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Performance measurement systems as generators of cognitive conflict in ambidextrous firms

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Performance measurement systems
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Abstract

This study explores the decision-facilitating role of performance measurement systems (PMSs) in firms attempting to translate competence ambidexterity (i.e., the simultaneous pursuit of exploration and exploitation) into innovation ambidexterity outcomes (i.e., the achievement of both radical and incremental innovations). Drawing on paradox and organisational conflict literature, this study emphasises the role of cognitive conflict, generated by PMSs, in shaping the relationships between competence ambidexterity and innovation ambidexterity. Based on survey data from a sample of 90 Irish firms, our findings indicate that competence ambidexterity is associated with (a) the choice to have a balanced set of performance measures, and (b) the use of PMSs for frequent and intensive debate between top managers. Furthermore, the study reveals that these choices are interdependent, as they function as complements in generating cognitive conflict, which in turn drives the realisation of innovation ambidexterity outcomes. The results also show that cognitive conflict is not directly associated with the development of competence ambidexterity, but is instead generated through the conjoint action of a balanced PMS design and the use of PMSs for intensive debate. Overall, this study demonstrates the interdependent nature of choices concerning the design and use of PMSs, and the significant role of PMSs as generators of cognitive conflict in firms attempting to achieve ambidexterity.

Keywords: performance measurement systems; cognitive conflict; ambidexterity.

1. Introduction

An emerging stream of management accounting (MA) research emphasises the importance of performance measurement systems (PMSs) for firms engaged in innovation (Chenhall & Moers, 2015; Davila, Foster, & Oyon, 2009; Moll, 2015). By incorporating a broad set of financial and non-financial measures, PMSs are able to reflect the wider span of activities and longer time horizons typically associated with innovation. This facilitates the achievement of innovation objectives by increasing the relevant information available for managerial decision-making (Grafton, Lillis, & Widener, 2010). Most of the literature in this area has been concerned with how PMSs are designed and used when managers face a consistent set of innovation priorities (Bisbe & Otley, 2004; Cardinal, 2001; Ylinen & Gullkvist, 2014). Firms are, however, increasingly pursuing ambidextrous innovation strategies that involve managing tensions and trade-offs between multiple and contradictory objectives (Birkinshaw & Gupta, 2013; Jansen, Simsek, & Cao, 2012). But as yet there is little empirical understanding of how PMSs are designed and used in these settings or of the psychological and organisational mechanisms through which PMSs enable ambidextrous innovation outcomes to be realised.

As organisational scholars observe, realising ambidexterity is one of the most complex challenges faced by managers (Atuahene-Gima, 2005; Birkinshaw & Gupta, 2013). Ambidextrous firms attempt to achieve both incremental and radical innovation outcomes by pursuing a strategic agenda that requires learning new competences and opportunities (i.e., exploration) while at the same time refining existing competences (i.e., exploitation). However, whether firms that develop competences in both exploration and exploitation simultaneously (referred to as *competence ambidexterity*) are able to effectively generate actual product and service innovations is far from unproblematic (Lin et al., 2013). The patterns of learning associated with exploration and exploitation tend to be self-reinforcing often to the exclusion of one another (Levinthal & March, 1993; March, 1991), while group and individual cognitive biases privilege consistency in decision-making over inconsistency (Smith & Tushman, 2005). These tendencies make translating competence ambidexterity into both incremental and radical innovations (known as *innovation ambidexterity*) extremely difficult to achieve, as there is a natural inclination for managers to make decisions that favour one objective over the other (Birkinshaw & Gupta, 2013; Lin et al., 2013). Without the implementation of structures and processes to counteract these tendencies, firms are likely to fail to achieve intended ambidexterity outcomes (Kortmann, 2014). O'Reilly and Tushman (2013, p. 333) recognise that "not all firms that attempt to be ambidextrous are successful", and point out that much more research is needed to know what distinguishes among those firms

that are unsuccessful and those that are able to simultaneously achieve competing objectives (see also Birkinshaw & Gupta, 2013; Lavie, Stettner & Tushman, 2010). While prior research considers PMSs to be one such practice that is fundamental to the success of organisational innovation (Chenhall & Moers, 2015; Davila, Epstein, & Shelton, 2012), little is known about the role they play in influencing the ability of managers to effectively achieve competing objectives.

In this study we explore how PMSs are designed and used to facilitate top management team (TMT) decision-making in firms attempting to translate competence ambidexterity into innovation ambidexterity outcomes. Our focus is at the TMT level, as prior literature demonstrates that achieving ambidexterity outcomes is significantly influenced by the effectiveness of TMT's decision-making processes (Lubatkin, Simsek, & Veiga, 2006; Smith & Tushman, 2005). In particular, we consider the role of PMSs in counteracting biases in TMT decision-making towards incremental innovation, which have higher certainty and shorter-term payoffs relative to radical innovation (O'Reilly & Tushman, 2013; Smith & Tushman, 2005), and the mechanisms through which PMS function to facilitate the realisation of innovation ambidexterity outcomes. Specifically, we address three related issues.

First, we examine the design and use of PMSs by the TMT in firms emphasising competence ambidexterity. The few studies that have examined MA in an ambidexterity context focus on the different ways accounting is used to influence subordinate behaviour (i.e., diagnostic and interactive uses) (Bedford, 2015; McCarthy & Gordon, 2011). As such, how the PMS is designed (in terms of its information contents) and used (to facilitate information exchange between TMT members) in order to effectively cope with contradictory objectives, is largely unknown. Second, we investigate whether the design and use of PMSs have independent or interdependent effects in influencing the achievement of innovation ambidexterity. While most prior studies in an innovation context investigate accounting and control choices independently, a recent stream of literature argues that certain accounting practices may have complementary effects (Bedford, Malmi, & Sandelin, 2016; Grabner & Moers, 2013). To address this issue, we build upon the organisational literature on strategic contradictions and paradoxical cognition (Smith, 2014; Smith & Lewis, 2011; Smith & Tushman, 2005) to theorise how choices made by the TMT about the design and use of PMSs are interdependent. Finally, we seek to understand the mechanisms through which PMSs influence the achievement of innovation ambidexterity outcomes. Although prior research demonstrates associations between PMSs and organisational outcomes, such as firm performance, little attention has been given to

revealing how this occurs in practice (Chenhall, 2007). In this study we hypothesise that a central mechanism through which PMSs enable the realisation of innovation ambidexterity is cognitive conflict (Smith, Binns, & Tushman, 2010; Smith, 2014).

We test our expectations using cross-sectional survey data from a sample of 90 Irish firms operating in innovative industries. Our findings reveal that firms emphasising competence ambidexterity design their PMSs in a manner that provides a balance between measures which incentivise incremental innovation and those that provide visibility to radical innovation and, in addition, use the PMS in a way that fosters information sharing and ongoing debate between members of the TMT. We also show that the combined presence of a balanced PMS design and the use of the PMS for frequent and intensive debate among TMT members positively influence the realisation of innovation ambidexterity through the generation of cognitive conflict, which acts as a mediating variable. Furthermore, it is found that developing competence ambidexterity is insufficient in itself for cognitive conflict to be triggered, thereby emphasising a significant role for PMSs in ambidextrous firms. Overall, our study demonstrates the role of PMSs in counteracting organisational biases towards the shorter-term and more certain payoffs provided by incremental innovations through the generation of cognitive conflict, thereby facilitating the achievement of innovation ambidexterity.

