innovation. Exploration tends to have a more long-term and uncertain payoff structure, but helps rejuvenate the knowledge base of the firm. Exploitation in turn is fueled by incremental fine-tuning, variance-reduction, and efficiency-seeking behaviors. Returns to exploitative strategies tend to be more predictable in the short term, but the supporting activities reduce adaptability by reinforcing the established knowledge base. Given the different payoff structures of these learning strategies, scholars have shown that firms that are dexterous at *both* learning strategies tend to be more innovative, globally competitive, and improve their chances of long-term survival (Piao, 2010). However, due to the paradoxical nature of these activities, organizations often over engage in one at the expense of the other (Levinthal & March, 1993), often to their own detriment (Wang & Li, 2008).

Bustling literature on organizational ambidexterity (OA) has sought to examine the mechanisms through which firms can simultaneously explore and exploit (see O'Reilly & Tushman, 2013; Raisch & Birkinshaw, 2008; Simsek, 2009; Turner, Swart, & Maylor, 2013 for overviews of this literature). Early studies established the case for the importance of OA by emphasizing its outcomes (e.g. He & Wong, 2004). More recently, academic discourse has shifted to the antecedents of OA at the industry (e.g. Jansen, Van den Bosch, & Volberda, 2005), firm (e.g. Jansen, van den Bosch, & Volberda, 2006), business unit (e.g. Yitzhack Halevi, Carmeli, & Brueller, 2015), and senior manager level (e.g. Jansen, George, Van Den Bosch, & Volberda, 2008). Notably absent from this discussion, however, is the board of directors. This is a key omission, as the board of directors represents the highest level of strategic leaders entrusted with safeguarding the well-being of the organization (Forbes & Milliken, 1999; Triana, Miller, & Trzebiatowski, 2014). Addressing this gap, we seek to introduce the board of directors as an important, yet previously omitted, antecedent of OA. We seek to offer several contributions with our approach.

First, we contend that the board is an important micro-foundational antecedent of KIFs' ability to pursue both exploration and exploitation (Polanyi, 1966;

Starbuck, 1992). We build on studies showing that boards have become more actively involved in strategy-making by setting strategic priorities, contributing heterogeneous knowledge resources from outside the firm, and defining the scope of task-discussions (Hendry, Kiel, & Nicholson, 2010; Mínguez-Vera & Martin, 2011). Although literature on OA has started to address the influence of other strategic leaders, such as senior (e.g. Yitzhack Halevi et al., 2015) and middle managers (e.g. Burgess, Strauss, Currie, & Geoffrey, 2015; Chang & Hughes, 2012), to our knowledge, only two studies have looked at the link between boards and exploration/exploitation more generally (Heyden, Oehmichen, Nichtig, & Volberda, 2015; Walrave, van Oorschot, & Romme, 2011). Advancing this nascent sub-stream of inquiry into OA, we add that boards of directors play a distinctive role in shaping the extent to which exploration and exploitation are integrated in strategy. Incorporating boards ultimately helps us advance a more comprehensive picture of how strategic leaders across the hierarchy influence OA (Bledow, Frese, Anderson, Erez, & Farr, 2009; Simsek, 2009).

Second, we contribute by proposing and testing a U-shape association between board knowledge heterogeneity and OA. Highlighting the complex nonlinear link between boards and OA is an important contribution, as previous studies have only examined how the board influences either exploratory *or* exploitative strategies. For instance, board heterogeneity has been associated with exploratory types of strategic outcomes such as new market entry decisions (Diestre, Rajagopalan, & Dutta, 2015), entrepreneurial focus (Tuggle, Schnatterly, & Johnson, 2010), and strategic change (Haynes & Hillman, 2010). Board characteristics have also been linked to exploitation type outcomes such as downsizing decisions (Yawson, 2006), divestiture intensity (Hoskisson, Johnson, & Moesel, 1994), and restructuring (Abor, Graham, & Yawson, 2011). Our theorized U-shape association between board knowledge heterogeneity and OA allows us to consolidate these findings by unearthing threshold effects in the relation between board composition and OA.

Third, although studies often emphasize the benefits of knowledge heterogeneity of boards (Heyden, Oehmichen, et al., 2015; Tuggle, Schnatterly, & Johnson, 2010), we add nuance to these insights by co-theorizing the 'costs' of integrating knowledge across heterogeneous functional boundaries (Bechky, 2003; Carlile, 2002, 2004). In particular, although the board's heterogeneous knowledge resources can improve the quality of decisions (McDonald, Westphal, & Graebner, 2008), expand the richness of solutions developed (Jackson, 1992), and increase comprehensiveness of short-term and long-term issues covered (Tuggle et al., 2010), combining heterogeneous knowledge often incites conflict, slows decision speed, and increases polarization in decision behaviors (Nielsen & Nielsen, 2013). Our study provides important insights into both costs and benefits of knowledge heterogeneity of the board and allows us to inform scholars and practitioners on the implications of board-level configurations in KIFs.