This study contributes to the literature in three ways. First, we provide evidence on the design and use of PMSs in firms pursuing ambidexterity. In particular, we extend prior research investigating PMS design in firms that emphasise multiple strategic objectives (Dekker, Groot, & Schoute, 2013; Lillis & van Veen-Dirks, 2008), by showing that when firm objectives are contradictory, managers not only increase the diversity of measures in the PMS, but also increase the relative balance between measures that provide visibility to radical innovation efforts and those that encourage investment into more incremental outcomes. Second, we contribute to the small but growing literature investigating interdependencies between accounting and control practices (Bedford et al., 2016; Grabner & Moers, 2013). Prior literature provides little indication as to whether, and in what context, verbal and documented forms of accounting information might act as complements or substitutes (Hall, 2010). Our analysis shows that combining a balanced PMS design and an intensive use of PMS to stimulate debate is pivotal for effectively managing the tensions inherent in attempting to achieve innovation ambidexterity, as they function as complements to spark cognitive conflict within the TMT (Smith & Tushman, 2005). As such, this study reveals the capacity of PMSs to generate conflict, a role that has been generally neglected in prior literature (for an exception see Vaivio, 2004). Third, in examining the association between PMSs and cognitive conflict, this

study identifies one of the mechanisms through which PMSs influence organisation level outcomes. As Hall (2016) observes, even though many studies draw upon theories from psychology, few actually attempt to empirically examine the underlying cognitive processes. Our study contributes by demonstrating how the design and use of PMSs are implicated in realising ambidextrous innovation outcomes through the generation of cognitive conflict. Overall, the findings of this study highlight the relevance of PMSs for ambidextrous firms, and in particular, the role of PMSs as generators of conflict which enables firms to effectively translate competence ambidexterity into realised innovation outcomes.

The remainder of this study is structured as follows. Section 2 reviews the theoretical foundations of this study. We then describe the theoretical model and development of hypotheses in Section 3. Section 4 outlines the research method, with the empirical findings presented in Section 5. Section 6 discusses the findings and implications of this study, while Section 7 concludes.

2. Theoretical framework

2.1. Organisational ambidexterity

Ambidexterity refers to the capacity of an organisation to simultaneously and equally address multiple but contradictory objectives (Birkinshaw & Gupta, 2013; Simsek, 2009).[1] As the literature has developed, the conceptualisation of organisational ambidexterity has evolved into two distinct aspects. The first is *competence ambidexterity*, which is an approach to organisational learning that denotes the propensity (Jansen, Tempelaar, Van den Bosch, & Volberda, 2009), intention (He & Wong, 2004) or capacity (Gibson & Birkinshaw, 2004) to simultaneously develop competences or capabilities in exploitation (the ability to refine and extend existing knowledge, skills and processes) and exploration (the ability to generate entirely new knowledge, skills and processes) (March, 1991). Exploitation and exploration are associated with different organisational structures and processes that are based upon contradictory logics. While "exploration is rooted in variance-increasing activities, learning by doing,

[1] The literature on ambidexterity considers that the terms that define an ambidextrous duality are contradictory to the extent that their simultaneous pursuit pushes the organisation in opposing directions, creating tensions and necessitating trade-offs between competing demands. These tensions and trade-offs are exacerbated by the self-reinforcing nature of each opposing term of the duality. Yet, despite the opposing nature of the duality, this does not necessarily mean that they are impossible to achieve simultaneously. Ambidextrous firms are precisely those who manage to simultaneously achieve the two terms despite their contrasting nature (Birkinshaw & Gupta, 2013; O'Reilly & Tushman, 2013).

and trial and error, exploitation is rooted in variance-decreasing activities and disciplined problem-solving" (Smith & Tushman, 2005, p. 522).[2] The second aspect, *innovation ambidexterity*, relates to the simultaneous realisation of opposing organisational outcomes and, in particular, to the simultaneous achievement of incremental and radical innovations (He & Wong, 2004; Kortmann, 2014; Lin et al., 2013; Raisch & Birkinshaw, 2008). Incremental innovations refer to small improvements or extensions to existing products or services that build on the existing technological trajectory and require relatively minor changes, while radical innovations are completely new products or services that involve a shift to a different technological trajectory and require fundamental changes (Atuahene-Gima, 2005; Benner & Tushman, 2003). Achieving innovation ambidexterity is a significant challenge as it requires making appropriate trade-offs between short- and long-term objectives and effectively allocating scarce resources between competing priorities (Birkinshaw & Gupta, 2013).

Most prior studies have examined only one of these two aspects of ambidexterity, with only a few recent studies providing some evidence of a positive association between competence ambidexterity and innovation ambidexterity (Kortmann, 2014; Wang & Rafiq, 2014). Yet not all firms that attempt to be ambidextrous are actually successful (O'Reilly & Tushman, 2013); as explained in research on organisational resources and capabilities, it is not the presence of competences themselves, but their application and use under particular conditions that result in the realisation of intended firm outcomes (Lin et al., 2013). As Birkinshaw and Gupta (2013, p. 293) observe:

> We know some organizations are more ambidextrous than others, but for this insight to be valuable we have to take a more detailed look at the way they make their decisions, who gets involved in those decisions, and how those decisions are implemented

[2] An additional issue addressed in the literature is the difference between structural (e.g., Smith & Tushman, 2005) and contextual (e.g., Gibson & Birkinshaw, 2004) approaches to managing ambidexterity. Structural ambidexterity is achieved through the use of separate organisational units that are designed to meet the specific requirements of each strategy, whereas contextual ambidexterity refers to the use of behavioural and social means to integrate the disparate demands of different strategies. From the perspective of TMTs, both approaches entail achieving a balance between developing and integrating opposing strategic competences and achieving competing organisational outcomes (Simsek, 2009).

Therefore, an important area for research is to understand the structural attributes and psychological mechanisms that enable firms to translate simultaneous competencies in exploration and exploitation into innovation ambidexterity.

2.2. Managing contradictory demands

Some insight into how firms can manage contradictory strategic objectives is provided by the literature on organisational paradoxes. A paradox refers to contradictory yet interrelated elements that coexist simultaneously and persist over time (Cameron, 1986; Lewis, 2000; Smith & Lewis, 2011). Ambidexterity represents a paradox as it requires the TMT to simultaneously address opposing demands: focus versus experimentation, efficiency versus flexibility, refinement versus search, consistency versus divergence (Andriopoulos & Lewis, 2009, 2010; Fredberg, 2014; Smith, 2014; Smith & Tushman, 2005). This literature argues that the effective management of paradoxes involves embracing tensions by framing contradictions as "both/and" possibilities rather than "either/or" alternatives and by making such contradictions salient (Lewis, 2000, p 764; Smith & Lewis, 2011). To achieve this, TMTs in ambidextrous firms need to develop paradoxical cognitive frames that allow them to "not only recognize, appreciate, and embrace distinctions and contradictions between strategic agendas but also resist the natural inclination to reduce, suppress, or eliminate those distinctions" (Heavey & Simsek, 2017, p. 921).[3]

One consequence of recognising and engaging in the tensions underlying organisational paradoxes is conflict (Smith & Tushman, 2005). Conflict refers to a general perception of differences between ideas supported by opposing parties in situations where resources are scarce; one party perceives that its interests are being opposed or negatively affected by another (DeChurch & Marks, 2001), and parties compete against the opinions or initiatives of others (Chenhall, 2004). Prior paradox research indicates that intra-group conflict at the TMT level is higher in organisations that simultaneously engage in exploration and exploitation (Smith, 2014). Additionally, it is observed that firms which actively engage in conflict execute strategies involving paradoxical tensions – including ambidextrous strategies – more effectively than firms where the TMT attempts to avoid or suppress conflict (Eisenhardt & Westcott, 1988; Lewis, 2000; Smith et al., 2010; Smith, 2014; Smith & Tushman, 2005).

[3] Cognitive frames are mental templates provided by management tools, processes and practices that individuals impose on an environment to give it form. Cognitive frames create lenses that drive cognitive efforts (Smith & Lewis, 2011) and through which managers filter information and direct attention (Smith & Tushman, 2005).

The literature on organisational conflict recognises that there are different forms of conflict at the TMT level (Amason, 1996; Amason & Schweiger, 1994; De Dreu & Weingart, 2003; Jehn, 1995; Rahim, 2015). *Affective conflict*, or relational conflict, arises from perceived interpersonal incompatibilities, involves inter-personal tensions or disputes, and tends to be emotional in nature. *Cognitive conflict*, or task conflict, arises from the perception of disagreements about content and judgmental differences in viewpoints, ideas and opinions on how to realise a common objective. Cognitive conflict occurs in a TMT when its members argue over interpretation of facts, distribution of scarce resources, implementation of policies and strategies and in general, over alternatives related to the team's decision-making process. Research demonstrates that for teams facing complex and non-routine decisions, cognitive conflict is associated with increased understanding, higher commitment, better quality of decisions, and higher performance (Amason, 1996; Baron, 1991; Chenhall, 2004; DeChurch & Marks, 2001; Olson, Parayitam, & Bao, 2007; Parayitam & Dooley, 2009; Simons & Peterson, 2000).[4]

Despite the importance of conflict in firms engaged in paradoxical tensions, prior contingency-based studies that examine factors influencing the effective implementation of ambidextrous strategies have largely ignored the role of conflict. Although case-based studies have noted the presence of conflict in firms pursuing ambidexterity, they have not provided much insight into how it arises in the decision-making processes of TMTs or its effects. The absence of any consideration of the cognitive implications of paradoxical tensions and conflict applies in particular to studies that have examined the effects of PMSs in ambidextrous organisations.

2.3. Performance measurement systems and ambidexterity

A significant body of research demonstrates the beneficial role of PMSs for managing innovation when designed and used in certain ways (Bisbe & Malagueño, 2015; Chenhall & Moers, 2015; Davila et al., 2009). While recent research has begun to examine variations in the design and use of PMSs across different types of innovation (Bedford, 2015; Cardinal, 2001; Curtis & Sweeney, 2017; Grafton et al., 2010; McCarthy &

[4] For example, Amason (1996) finds that cognitive conflict improves the quality of decisions around complex tasks. Parayitam and Dooley (2009) show that cognitive conflict is positively related to both decision quality and decision commitment of the TMT, while Chenhall (2004) reports that cognitive conflict helps translate the implementation of activity-based costing management into beneficial firm outcomes.

Gordon, 2011; Ylinen & Gullkvist, 2014), little attention has been given to examining the role of PMSs in facilitating decision-making in contexts where managers need to address the contradictory demands of ambidextrous innovation strategies. In one of the few studies to do so, Bedford (2015) shows that both the balance and combination of diagnostic and interactive control uses of accounting information by the TMT are positively associated with performance in firms pursuing competence ambidexterity. He argues that an imbalance between diagnostic and interactive control uses will disrupt the dynamic tension needed to manage competing objectives (Simons, 1995). In contrast to Bedford's (2015) focus on the decision-influencing role of accounting information, this study is concerned with the design and use of PMSs that facilitate decision-making by TMTs attempting to manage the underlying tensions and contradictions inherent in the pursuit of ambidexterity. Specifically, we examine two PMS attributes.

In terms of PMS design, we are interested in examining attributes that relate to the substantive contents of what is measured and reported to TMTs. Studies have shown that when multiple strategic priorities are emphasised (e.g., both cost leadership and differentiation), firms choose to implement PMSs with a greater diversity of performance measures as they are considered to be more effective at directing effort and decisions toward the multiple strategic objectives pursued (Dekker et al., 2013; Lillis & van Veen-Dirks, 2008). However, simply increasing the number or diversity of performance measures may be problematic for firms pursuing ambidexterity. This is because the characteristics of many metrics commonly used to manage innovation (e.g., return on investment, number of new products launched, time-to-market, patent filings) tend to favour an emphasis on incremental innovations at the expense of radical innovation efforts (Anthony, Johnson, Sinfeld, & Altman, 2008; Davila et al., 2012). This tendency relates to the relative measurability of behaviours that increase the efficiency of existing products and operations compared to the more intangible nature of exploratory activities that increase the probability of success in the long-term (McCarthy & Gordon, 2011). Using such measures for target setting is also likely to crowd out radical innovation because incremental innovation provides easier, less risky ways for meeting or exceeding targets in the short-term (Anthony et al., 2008; Davila et al., 2012). Davila, Epstein, and Matusik (2004) maintain, however, that PMSs are still important for radical innovation as they "provide the underlying information to support the interaction needed to understand these intangibles" (p. 33). To do so we argue that the PMS must be explicitly designed with a balanced representation of measures to prevent the crowding out of radical innovation efforts.

The second attribute relates to how PMSs are used to facilitate information exchange and increase the effectiveness of decision-making processes by TMTs. Prior literature has emphasised the relevance of patterns of PMS use for successful innovation, by examining how managers use them in an enabling, interactive and learning-oriented manner (Ahrens & Chapman, 2004; Bisbe & Otley, 2004; Henri, 2006; Jorgensen & Messner, 2010; Simons, 1995). These studies demonstrate that the relevance of PMS for innovation is not solely a function of its information characteristics and form of presentation, but is also conditional on whether and how managers use this information (Hall, 2010; Simons, 1999). This is consistent with prior literature suggesting that interpersonal communication and intensive forms of information exchange, such as dialogue and debate, are important for coordination and knowledge integration when firms face equivocal and cognitively complex decision tasks, such as those experienced in the context of ambidexterity (Daft & Lengel, 1986; Ditillo, 2004).

3. Hypotheses development

In this section we develop hypotheses to explain the role of PMS design and use in translating competence ambidexterity into innovation ambidexterity outcomes by generating cognitive conflict within TMTs. First, we argue that firms pursuing competence ambidexterity will tend to design PMSs with a balanced set of performance measures (H1). Second, we contend that TMTs in firms pursuing competence ambidexterity are more likely to use the PMS as a basis for intensive debate (H2). Third, we expect that the combination of a balanced set of performance measures with the use of the PMS for intensive debate will trigger cognitive conflict between TMT members (H3). Finally, we argue that TMTs experiencing greater cognitive conflict are more effective in realising innovation ambidexterity (H4). An overview of the theoretical model is presented in Fig. 1.