Conceptual background and hypothesis

OA in knowledge-intensive firms

'Knowledge intensity indicates that production of a firm's output relies on a substantial body of complex knowledge' (Von Nordenflycht, 2010, p. 159). To leverage this complex knowledge, KIFs are characterized by particular human capital needs (Swart & Kinnie, 2003b), features of innovation processes (Swart & Kinnie, 2003a), and structural arrangements (Jansen, Tempelaar, Van den Bosch, & Volberda, 2009). These interrelated properties pose particular demands for integrating simultaneous exploitation and exploration at the highest level of strategy.

The human capital needs are driven by the fact that work in KIFs is highly intellectual in nature (Alvesson, 2000; Swart & Kinnie, 2003b). Knowledge workers have a strong need for autonomy (Von Nordenflycht, 2010) and KIFs need to prescribe boundaries to achieve strategically aligned behaviors (Mom, Van den Bosch, & Volberda, 2009), while at the same time stimulating the autonomy necessary for fresh ideas that challenge the status quo (Burgelman, 1983). Their innovation process in turn requires explorative mechanisms to identify and support promising new products (Vassolo, Anand, & Folta, 2004), while simultaneously having exploitative filters to terminate unsuccessful product streams and avoid escalation of commitment (Boulding, Morgan, & Staelin, 1997). Structurally, KIFs rely on an intricate mix of coordination mechanisms to manage cross-functional knowledge across hierarchical interfaces (Mom, Van den Bosch, & Volberda, 2007). Therefore, KIFs need structures that are sufficiently formalized as to gain exploitation benefits (Jansen et al., 2006), as well as sufficiently flexible to explore knowledge recombination opportunities across functional domains (Jansen et al., 2009).

As the aforementioned characteristics of KIFs coexist in intricate ways and have long-term implications for the well-being of the organization, how they are consolidated in organizational strategy requires input and approval from their boards of directors.

Boards of directors and OA

Boards function as a mechanism for aligning the organization with its environment at the highest level of strategy (Boyd, 1990). Boards bring new and valuable tacit knowledge to strategy through the functional expertise of non-executive directors as they 'inform firm strategy with insights about opportunities and threats residing in blind spots (e.g. changing consumer preferences), assist in identifying weak signals in the environment (e.g. emerging technologies), act as early-warning system for imminent changes (e.g. regulatory), and provide assessments and judgments of best practices. (e.g. new ways of working)' (Heyden, Oehmichen, et al., 2015, p. 156). However, knowledge heterogeneity has been shown to have both benefits and costs.

Upsides of board knowledge heterogeneity for OA

Studies have shown that heterogeneity in characteristics of boards is crucial for understanding how their knowledge resources influence strategy (Minichilli, Zattoni, & Zona, 2009). Boards embody tacit knowledge accumulated through the dominant expertise of their directors in different organizational functions (Heyden, Oehmichen, et al., 2015). Heterogeneity in functional expertise of the board has particularly been shown to enable boards to provide the firm with broader expertise, perspectives, and skills (Zoogah, Vora, Richard, & Peng, 2011).

Board knowledge resources stemming from expertise in organizational functions can be classified into two higher order dimensions of task orientations (Hambrick & Mason, 1984). 'Output' orientations stem from expertise in domains such as marketing, sales, and product R&D that focus attention on growth, customer demands, and emphasize the search for new market opportunities 'Throughput' orientation follows from experience in functions such as production, process engineering, and accounting where the emphasis is on the internal organization and on improving how the organization turns inputs into output. An output-oriented emphasis ensures that opportunities for growth are taken into account (exploration), whereas throughput orientation ensures that efficiency is not disregarded (exploitation).

Board functional knowledge heterogeneity compels members to undertake more in-depth discussions and more elaborate decisions. As a result, more heterogeneous groups tend to devise multiple viable solutions for the same issue (Heyden, van Doorn, Reimer, Van Den Bosch, & Volberda, 2013). Dealing with multiple issues simultaneously improves cognitive processing and allows the group to integrate a more varied range of possible solutions (Judge & Miller, 1991). From the aforementioned interpretation, functionally heterogeneous boards can be expected to be more inclined to prioritize simultaneous consideration of long- and short-term issues, while also being more adept at coming up with diverse solutions to creatively synthesize the contradictory demands of exploration and exploitation.