<Insert Fig. 1 about here>

3.1. Competence ambidexterity and PMS design (PM balance)

Prior research finds that firms pursuing multiple strategic priorities tend to adopt broader, more diverse sets of performance measures than firms pursuing one single archetypal strategy (Dekker et al., 2013; Lillis & van Veen-Dirks, 2008). Consistent with these arguments, it is expected that firms pursuing an ambidextrous innovation strategy will adopt PMSs with a broad scope of performance measures that capture a diverse range of key factors related to both incremental and radical innovation. However, prior findings in both the accounting and the innovation literature indicate that in settings where contradictory strategic objectives are simultaneously pursued, the design of PMSs is more complex than in firms adopting multiple, but non-contradictory, strategies. In firms pursuing ambidexterity, successfully juxtaposing their contradictory strategic objectives involves going beyond the facilitation of both separate objectives. It further entails emphasising the interdependencies between their contradictory objectives and bringing the consequent trade-offs and tensions to the surface (Smith & Tushman, 2005).[5]

One particularly complex aspect in the design of PMSs in ambidextrous firms is the need to mitigate the risk of some objectives being crowded out by other objectives. The literature on organisational ambidexterity has recognised the risk of exploitation crowding out exploration efforts because of managers' cognitive preferences for certainty (Atuahene-Gima, 2005; Levinthal & March, 1993; Smith & Tushman, 2005; O'Reilly & Tushman, 2013). Some potential choices for PMS design are at risk of downplaying the outcomes of exploration efforts and hence crowding out radical innovation. This is demonstrated by Benner and Tushman (2002, 2003) who observe that the development of metrics associated with process management and control tend to increase both incremental innovations and their share of total innovations at the expense of radical innovation. Radical innovation projects can also fail because of the emphasis of performance measures on process efficiency, outputs and near-term gains, whereas performance measures suitable for radical innovation should be oriented towards inputs devoted to radical initiatives, learning from cross-functional teams and long-term prospects (Kupper, Lorenz, Maurer, & Wagner, 2013). Many innovation measures that are typically incorporated into PMSs (e.g., return on innovation investment, number of new products, patent filings, time-to-market) capture efforts towards both types of innovation. However, measures that do not focus on explicitly providing visibility to activities related to radical innovation tend to promote incremental innovations to the exclusion of radical innovations — the former provide an easier, less risky form of achieving better

[5] For example, the benefits of developing completely new products will not be fully realised unless the firm can bring the product or service to market efficiently (Cao et al., 2009).

performance outcomes in the short-term (Anthony et al., 2008; Davila et al., 2012). For example, while the metric 'number of new products' encapsulates both incremental and radical new products, its use favours the prioritisation of projects which lead to a greater number of new products with small improvements in the shorter term, at the expense of longer term projects leading to innovations that involve fundamental changes.

Based on the arguments outlined above, we expect firms that invest in developing competences in both exploitation and exploration, will aim to design their PMS in ways that take into account the interdependencies between contradictory objectives, and that counteract tendencies towards the crowding out of any of these objectives. Specifically, we predict that these firms will design the substantive contents of their PMS so that there is a close match in the relative magnitude of the emphasis placed on measures which increase the visibility of radical innovation and the emphasis placed on measures that do not. We refer to this close match in emphases as 'PM balance'. This expectation is in line with prior claims referring to the necessity for a balanced mix of metrics to assess innovation-related activities (Anthony et al., 2008), the need to tailor PMSs to the firm's portfolio of incremental and radical innovation (Davila et al., 2012), and the importance of defining distinct goals for both incremental and radical innovations to promote integration of effort (Smith & Tushman, 2005). In sum, we expect that the more a firm focuses on developing competence ambidexterity, the more it will be interested in designing a PMS with high PM balance. We formalise this as:

H1. Competence ambidexterity is positively associated with PM balance.

3.2. Competence ambidexterity and PMS use (PM debate)

Contexts that involve complex problem solving require the transfer of tacit forms of information (Daft & Lengel, 1986). Verbal communications in the form of dialogues and discussions enable the exchange of more implicit understandings that are difficult to formally articulate. Consequently, managers dealing with complex or equivocal contexts tend to rely on interpersonal communication and intensive verbal forms of information exchange (Ditillo, 2004). Hall (2010) points specifically to verbal communication around the meaning and implications of accounting information as enabling the exchange of tacit information in such contexts.

Prior literature demonstrates that innovative companies rely upon and benefit from performance measurement (Anthony et al., 2008; Chenhall and Moers, 2015; Davila et al., 2012; McCarthy and Gordon, 2011). Drawing upon Hall's (2010) argument, we argue that firms pursuing ambidextrous innovation will rely upon verbal communication in the form of debate around PMSs among their TMT members. Debate among TMT members refers to a specific behaviour by which these members interact, engage in open discussions of task-related differences, and advocate for differing views, preferences or approaches (Simons, Pelled, & Smith, 1999). Debate around the meaning and implications of the metrics captured by a PMS facilitates the transfer of tacit information in innovative settings that, by nature, are complex and equivocal. As firms intending to simultaneously develop the contradictory objectives of exploration and exploitation are an instance of a particularly complex and equivocal context, they are likely to gain significant benefit from debating the meaning and implications of performance measurement information. Therefore, we contend that the more a firm focuses on developing competence ambidexterity, the more likely it is that performance measures are the object of frequent and vigorous debate among TMT members.

This expectation is consistent with prior research on TMT processes. Hambrick (1995) shows that a company's competitive strategy affects the degree of behavioural integration within TMTs, and the level of debate in which their members engage. Hambrick argues that the more a company intends to compete by stimulating and meeting broader and more novel market opportunities, the more likely it is that their top executives will frequently come together face-to-face in order to debate and orchestrate its offerings. In sum, we reason that top executives in firms simultaneously pursuing exploration and exploitation will come together to debate organisational objectives and how to achieve them more often than those in non-ambidextrous firms, with performance measurement information being central to these interactions. Hereafter, we refer to debate around performance measures among TMT members as *PM debate*. We formalise our prediction as:

H2. Competence ambidexterity is positively associated with PM debate.

3.3. PMS attributes and cognitive conflict

The design attributes of a PMS delineate the type of cognitive frame that it is likely to produce (Chenhall, 2005; Hall, 2011; McKinnon & Bruns Jr, 1992). If an ambidextrous firm designs a PMS with high PM balance, it should be better equipped to provide juxtaposing accounts of the resources, actions and outcomes related to efforts towards the contradictory objectives it pursues. Under high PM balance, the emphases on these juxtaposing accounts are of similar relative magnitude, and this should help make organisational contradictions more salient. In contrast, a lack of PM balance should result in relatively more consistent and coherent information. If the emphases on opposing accounts are of disparate relative magnitude, managers are more likely to ignore organisational contradictions. Consequently, PM balance will help ambidextrous firms to support paradoxical cognitive frames that embrace opposing views.

Through paradoxical cognitive frames, PMSs designed with high PM balance will provide cues to managers about the issues that need to be addressed to simultaneously achieve contradictory objectives, and offer a context in which to discuss these issues. Prior accounting literature highlights the potential for accounting information, including PMSs, to provide an organising rationale around which debate can occur (Chenhall & Moers, 2015; Hall, 2010). Vaivio's (2004) findings further point to the importance of accounting information as a platform for "speaking out" (p. 53) contradictory views about problematised issues. Following these arguments, it is expected that when a PMS is the object of frequent and vigorous debate, the meanings and consequences of PM information come to be known, shared and connected to specific managerial problems and issues (Hall, 2010; Simons et al., 1999). This is also consistent with broader management research emphasising the importance of dialogue and debate in making paradoxes salient (Calton & Payne, 2003).

The combination of PM balance and its associated paradoxical cognitive frames with PM debate should intensify the collective acknowledgment of the tensions between the TMT members' contrasting agendas (Smith & Lewis, 2011; Smith & Tushman, 2005). We predict that the conjoint action of PM balance and PM debate further accentuates the perception of judgemental differences and clashing positions between TMT members regarding different courses of action to achieve contradictory organisational objectives (Lüscher & Lewis, 2008; Murnighan & Conlon, 1991; Smith, 2014; Smith & Tushman, 2005). This suggests that, functioning as complements, PM balance and PM debate are likely to conjointly spark cognitive conflict within TMTs. This prediction is in line with previous qualitative research that has pointed to the provocative

role of PMS in the articulation of local knowledge at the grass roots level, opening new visibility, problematising established practices, and deliberately creating controversy (Vaivio, 2004).