Downsides of board knowledge heterogeneity for OA

The heterogeneous functional knowledge that boards embody is largely tacit. As a result, deeply rooted assumptions only become evident as members engage in task discussions and are forced to elaborate and clarify their distinctive beliefs to dissimilar others. These disclosures highlight the different perspectives of each board member concerning the content and timeline of issues that need to be prioritized (Triana et al., 2014). Indeed, functional heterogeneity may inhibit internal task processes within a team due to different thought worlds (Dougherty, 1992) and can translate into communication problems, interpersonal conflicts, high turnover in the group, and reduced willingness to cooperate (Ali, Kulik, & Metz, 2011). Heterogeneity is thus often associated with interactional difficulties and reduced levels of behavioral integration (Milliken & Martins, 1996).

In addition, heterogeneous teams tend to be slower in their decision-making (Hambrick, Cho, & Chen, 1996), which can limit 'the board's ability to take timely strategic action' (Goodstein, Gautam, & Boeker, 1994, p. 246). Yet, strategic decisions are often uncertain and decision-makers have to adjust swiftly by incorporating performance feedback (Stern, 1989). Slower decision-making reduces the frequency of performance feedback, making it more difficult for decision-makers to counterbalance tendencies towards over-exploration or over-exploitation in a timely fashion (Lungeanu, Stern, & Zajac, 2016; Maslach, 2016). Indeed, evidence suggests that short cycles of performance feedback, as a result of swift decision-making, can accumulate into a better balance of long- and short-term decisions (Ben-Oz & Greve, 2012), while simultaneously improving the quality of exploratory (e.g. forward-looking patents; Khanna, Guler, & Nerkar, 2016) and exploitative (e.g. restructuring; Vidal & Mitchell, 2015) decisions.

Consolidating effects of board knowledge heterogeneity on OA

The literature on knowledge coordination has highlighted that cross-functional groups often incur coordination costs without achieving the prospective benefits (Ben-Menahem, von Krogh, Erden, & Schneider, 2016; Majchrzak, More, & Faraj, 2012). Indeed, groups may face several challenges at differing degrees of heterogeneity. When groups have low to moderate levels of heterogeneity, they are likely to come up with a more restricted, but more polarized, set of solutions (Heyden et al., 2013; Lau & Murnighan, 1998). Polarized viewpoints can negatively affect the quality of decisions, as members search and emphasize information that reinforces their preferred positions, thus further dividing the group (van Knippenberg, De Dreu, & Homan, 2004). Hence, groups with moderate levels of heterogeneity either have difficulties to reach true consensus (Knight et al., 1999) or engage in consensus-seeking behaviors by basing decisions on mutually shared knowledge while omitting dissenting information (van Ginkel & van Knippenberg, 2008). As a result, the negative aspects of diverse knowledge mentioned above are more likely to occur at low to moderate levels of heterogeneity.

In turn, the beneficial aspects of heterogeneity are likely to occur at high levels of board heterogeneity. Although highly heterogeneous boards sometimes struggle to exchange and integrate knowledge across domains of expertise (Cannella, Park, & Lee, 2008), these differences drive them to elaborate and explain their distinctive perspectives and viewpoints when there is minimal overlap in functional understandings (i.e. high heterogeneity; van Knippenberg et al., 2004). Highly heterogeneous teams have 'few common bases for subgroup formation and social identity are likely to exist in [decision-making] groups with relatively high levels of diversity' (Richard, Barnett, Dwyer, & Chadwick, 2004, p. 256). This results in more information elaboration and richer discussions (Bezrukova, Jehn, Zanutto, & Thatcher, 2009), while also increasing the speed of cognitive processing (Judge & Miller, 1991), as members expand their cognitive frames to accommodate new insights from those with knowledge that is different from their own.

We suggest that board heterogeneity will have a nonlinear effect on OA. As heterogeneity increases from low to moderate degrees, conflict and disintegration challenges will constrain moderately heterogeneous boards to benefit from the variety of knowledge of dissimilar members. As such, the costs will outweigh the benefits of heterogeneity (Harrison & Klein, 2007). However, as levels of heterogeneity increase beyond the moderate threshold, board members are forced to develop synthesizing mechanisms through which they create a new common ground that incorporates discrepant insights. For example, as heterogeneity levels move from moderate to high, group members will learn to recognize the bounds of each other's distinctive knowledge by establishing bounds of who knows what (Heavey & Simsek, *in press*; Mell, van Knippenberg, & van Ginkel, 2014; Zhang, Hempel, Han, & Tjosvold, 2007), which allows members to dissect complex problems in more digestible bits.

Acknowledging and recognizing knowledge boundaries in the group allows highly heterogeneous boards to overcome potential subgroup formation and incorporate different perspectives to the task problem at hand, mitigating disruptive conflict and increasing the efficiency of processing of distributed information. In this range, the benefits of knowledge heterogeneity for OA become increasingly realized through more dexterous interpretations of strategy, as boards devise more creative solutions to integrate the paradoxical demands of exploration and exploitation. On this basis, we argue that highly heterogeneous boards will be better able to synthesize the diverse knowledge in exploring and exploiting organizational resources. Accordingly,

Hypothesis: There will be a U-shaped relationship between board functional knowledge heterogeneity and OA.