PM balance alone is unlikely to generate cognitive conflict if it is not the object of vigorous debate, as TMT members will not have the opportunity to directly confront different issues and positions. We expect that the ability of PM balance to generate cognitive conflict is dependent upon PM debate. In turn, prior literature has cast doubt on the ability of PM debate to generate cognitive conflict on its own. Research on behavioural integration (e.g., Mooney & Sonnenfeld, 2001) suggests that TMTs engaged in frequent interactions are inclined to develop a single shared logic, suppress contrasting views, and are less likely to disagree on the best course of action. However, while PM debate in itself may not generate cognitive conflict, we predict that PM debate is likely to generate cognitive conflict if the performance measures that are the object of debate are more balanced between opposing perspectives. TMTs that debate information that is biased towards certain objectives over others are less likely to generate cognitive conflict than TMTs that equally emphasise different strategic objectives. In sum, we predict that balanced designs of PMSs, accompanied by high levels of TMT debate and discussion around the performance measures, will result in higher levels of cognitive conflict. We formalise the expected joint effect as:

H3. The interaction of PM balance and PM debate is positively associated with cognitive conflict.

3.4. Cognitive conflict and innovation outcomes

The strategic decision-making behaviours of the TMT are important determinants of an organisation's success (Hambrick & Mason, 1984). The effectiveness of the decisions reached by the TMT and the overall effectiveness of the organisation are influenced by the level and type of conflict present in TMT decision-making processes (Amason & Mooney, 1999). High levels of cognitive conflict are generally associated with net beneficial effects for decision making in organisations, particularly in contexts involving complex, uncertain and non-routine tasks (De Dreu & Weingart, 2003; Simons & Peterson, 2000). Negative effects of cognitive conflict experienced by teams include stress, distraction and cognitive overload (De Dreu, 2006; Wang, Jing, & Klossek, 2007), which impairs team performance. However, organisational conflict literature has found

that these negative effects are generally outweighted by potential benefits. On the positive side, cognitive conflict increases TMT members' tendency to critically scrutinise issues with no standard solution, and to engage in deep and deliberate processing of task-relevant information. Awareness of perceptual diversity and judgemental differences over how to best achieve the organisation's goals encourages a thorough evaluation of underlying assumptions (Putnam, 1994), helps generate creative insights and new approaches (Baron, 1991), prevents groupthink (Jehn, 1995), and is likely to produce a synthesis that is qualitatively superior to the initial positions of individual TMT members (Amason, 1996; Parayitam & Dooley, 2009). As a result, cognitive conflict has been found to be positively associated with TMT decision quality, TMT decision commitment (Amason, 1996; Parayitam & Dooley, 2009), the ability to implement plans (Chenhall, 2004), and in general, with team effectiveness and performance (De Dreu & Weingart, 2003). In contrast, a low level of cognitive conflict may lead to managers neglecting relevant information, refraining from critical evaluation, falling into confirmatory biases in team decision-making, and inhibiting the creation and dissemination of new ideas (De Dreu, 2006).[6]

As the decision making context faced by TMTs in ambidextrous firms contains significant complexity and uncertainty, we expect these arguments to apply in particular to the achievement of innovation ambidexterity. Smith and Tushman (2005), Smith et al. (2010) and Smith (2014) refer to the need for TMTs to embrace conflict in order to be able to manage paradoxical tensions. Given the paradoxical nature of ambidexterity, we expect that the presence of cognitive conflict is associated with a more effective management of its contradictory demands. The identification, confrontation and synthesis of diverse viewpoints and perspectives that arise from cognitive conflict should contribute to finding more effective ways to realise ambidextrous innovation outcomes. Hence, we formalise our expectation as:

H4. Cognitive conflict is positively associated with innovation ambidexterity.

[6] Some researchers suggest that at very high levels of cognitive conflict, its negative effects may outweigh its potential benefits, hindering the decision-making effectiveness of management teams. At the extreme, cognitive conflict may be associated with information overload, increasing the time and cost to gather and assess information, and an inability to reach a consensus (De Dreu, 2006; Jehn, 1995; Parayitam & Dooley, 2011). We assess this possibility in a sensitivity test of our empirical model (see footnote 13).

4. Research method

4.1 Sample selection and data collection

Data for this study were collected using a cross-sectional questionnaire. The target population consists of Irish firms, defined as legal entities that are independent or subunits of a larger organisation, operating in innovative industries. Innovative industries were identified from a report of top global innovators by Thomson Reuters (now Clarivate Analytics) carried out using data on patent filings (Thomson Reuters, 2014). The enumeration of innovative industries in this report includes: computing; peripherals and telecommunications (grouped as 'information technology' in our survey); medical devices; food, tobacco and beverage; semi-conductors; and pharmaceuticals, among others. Firms in these industries are expected to differ significantly in their innovation investment decisions, resulting in variance in the degree of ambidexterity (Cao, Gedajlovic, & Zhang, 2009). To increase the likelihood that the organisational and strategic variables of interest were applicable, and that a formal PMS was in place, firms were required to have a minimum of 20 employees and have operated for at least three years. The target respondents were the CEO or other members of the TMT familiar with the innovation strategy and the management systems of their firm. Respondents were required to have at least one year of tenure at the firm.

Firms in the target population were ascertained through a number of sources. Firms were initially identified from the membership list of the Irish Business and Employers' Confederation (IBEC) (330 firms) which has a particular focus on the industries of interest to this study. This was supplemented with firms identified through the Irish Times Top 1000 firms (271 firms), the FAME listing of medical device companies (151 firms), and an online listing of IT firms in Ireland (makeITinIreland.ie) (55 firms). This resulted in a target population of 807 firms.

Where possible, the recommendations of Dillman (2011) for survey design and implementation were followed. To encourage survey completion, a summary of the findings was promised to participants. Due to confidentiality, IBEC administered the survey to their members. This consisted of an email to the targeted respondent outlining the purpose of the study and an electronic link to the questionnaire. Firms identified through additional sources were initially telephoned to ensure that the firm and respondent were suitable for the purpose of this study.

Questionnaires were provided either through an electronic link in an email or as a hardcopy if requested.[7] Reminder emails were sent weekly for three weeks to those completing the survey electronically. For hardcopy recipients, a follow-up telephone call was made after two weeks.

A total of 125 responses were received, resulting in a response rate of 15.5 per cent. The response rate is in line with those reported for surveys of top managers in the accounting literature (Van der Stede, Young, & Chen, 2005). From these responses, 32 firms that did not meet one or more of the screening thresholds (i.e., industry, size, age and tenure) were removed. In addition, as some of the firms in the surveyed population were business units of larger corporations, a question was included to assess whether the firm had decision authority on innovation investments. We excluded three firms that reported having no say in innovation investment decisions. Removal of these responses resulted in a usable sample of 90 firms. Respondents in the usable sample have an average tenure of 15.1 years. Information on the distribution of firm size and industry classification are detailed in Table 1. Two tests were conducted to assess possible non-response bias. First, the variable means of early and late respondents were compared. Second, the industry and size profile of respondents were compared to non-respondents. No significant differences were identified in either comparison.

<Insert Table 1 about here>

To minimise common method bias we reverse-coded selected items, paid close attention to wording, provided succinct instructions for survey completion, and separated items of constructs throughout the questionnaire (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). In addition, a Harmann's single factor test was conducted on the survey items used to form the constructs. The unrotated principal components analysis returned fourteen components with the variance accounted by the first component (25.2%), well below half the total explained variance (76.9%), suggesting that single-source bias is not a significant concern.

[7] There were no substantive differences between the format of the online version and the paper version of the questionnaire.

4.2 Variable measurement

The questionnaire was pilot-tested with five TMT members in firms operating in innovative industries and three academics. This process led to a small number of changes to the included items, and minor adjustments to the survey design and item wording to enhance face validity. In developing the questionnaire, we paid close attention to the conceptual nature of each construct, including issues of dimensionality and the use of either formative or reflective indicators (Bedford & Speklé, 2018a; Bisbe et al., 2007). The questionnaire items are detailed in Appendix A. Descriptive statistics are reported in Table 2, together with reliability and validity statistics for constructs measured with reflective indicators.

<Insert Table 2 about here>

Competence ambidexterity (*COMAMB*) is assessed in terms of the firm's intention to invest in exploitation (*EXPLOIT*) and exploration (*EXPLORE*) over the previous three years using a modified version of the instrument developed by Atuahene-Gima (2005). While the original instrument captures the extent to which firms had acquired skills and competences over the previous three years, we adapted the construct to measure the ex-ante objectives of the firm to develop these skills and competences — which is in line with the reasoning of He and Wong (2004). Five reflective items, which are expected to covary, are used for both exploitation and exploration. Exploratory factor analysis results reported in Appendix B reveal that the ten items load as expected on two factors representing the development of exploitation and exploration competences. The Cronbach's alphas of both constructs are 0.85, well above acceptable minimum thresholds for construct reliability (Nunnally, 1978).

Recent research has conceptualised ambidexterity as an aggregate multidimensional construct comprising the interaction of two dimensions (Cao et al., 2009; Simsek, 2009).[8] The first dimension concerns the relative balance, or match, between *EXPLOIT* and *EXPLORE*, which is measured as the absolute difference between their scores. We use the reversed score from this calculation so that higher values equate to higher

[8] An aggregate multidimensional construct is comprised of formative dimensions (the dimensions form the construct), while a superordinate multidimensional construct is represented by reflective dimensions (the dimensions are manifestations of the constructs) (Bisbe et al., 2007; Edwards, 2001).

levels of balance. The second dimension refers to the combination of *EXPLOIT* and *EXPLORE*, which we calculate as the multiplication of scores. The aggregate construct of *COMAMB* is then calculated as the multiplication of the balance dimension and the combined dimension. This operationalisation recognises that ambidexterity is achieved only by balancing high levels of exploitation and exploration rather than by attaining balance at any level of emphasis. That is, a high score on *COMAMB* indicates that *EXPLOIT* and *EXPLORE* have a high emphasis of a similar magnitude.

Innovation ambidexterity (*INNAMB*) is assessed in terms of radical innovation (*RADIC*) and incremental innovation (*INCREM*) outcomes over the previous three years. Each construct is measured through four reflective items derived from a combination of the three-item scales developed by Lin et al. (2013) and Atuahene-Gima (2005). As reported in Appendix B, exploratory factor analysis results indicate that three of the four items for *RADICAL* load on one factor, while three of the four items for *INCREM* load on a separate factor. The single items that loaded on separate factors were removed from the analysis. The resulting measurement instrument coincides with the original Lin et al. (2013) scales. Cronbach's alphas for the three-item constructs of *RADIC* and *INCREM* are 0.91 and 0.82 respectively. Like *COMAMB*, *INNAMB* is conceptualised as an aggregate multidimensional construct and calculated as the interaction of the balanced dimension (the reverse score of the absolute difference between *RADIC* and *INCREM*) and combined dimension (the multiplication of *RADIC* and *INCREM*) (Cao et al., 2009).

PM balance (*PMBAL*) is conceptualised as an aggregate multidimensional construct with two dimensions: one dimension relating to performance measures that increase the visibility of radical innovation, the other relating to performance measures that do not. A purpose specific instrument was developed as there were no pre-existing construct measures assessing the relative magnitude of the use of the two types of performance measures. We used a composite measurement model to assess each dimension, as determining which performance measures to include in the survey instrument was based on their relevance to the sample of this study (i.e., firms operating in innovative intensive industries) (Bedford & Speklé, 2018a). An initial list of metrics, likely to increase (or not) the visibility of radical innovation efforts, were identified from a review of the literature on performance measurement in innovation contexts (Anthony et al., 2008; Chiesa et al., 2009; Cooper, Edgett, & Kleinschmidt, 2004; Davila et al., 2012). As part of pilot-testing, top managers were questioned about the importance of the metrics and the actions fostered by them. Based on the literature review and pilot-testing feedback, a total of seven metrics were identified as not increasing the visibility of radical

innovation (i.e., number of new products/services launched, percentage of revenue from new products, number of products/services first to market, lead time over competition, average time to market for new products/services, total number of patents granted each year, return on innovation investment) (see survey items in Appendix A). While these metrics do not exclude radical innovations, they are likely to encourage decisions that favour incremental innovations over radical innovations (Anthony et al., 2008). For example, Davila et al. (2012) found that the effect of emphasising the number of products launched to evaluate performance in a company intending to be highly innovative was that "they focused on achieving many small product improvements" (p. 26). The emphasis on performance metrics that do not increase the visibility of radical innovation is calculated as the average of the scores measuring the importance given to each of these seven items.

In contrast, metrics that give explicit visibility to aspects of activity directed towards radical innovation provide information to managers that help the organisation maintain an appropriate balance between investments aimed at producing incremental improvements in the short-term and those investments in radical ideas that are riskier but have higher long-term payoffs (Anthony et al., 2008; Cooper, Edgett, & Kleinschmidt, 2001; Davila et al., 2012). Kupper et al. (2013) identify the importance of measuring resources devoted to radical type innovations, while Cooper et al. (2001) point to the importance of a portfolio approach for managing a mix of innovation types. Based on the literature and our pretesting, we identified seven metrics which increase the visibility of radical innovation (i.e., headcount devoted to radical innovation projects; financial resources devoted to radical innovation projects; number of patents for radical innovation projects; portfolio analysis by (a) risk, (b) breakeven time, (c) stage of development, and (d) project type). The emphasis on performance metrics that provide increased visibility of radical innovation efforts is calculated as the average of the scores measuring the importance given to each of these seven items. *PMBAL* is operationalised as the absolute difference between the average of the scores of metrics increasing the visibility of radical innovation and the average of the scores of metrics that do not. *PMBAL* scores are reversed so that higher values represent greater balance.

PM debate (*PMDEB*) refers to the extent to which TMT use performance measures as a basis for informing their discussions surrounding investment decisions and actions plans and the assumptions upon which these are based. As debate and discussion have been acknowledged in the accounting literature as one of the constitutive dimensions of interactive use of control systems (Bisbe, Batista-Foguet, & Chenhall, 2007; Simons, 1995), we reviewed prior empirical research that operationalises interactive use of controls in order to identify the items specifically used to assess

the debate dimension (Chong & Mahama, 2014; Henri, 2006; Marginson et al., 2010, 2014; Naranjo-Gil & Hartmann, 2007; Su, Baird, & Schoch, 2015; Widener, 2007; see Bedford & Speklé, 2018b). Items related to other dimensions of interactive use of control systems were ignored. Based on previously used items related to debate, we develop a reflective four item measure to capture the degree of PMS use for debate within the TMT.[9] All four items load on a single factor which returns a Cronbach's alpha of 0.87.

Cognitive conflict (*COGCON*) is measured with a reflective measurement model using the four item scale developed by Simons and Peterson (2000). This measure is based on Jehn (1995) and is tailored to the TMT context. The four items load on a single factor with a Cronbach's alpha of 0.81.