Data and definition of variables

Sample and research design

We tested our hypothesis on a longitudinal panel of publicly listed UK pharmaceutical firms from 2005 to 2009. Pharmaceutical companies are KIFs with large economic implications (Coff, 1999). Work in pharmaceutical companies is of highly intellectual nature (Alvesson, 2000; Swart & Kinnie, 2003b) and most workers have to be well educated and qualified (Swart & Kinnie, 2003b). These companies also engage actively in discovery and patenting activities (Khanna et al., 2016) and also have intricate global structures (Hess & Rothaermel, 2011). In 2009, the European pharmaceutical industry accounted for 30.6% of global pharmaceutical sales according to the consultancy firm Pharma Strategy Group, compared with 39.8% for North America of a total market value around 700 billion US\$ and CAGR of 7% between 2005 and 2010. Our data-set includes all publicly listed companies in the United Kingdom within the '21'-sector of the NACE Rev. Two classification systems are used in the European Union to classify economic

activities. This classification is comparable to the ‘283’ sector of the Standard Industrial Classification of the United States. Looking at the pharma industry in the UK is also appropriate, as UK firms are characterized by a one-tier board model, which has been shown to be a crucial condition for boards to influence strategy (Heyden et al., *in press*).

Data and measures

Organizational ambidexterity

As we have conceptualized ambidexterity as the simultaneous pursuit of exploration and exploitation in strategy, we operationalized OA as the multiplicative of exploration and exploitation, consistent with recent studies (e.g. Cao, Gedajlovic, & Zhang, 2009; Jansen, Simsek, & Cao, 2012; Mom, Fourné, & Jansen, 2015). We followed the operationalization of Heyden et al. (*in press*) to obtain separate scores for both exploration and exploitation first. This approach is based on a computer-aided text analysis of corporate documents (e.g. annual reports) and builds on an increasingly established approach to capture exploration and exploitation (e.g. Uotila, Maula, Keil, & Zahra, 2009; Volberda, Baden-Fuller, & Van den Bosch, 2001). As annual reports tend to comprise the most comprehensive overview of issues emphasized in the organization’s strategy and can reliably be compared across firms and over time ((Heyden, Sidhu, & Volberda, *in press*), we drew on the full textual input from annual reports corresponding to the firm-year observations in our sample. This approach is consistent with innovative developments in the broader field of strategic leadership to measure different aspects of strategy, such as the focus on entrepreneurial issues in strategy (e.g. Tuggle et al., 2010) and management innovation (Heyden, Sidhu, et al., *in press*).

We applied the validated dictionary of Heyden et al. (2015), which expanded and contextualized the search terms of March (1991), as applied in Uotila et al. (2009). Importantly in this operationalization is a contextually appropriate interpretation of exploration and exploitation in our empirical setting. In particular, Heyden et al. (2015, pp. 161–162) contextualized exploration in the European pharmaceutical industry as embracing activities such as the development of products (drugs, devices), services, and technologies, the entering of markets that are new to the firm, or a combination of both. Exploitation in this setting was contextualized as capturing activities like optimization, rationalization, and fine-tuning of existing drugs, services, and technologies for existing customers and families of drugs. The search dictionary is presented in Table 1.

Board knowledge heterogeneity

We operationalized board members as the group of non-executive directors for the UK. Membership to the boards was based on the directors listed in Boardex. Information of individual directors was aggregated using Blau’s index. Blau’s index is a function of the proportion (P) of members of the board in the k th category

Table 1. Search dictionary for content analysis.