We control for a number of theoretically relevant factors. As prior studies indicate that firms pursuing multiple strategic priorities emphasise a broader range of metrics than firms that have more focused strategic orientations (Dekker et al., 2013; Lillis & van Veen-Dirks, 2008), we include a control variable to capture the diversity of performance measures used by the firm. Following Dekker et al. (2013) and Henri (2006), performance measurement diversity (*PMDIV*) is operationalised as the mean score across all fourteen metrics included in *PMBAL*.[10] Prior research shows that the experiences and backgrounds of TMT members are associated with the design and use of performance measures (Naranjo-Gil & Hartmann, 2007), the level of conflict experienced by the TMT (Mooney, Holahan, & Amason, 2007), and firm innovation outcomes (Alexiev, Jansen, Van den Bosch, & Volberda, 2010). We control for this by including three reflective items to measure the diversity of TMT member experiences and backgrounds (*TMTDIV*) (Campion, Medsker, & Higgs, 1993). The three items load on a single factor and return a Cronbach's alpha of 0.81. We also control for firm size (*SIZE*), measured as the natural log of full-time employees (Kortmann, 2014; Lin et al., 2013), as well as industry effects

[9] The literature on the conceptual domain of 'interactive use of control systems' suggests that this is a multidimensional construct that includes constitutive dimensions such as debate and discussion, intensive use by operating managers, and a focus on strategic uncertainties. These dimensions do not necessarily covary (Simons, 1995; Bisbe et al., 2007; Bedford & Speklé, 2018a). Given the focus of this paper, we are specifically interested in the patterns of communication within TMTs. Debate and discussion at other levels of the organisation and the remaining constitutive dimensions of 'interactive use of control systems' are outside the scope of this paper. Consequently, we adapt the items related to debate that we identified in the literature on interactive control systems to specifically refer to debate and discussion between members of the TMT.

[10] As a robustness test we construct an alternate measure for performance measure diversity. Following Dekker et al. (2013) we take a value of 1 when an item scores 6 or 7 and calculate the sum over all items (mean = 6.23; range 0–14; stdev = 4.32). This variable is significantly correlated with *PMDIV* (r = 0.95); using this variable in our empirical model does not substantively affect the results of our hypothesis tests. Variables are also constructed for values larger than 4 and only for values of 7. Both of these variables are significantly correlated with *PMDIV* (r = 0.88 and r = 0.69) and neither substantively influence our empirical results.

by including an indicator variable (*INDPROD*) that takes a value of 1 if the firm is primarily product oriented, and a value of zero if it is a service provider.

5. Results

Data are examined using partial least squares (PLS) regression analysis. This latent variable modelling technique is suitable for this study because it imposes few data assumptions, is valid for relatively small sample sizes, and recognises measurement error (Chin, 1998; Hair Jr, Hult, Ringle, & Sarstedt, 2013). PLS simultaneously considers a measurement model and a structural model. The measurement model allows for an assessment of construct validity and reliability. Cross-loadings of reflective constructs are reported in Table 3. All items load above 0.5 on their respective constructs except for one item related to *PMDEB*. This item is dropped from the analysis.[11]

<Insert Table 3 about here>

As displayed in Table 2, multi-item reflective constructs show acceptable reliability with Cronbach's alphas and composite reliability scores above 0.70 (Nunnally, 1978). Convergent validity is assessed through average variance extracted (AVE) statistics. AVE for each construct is above 0.50, which indicates that more variance is explained by its indicators than by error (Chin, 1998). To establish discriminant validity the square root of the AVE statistics are compared to the correlations among the latent variables. AVE statistics and the correlation matrix are shown in Table 4. For each construct the square root of the AVE is greater than the correlation with all other constructs (Chin, 1998). The factor loadings from the PLS measurement model also show that each item loads higher on the expected construct than any other construct, providing further support for discriminant validity. In particular, the analysis demonstrates that items for *COMAMB* and *INNAMB* load on separate factors, indicating that they are empirically distinct constructs.

[11] Retaining the item has no substantive effect on the results of the analysis.

<Insert Table 4 about here>

Results of the PLS structural model are reported in Table 5.[12] Bootstrapping (with 5000 subsamples) is performed to test the statistical significance of path coefficients. In addition to the hypothesised relationships, the structural model controls for other non-hypothesised associations. In particular, we include the direct effect of *COMAMB* on *COGCON* and *INNAMB*. We also control for the main effects of *PMBAL*, *PMDEB* and *PMDIV* on *COGCON*, as well as potential interdependencies between these PMS characteristics and *TMTDIV*, *PMDIV* and *SIZE* on *COGCON* by including relevant interaction terms (Grabner & Moers, 2013).

<Insert Table 5 about here>

H1 predicts a positive relationship between *COMAMB* and *PMBAL*. Table 5 shows that the structural path coefficient is positive and significant, providing support for H1 ($\beta = 0.260$, $p < 0.01$). The results also provide support for H2, which predicts a positive relationship between *COMAMB* and *PMDEB* ($\beta = 0.161$, $p < 0.10$). In addition, results show a positive and significant (non-hypothesised) association between *COMAMB* and *PMDIV* ($\beta = 0.507$, $p < 0.01$).

H3 predicts that *PMBAL* combined with *PMDEB* will have a positive and significant association with *COGCON*. The results support the expectation that the combination of *PMBAL* and *PMDEB* effectively influence the level of TMT cognitive conflict ($\beta = 0.200$, $p < 0.05$). Interestingly, the path between *COMAMB* and *COGCON* is insignificant, suggesting that pursuing contradictory strategic objectives does not directly lead to increased cognitive conflict within the TMT.

[12] Hypotheses are examined using SmartPLS 3 (Ringle, Wende, & Becker, 2015).

H4 expects a positive relationship between *COGCON* and *INNAMB*. The results indicate a positive and significant association providing support for H4 (β = 0.219, $p < 0.05$).[13] The results of our analysis are summarised in Figure 2.

<Insert Figure 2 about here>

H3 and H4 also imply that *COGCON* is expected to function as a mediator between the combination of *PMBAL* and *PMDEB* and the outcome of *INNAMB*. To assess this possibility, we calculate the 95% confidence interval for the indirect path between the interaction term (*PMBAL***PMDEB*) and *INNAMB* (Preacher & Hayes, 2004; Zhao, Lynch, & Chen, 2010). The lower (0.003) and upper (0.129) confidence intervals are both positive. This indicates a significant and positive indirect effect (β = 0.044) of the combination of PM balance and PM debate on the achievement of innovation ambidexterity, through cognitive conflict.

We conduct a number of robustness tests to assess the validity of our main results. First, we examine the hypothesised model using two alternative approaches that have been used in prior research to measure ambidexterity. In the first alternative, we operationalise *COMAMB* and *INNAMB* as the interaction of their dimensions (e.g., Jansen et al., 2012; Lin et al. 2013).[14] The results of the model are consistent with those reported in Table 5, with the associations between *COMAMB* and *PMBAL* (β = 0.278, $p < 0.01$), *COMAMB* and *PMDEB* (β = 0.223, $p < 0.05$), the interaction of *PMBAL* and *PMDEB* and *COGCON* (β = 0.200, $p < 0.05$), and *COGCON* and *INNAMB* (β = 0.200, $p < 0.05$) all significant and positive. In the second alternative, *COMAMB* and *INNAMB* are constructed as the simple sum of the first-order dimensions (e.g., Jansen et al., 2009; Lubatkin et al., 2006).[15] The results of hypothesised associations are again substantively unaffected, with significant and positive associations reported between *COMAMB* and *PMBAL* (β = 0.277, $p < 0.01$), *COMAMB* and *PMDEB* (β = 0.216, $p < 0.05$), *COGCON* and the interaction of

[13] As mentioned in footnote 6, some prior research suggests that very high levels of cognitive conflict may have negative consequences for team decision-making and firm performance outcomes. This implies a concave curvilinear association between cognitive conflict and ambidextrous innovation. We assess this possibility by including a quadratic term for cognitive conflict. No evidence of a concave curvilinear effect is found.