Exploitation in European pharmaceutical industry	Exploration in European pharmaceutical industry
Exploit*, Certain*, Fast, React*, Refine*, Certification, Formalization, Reduction_of_costs, Cost_reduction, Choice, Clarity, Reliab*, Codification, Improv*, Restyl*, Efficiency, Commercial_alliance, Incremental_innovation*, Result_based_objective, Select*, Continu*, Local_search, Routin*, Implement*, Control*, Modular_production, Rules, Directives, Execute, Correct*, Operational_strateg*, Serial_production, Accelerat*, Customer_loyalty, Perfect*, Short_term, Adaption*, Deep_background, Planning, Shorten, Adjust*, Defend*, Practicality, Stabil*, Applied_research, Differentiat*, Precision, Standard*, Automat*, Execution, Predictability, Up-date, Aversion_to_risk, Procedure, Variant*, Bureaucr*, Programm*, Verification, Caution*, Existing, Prudence, Low_cost, Centraliz*, Rational*, Inertia, Shareholder_value, Short_run, Short_time_horizon, Speed, Proxim*, Current, Extens*, Blockbuster_revenue, Optimize, Streamline	Explor* Chang*, Freedom, Patent, Search*, Creative, Idea, Proactiv*, Variation*, Decentral*, Innovat*, R&D_alliance, Invent*, Development_programme*, Research_development, Experiment*, Discontin*, Long_term, Release, Play, Distant*, Low_codification, Revolution*, Flexib*, distant_search, Low_formalization, Slow_learning, Discover*, Diversif*, Low_standardization, Something_extra, Dynamic*, New, Spirit_of_initiative, Adventur*, Evolution*, Start_Up, Anticipat*, Expand*, Tacit_knowledge, Astound*, Transform*, Autonom*, Fantasy, Uncertain*, Being_the_first, Far_beyond, Novel*, Vary, Break*_away, Forefront, Open_mentality, Wide_background, Diffus*, Long_run, Long_time_horizon, Adapt*, Stakeholder_value, Stress, Collaboration, Cooperation, Strength*_Pipeline, Expans*, Reposition*, Licensing, R&D_Outsourc*

(Harrison & Klein, 2007) and is formally defined $1 - \sum P_k^2$. We operationalized knowledge heterogeneity as proxied by board functional experience heterogeneity. We coded heterogeneity in predominant functional experience attributes along eight categories (1 = production and operations; 2 = R&D and engineering; 3 = accounting and finance; 4 = management and administration; 5 = marketing and sales; 6 = law; 7 = personnel and labor relations; 8 = other). This information was hand collected from publicly available sources. Index scores were only included when at least 75% of complete information was available.

Control variables

We controlled for board, firm, and ownership effects by adding the following variables to our multivariate analyses. To control for general board effects we included the natural logarithm of board size and the board members average tenure. The variables educational heterogeneity, age heterogeneity, tenure heterogeneity, and gender, controlled for additional board heterogeneity effects. We measured educational heterogeneity as the Blau index of board members highest education (Georgakakis & Ruigrok, *in press*; Nielsen & Nielsen, 2013), age and tenure heterogeneity with the respective coefficient of variation of age and tenure. Gender is coded as the percentage of female board members. Firm level controls include firm size, measured as the natural logarithm of the number of employees and firm age measure as natural logarithm of the number of years since foundation. Furthermore, we added financial leverage, return on assets as a measure of performance, and research and development investments. To control for firms' corporate governance structure beyond their board composition, we used the following two ownership variables: the percentage of stock owned by institutional investors and the percentage of stock owned by strategic investors. Board data

were hand collected, while Datastream and ThomsonOne were consulted for firm and ownership data.

Analysis and results

We analyzed the data using Generalized Estimating Equations. This multivariate technique is suitable in the event of non-independent observations and has been considered an emerging best practice in quantitative management research, as it accounts for both time-invariant ‘subject’ effects and auto-correlated, time-varying, ‘within-subject’ effects (Ballinger, 2004). This technique has further demonstrated its usefulness and versatility for longitudinal data structures commonly used in the broader strategic leadership literature (e.g. Chatterjee & Hambrick, 2007). We specified firm subject effect and treated the repeated annual observations as within-subject effects. Model fit was assessed based on the level and significance of the Wald’s chi-square and QIC statistics (Pan, 2001).

Multivariate results

Descriptives and correlations of all variables used are highlighted in Table 2. Our results in Table 3 support our hypothesis of the U-shaped relationship between board functional knowledge heterogeneity and OA. Additionally, the highest variance inflation factor is 7.32, well below the tolerated threshold of 10 (Hair, Anderson, Tatham, & Black, 1998). As Model 1 in Table 2 indicates, we do not find a significant linear effect of board functional knowledge heterogeneity on OA. However, the negative and significant coefficient of the linear term and the positive significant coefficient of the squared term allude to a nonlinear effect. To examine this, we followed the latest recommendations in the methodological literature and plotted our results (Haans, Pieters, & He, 2016). Figure 1 indeed depicts a U-shaping association, corroborating our hypothesis of a nonlinear U-shaped relationship between board functional knowledge heterogeneity and OA.

Discussion

In this study, we have examined the link between board of director knowledge heterogeneity and OA. We first briefly outlined the importance of OA for the specific strategic needs of KIFs, which has previously not been addressed. Next, we drew on the knowledge-based view that primarily accentuates heterogeneity’s benefits and research on knowledge coordination that has emphasized potential costs. As the sharing of knowledge is of special importance in KIFs (Swart, Kinnie, van Rossenberg, & Yalabik, 2014), we expect the heterogeneity of knowledge on the board to have a significant impact on strategy. Although heterogeneity can be expected to be beneficial for the quality of decisions (McDonald et al., 2008), it also has costs that can undercut its potential benefits. Integrating these streams

Table 2. Descriptive statistics.

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Organizational ambidexterity	.08	.03	1.00														
2. Board fct. experience heterogeneity	.36	.10	-.09	1.00													
3. Educational heterogeneity	.44	.14	-.20*	.36***	1.00												
4. Age heterogeneity	.16	.04	.00	.19*	.34***	1.00											
5. Tenure heterogeneity	.57	.21	.26**	-.16†	-.42***	-.21*	1.00										
6. Gender	.06	.09	.02	.18†	.05	-.21*	.06	1.00									
7. Leverage	.04	.08	.12	.02	.16†	.04	.02	-.14	1.00								
8. Performance	-.27	.80	.23*	-.18†	-.18*	-.08	.17†	.15	-.07	1.00							
9. R&D	.88	1.16	.31***	-.06	-.09	-.31***	.34***	.26**	-.02	.22*	1.00						
10. Institutional investors	.21	.19	-.18*	-.05	.02	.03	-.14	.12	.07	.04	-.24**	1.00					
11. Strategic investors	.16	.19	-.16†	-.11	-.01	.20*	-.07	-.22*	.13	-.10	-.49***	-.20*	1.00				
12. Board size (log)	2.01	.33	.14	-.21*	-.34***	-.34***	.46***	.08	-.03	.14	.72***	-.17†	-.30***	1.00			
13. Board tenure	5.80	2.67	.34***	.18*	-.10	.10	.26**	.01	.16†	.16†	.31***	-.11	-.14	.23*	1.00		
14. Firm age (log)	1.17	.46	.43***	-.13	-.24**	-.41***	.54***	.15	.17†	.21*	.56***	-.16†	-.33***	.42***	.47***	1.00	
15. Firm size (log)	5.06	2.47	.52***	-.12	-.24**	-.35***	.43***	.24**	.08	.32***	.78***	-.28**	-.23*	.52***	.49***	.72***	1.00

n = 120;

***p < .001; **p < .01; *p < .05; †p < .1.

Table 3. GEE regression results.

Method	Model 1	Model 2
	GEE	GEE
Dependent variable	Organizational ambidexterity	Organizational ambidexterity
Constant	.083* (.036)	.166*** (.036)
Board fct. experience heterogeneity	-.029 (.022)	-.316** (.100)
Board fct. experience heterogeneity (sqr)		.347** (.125)
Educational heterogeneity	-.030 (.019)	-.049* (.021)
Age heterogeneity	.170** (.058)	.182*** (.055)
Tenure heterogeneity	.009 (.009)	.006 (.008)
Gender	-.020 (.032)	-.030 (.033)
Leverage	.034* (.014)	.049** (.016)
Performance	.003 (.003)	.004 (.003)
R&D	-.004 (.005)	-.002 (.005)
Institutional investors	-.013 (.015)	-.011 (.016)
Strategic investors	-.040** (.013)	-.051*** (.012)
Board size (log)	-.016 (.013)	-.024* (.011)
Board tenure	-.001 (.001)	-.001 (.001)
Firm age (log)	-.002 (.007)	-.007 (.006)
Firm size (log)	.008*** (.002)	.008*** (.002)

Note: $n = 120$ firm-years. Standard errors in parentheses; time effects are included but not reported.

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .1$.

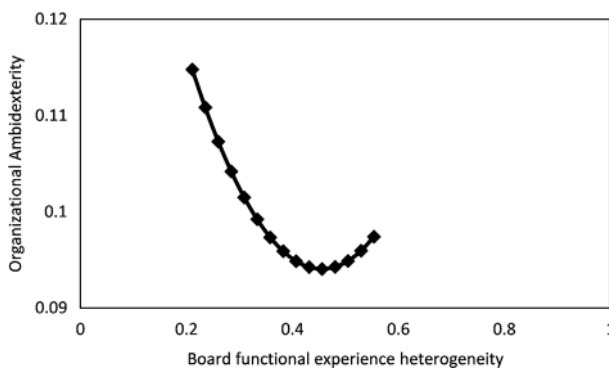


Figure 1. Effect of board functional experience heterogeneity on organizational ambidexterity.

of arguments, we hypothesized a U-shaped association between board knowledge heterogeneity and OA. However, the benefits of knowledge heterogeneity for OA only start outweighing the costs for boards that are highly heterogeneous. This

implies that bringing boards and their characteristics into the dialog on OA is important, especially in KIFs, as the literature on OA is incomplete if it does not take into account the group of strategic leaders who shape strategic priorities and are ultimately held accountable for its outcomes. Our theory and findings have several implications for theory and practice.

Contributions and implications

Organizational learning strategies in KIFs

First, we contribute to the literature on organizational learning in KIFs. We argued for the need of balancing exploration and exploitation as a fundamental requirement for KIFs to remain globally competitive. We argued that given the importance of learning for KIFs, OA needs to be embedded at the highest level of strategy. As the board of directors shapes firm strategy through the tacit knowledge resource they provide (Heyden, Oehmichen, et al., 2015), we theorized about benefits of knowledge provision and cost of knowledge coordination in defining an ambidextrous learning strategy for KIFs. Additionally, our study has implications for the strategic human resource management (SHRM) literature as it offers an integration of this literature with organizational learning in the context of KIFs (Sekiguchi, Bebenroth, & Li, 2011). This addition to the literature bolsters a complementary stream of literature that is increasingly focused on knowledge management and knowledge sharing in SHRM (Foss, Minbaeva, Pedersen, & Reinholt, 2009). Accordingly, our study also provides important insights for the recruitment and staffing stream of HR literature (see e.g. Collings & Mellahi, 2009). Recent studies demonstrate the increasing interest of HR research for appointment and dismissal decisions at the top levels of a firm's hierarchy (see e.g. Hamori & Kakarika, 2009; Oehmichen, Schult, & Wolff, [in press](#)). With respect to the recruitment and appointment of directors, KIFs could benefit from a deliberate recruitment of directors with varied functional backgrounds.

Strategic leadership antecedents of OA

We contribute to OA research by introducing boards as an underrepresented group of strategic leaders. We especially inform scholars and practitioners about key boundary conditions to the resource provision role of boards in relation to OA in KIFs. The role of the board has remained largely unaddressed prior to this study. Addressing this omission is essential, as boards define the strategic scope of the firm and are held accountable for long-term outcomes (Sundaramurthy, Mahoney, & Mahoney, 1997). Given the importance of OA for KIFs, they face a particular need to embed a learning focus that incorporates both exploration and exploitation at the highest level of strategy.

The extent to which boards embed a balance between exploration and exploitation is important because these strategies cascade throughout the organization to inform how contradictory forces are reconciled in a day-to-day realization

of strategy. We address a pressing need to understand the role of these strategic leaders in influencing OA in KIFs. As such, our study also contributes to OA literature in a broader sense as recent studies called for a more comprehensive understanding of interrelated multilevel antecedents of OA (Andriopoulos & Lewis, 2009; Bledow et al., 2009; Simsek, 2009), especially accounting for the board as an important microfoundation of OA (Bonesso, Gerli, & Scapolan, 2014).

Costs and benefits of board knowledge heterogeneity

Our study contributes to research about the impact of group composition, knowledge heterogeneity of boards in particular, but also of decision-makers in general. With respect to board heterogeneity we inform a field of SHRM that has largely overlooked the role of boards (Sanchez-Marin, Baixauli-Soler, & Lucas-Perez, 2010; Wang & Chiu, 2013). This is despite the fact that some scholars have argued that ‘the board of directors is an important mechanism in determining a firm’s strategies and aligning the interests of insiders, controlling shareholders and minority shareholders’ (Mínguez-Vera & Martin, 2011, p. 2852). There is consensus that heterogeneity within boards generally matters (e.g. Mínguez-Vera & Martin, 2011; Triana et al., 2014). However, our study integrates the potential upsides and costs of board heterogeneity. Understanding when we can expect the benefits of heterogeneity to outweigh the costs enriches the SHRM literature concerned with heterogeneity (e.g. Ng & Tung, 1998; Richard, Ford, & Ismail, 2006; Zoogah et al., 2011).

Boards of directors and strategy

Directors are increasingly held accountable for outcomes of strategy (Aguilera, 2005; Huse, 2005; Oehmichen, Schrapp, & Wolff, 2016; Roberts, McNulty, & Stiles, 2005). The increasingly important role of boards in strategy making is illustrated by recent studies stressing that inadequate governance and resource provisioning of directors can result in inefficient decision-making processes and low performance (Piekkari, Oxelheim, & Randøy, 2015; Schmidt, 2015). Therefore, studies have recognized the increasing importance of heterogeneity in board characteristics for understanding their accountability and responsibilities in firm strategy (Hillman, Nicholson, & Shropshire, 2008). However, the degree of involvement of boards in strategy has been shown to vary across different global settings (Filatotchev, Chahine, & Bruton, *in press*). Notwithstanding the current variety in strategic roles of boards observed across the globe (Heyden, Oehmichen, et al., 2015), boards are progressively expected to be involved in strategy through active provision of knowledge resources (Hillman & Dalziel, 2003), and are being increasingly held accountable for the quality and effectiveness of strategic decisions across the globe (Hendry & Kiel, 2004; Oehmichen et al., 2016). Accordingly, scholarly and policy inquiries into the board-strategy link can be expected to be a crucial area of growth for the future.

Managerial implications

Some managerial implication can also be drawn from our study. The tensions we have described have been variously described in organization and managerial literature as change versus preservation (Poole & van de Ven, 1989), adaptation versus selection (Lewin & Volberda, 1999), adaptability versus alignment (Gibson & Birkinshaw, 2004), and exploration versus exploitation (Jansen et al., 2009; March, 1991). Striking a balance between these tensions remains one of the most fundamental problems for strategically leading KIFs. One recommendation would be to systematically chart the tacit knowledge of the board to consider how new appointments can influence the collective knowledge heterogeneity of the group. Therefore, this study has important implications for director selection, since it demonstrates that varying functional expertise should become a more important criteria used during appointment. An actionable intervention when this is not immediately feasible could be for low-to-moderately heterogeneous teams to draw on knowledge from outsiders, such as independent advisors, to help put different options into perspective and help synthesize polarized viewpoints (Alexiev, Jansen, Van den Bosch, & Volberda, 2010; Heyden et al., 2013).

Limitations and future research

Our study is prone to several limitations that can pave the way for future research. First, we focus on boards with the underlying assumption that boards participate in shaping strategy, however, some studies show that this is not the case in all global contexts (Heyden, Oehmichen, et al., 2015). To maintain a tightly focused study, we did not include the role of other important strategic leaders such as executives and middle managers. Future research hence might want to respond to the general call for multilevel investigations in HRM research (e.g. Day & Harrison, 2007; Snape & Redman, 2010) and consider the effects of multilevel heterogeneity on OA and also investigate the impact of cross-level interaction. It might be feasible that the effects of heterogeneity on different hierarchical levels might substitute or complement one another (Heyden, Sidhu, et al., *in press*). Future research might want to test if our trade-off of knowledge provision and knowledge coordination costs caused by heterogeneity can also be observed at hierarchical levels other than the board and in other heterogeneity dimensions.

For example, a promising avenue for future research is to investigate how cultural differences among board members enhance or hinder the ability of a functionally diverse board to influence OA. Indeed, scholars have long argued that cultural differences significantly affect the way through which directors communicate and interact (Greve, Biemann, & Ruigrok, 2015; Piekkari et al., 2015), or even how executive members benefit from diverse international career experience and knowledge from a variety of countries (Georgakakis, Dauth, & Ruigrok, 2016; Georgakakis & Ruigrok, *in press*). Assessing the impact of cultural diversity on

the effect of boards on OA can therefore provide implications that are relevant for the broader field of strategy and international management.

Finally, there could be other contingencies that determine how board knowledge and diverse functional expertise influence OA. Scholars have recently stressed role of institutional context for the effectiveness of boards (Oehmichen et al., 2016) and for determining the role and impact of the board of directors (Filatotchev et al., *in press*; Ruigrok & Georgakakis, 2012; Yoshikawa, Zhu, & Wang, 2014). The role of boards in appointing and dismissing key executives (see e.g. Flickinger, Wrage, Tuschke, & Bresser, 2016; Georgakakis & Ruigrok, *in press*) to help execute ambidextrous strategies could also be further explored. In addition, although the board itself also plays a role as an internal governance mechanism, there is an increasing interest in external forms of governance that could influence the decisions made by strategic leaders (Aguilera, Desender, Bednar, & Lee, 2015; Bednar, 2012; Heyden, Kavadis, & Neuman, 2014), ultimately highlighting other pressures that may lead firms to over-explore or over-exploit.

In this study, we focused on pharmaceutical companies based in the UK, and therefore, our findings cannot necessarily be generalized to firms in countries with other corporate governance arrangement or board models (Heyden, Oehmichen, et al., 2015). In addition, we did not focus on the heterogeneous pathways and career experiences through which directors accumulate their tacit expertise and their abilities to become valuable contributors to the board (Georgakakis et al., 2016). Future research should further follow the call for multi-country corporate governance research (e.g. Aguilera & Jackson, 2003; Hüttenbrink, Oehmichen, Rapp, & Wolff, 2014) and therefore adopt multi-country samples beyond the UK to look into the effect of SHRM mechanisms such as compensation or high performance work systems to help extract the value, while minimizing the costs, of heterogeneous groups of strategic leaders. Finally, future studies could also consider looking separately at different dimensions of exploration and exploitation decisions (Nielsen & Gudergan, 2012; Sidhu, Commandeur, & Volberda, 2007; Stettner & Lavie, 2014).

Acknowledgments

We would like to thank the guest editors for their editorial guidance and two anonymous reviewers for their constructive feedback throughout the review process.

Disclosure statement

No potential conflict of interest was reported by the authors.

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