[14] *COMAMB* is constructed as the multiplication of the scores of *EXPLOIT* and *EXPLORE*, while *INNAMB* is created by multiplying the scores of *INCREM and RADICAL*.

[15] *COMAMB* is operationalised as the summation of the scores of *EXPLOIT* and *EXPLORE*, while *INNAMB* is the summation of the scores of *RADICAL* and *INCREM*.

PMBAL and *PMDEB* (β = 0.200, p < 0.05), and *COGCON* and *INNAMB* (β = 0.174, p < 0.05). The only path to differ in this model is the direct association between *COMAMB* and *INNAMB*, which is insignificant (β = 0.151, p > 0.10). This further emphasises the importance of PMS design and use in translating competence ambidexterity into innovation outcomes.

Second, we control for additional contextual factors. Contingency literature suggests that PMS design and use may be influenced by environmental dynamism (*ENVDYN*) and firm age (*AGE*) (Chenhall, 2007; Davila, 2005).[16] Rerunning the model with direct paths from the two additional control variables to *PMBAL*, *PMDEB*, *PMDIV*, *COGCON* and *INNAMB*, does not substantively influence the hypothesis tests, and furthermore none of the paths from *ENVDYN* or *AGE* are significant (p > 0.10). In an additional analysis, we control for the interaction terms between *PMBAL* and *PMDEB* with *ENVDYN* and *AGE*.[17] All interaction terms are insignificant (p > 0.10), while the results of the hypothesis tests remain substantively unchanged.

As a final robustness test we replicate our base model using covariance-based SEM (CB-SEM). As our sample size to parameter ratio is below the minimum recommended threshold for CB-SEM analysis (Kline, 2005), we use manifest variables for reflectively measured constructs, calculated as the average of construct items. Replicating the same structural model as reported in Table 5, the CB-SEM results provide support for all four hypotheses.[18] However, model fit is somewhat unsatisfactory (χ^2 = 106.12, p = 0.032, CMIN/DF = 1.310, CFI = 0.827, RMSEA = 0.059). To address this, we trim the model by removing the insignificant unhypothesised paths from the control variables of *INDPROD*, *TMTDIV* and *SIZE* to the remaining endogenous variables in the model. This results in adequate model fit (χ^2 = 56.76, p = 0.133, CMIN/DF = 1.234, CFI = 0.905, RMSEA = 0.051). The trimmed model provides further support for each hypothesis, with positive and significant associations between

[16] ENVDYN is constructed as a composite using four items from the measure developed by Jaworski and Kohli (1993), while firm age is the natural logarithm of the number of years since the firm was founded.

[17] As including additional interaction terms results in the sample size to paths ratio falling considerably below the minimum recommended threshold, we restrict the model to interactions between the PM variables and two context variables (e.g., *ENVDYN* and *AGE*). We assess all other possible pairs of context variables and find no substantive changes to the results of the hypotheses tests.

[18] Path estimates and significance levels are as follows: *COMAMB* and *PMBAL* (β = 0.251, p < 0.01), *COMAMB* and *PMDEB* (β = 0.144, p < 0.10), *PMBAL*PMDEB* and *COGCON* (β = 0.218, p < 0.05), and *COGCON* and *INNAMB* (β = 0.224, p < 0.01).

COMAMB and *PMBAL* (β = 0.228, p < 0.05), *COMAMB* and *PMDEB* (β = 0.167, p < 0.05), *PMBAL*PMDEB* and *COGCON* (β = 0.211, p < 0.01), and *COGCON* and *INNAMB* (β = 0.208, p < 0.01). Overall, the robustness tests provide support for our main results.

6. Discussion

The empirical analysis reveals several findings that enhance our understanding of how PMSs intervene in the realisation of ambidextrous strategies. First, results provide evidence on how top managers in firms pursuing ambidexterity design and use their PMSs. The analysis shows that TMTs in these firms design their PMSs to reflect not only greater diversity of performance measures, but also a more balanced representation of the resources, activities and outcomes of efforts directed towards incremental and radical innovation. Achieving an effective balance is important for ambidextrous firms because many measures commonly used to assess innovation performance tend to incentivise incremental innovations at the expense of radical innovations. This suggests that the choice of performance measures for a TMT facing competing strategic objectives is considerably more complex than for those in firms pursuing a consistent set of priorities. We also provide evidence regarding the use of the PMS — the analysis indicates that TMTs in these firms use their PMS more intensively for discussion and debate. To simultaneously address the tensions and trade-offs associated with competing strategic priorities, the TMT must handle significant amounts of information and integrate diverse and conflicting perspectives (Cao et al., 2010). Our findings extend prior literature, which shows how managers use accounting and performance measures in ambidextrous firms to influence subordinate behaviours (Bedford, 2015), by providing evidence on how PMSs are used to encourage information exchange within the TMT.

Second, the findings of this study support the idea that cognitive conflict has a significant positive role in the realisation of ambidextrous outcomes and hence point to the need for organisations to employ practices that encourage cognitive conflict among senior managers. This result is consistent with the arguments of organisational conflict theory that cognitive conflict provides the opportunity for firms involved in complex and non-routine decisions to identify and openly contrast opposing viewpoints (Amason & Schweiger, 1994) and to take advantage of the perceptual diversity and judgemental differences of TMT members over how best to achieve the organisation's goals (Chenhall, 2004). This result is also consistent with paradox perspectives referring to the need for TMTs to embrace paradoxical tensions and their associated conflict in order

to deal with the contradictory demands associated with ambidexterity (Smith, 2014; Smith et al., 2010; Smith & Lewis, 2011; Smith & Tushman, 2005). Our results support that the identification, confrontation and synthesis of various viewpoints and judgmental differences that arise specifically from cognitive conflict contribute to finding more effective ways to realise ambidextrous innovation outcomes.

The results show, however, that the simultaneous pursuit of exploitation and exploration is not directly related to cognitive conflict. This implies that competence ambidexterity does not generate cognitive conflict on its own, but requires certain organisational processes and practices for this to happen. We show that one way to activate cognitive conflict within the TMT in ambidextrous organisations is through the combination of design and use attributes of PMSs. This emphasises the importance of PMSs for translating competence ambidexterity into ambidextrous innovation outcomes through the generation of cognitive conflict. The role of PMSs as generators of conflict, and their controversial, problematising potential, has generally been neglected in the literature (see Vaivio, 2004, for an exception). Our study suggests that the use of PMSs to provoke the articulation of different and opposing points of view is an important factor for achieving ambidextrous strategies.

Third, by investigating the association between PMS and cognitive conflict, this study responds to calls to empirically investigate the cognitive processes through which MA practices influence organisational level outcomes. Hall (2016) observes that while some studies draw on psychology theories to explain the effects of MA on organisational outcomes, most do not incorporate the cognitive processes that form the basis of the theory into their empirical models. In this study we demonstrate how the design and use of PMS help translate competence ambidexterity into innovation ambidexterity by generating cognitive conflict within the TMT.

Fourth, we contribute to the emerging literature on interdependencies between accounting and control mechanisms (Grabner & Moers, 2013) by providing evidence on the relationship between the design and use of accounting information. Prior research provides little insight into how the verbal communication of accounting is associated with the information characteristics of accounting reports (Hall, 2010). We show that higher levels of cognitive conflict are achieved when PM balance is combined with TMT debate of performance measurement information. Our result is consistent with Hall's (2010) speculation that "verbal and written forms of accounting information have the potential to reinforce each other and thus act as complements" (p. 308). These forms of information complement one another — verbal communication is more suited to speculative, informal and tacit types of knowledge, whereas written communication is more appropriate for information that is explicit and formalised (Ditillo,

2004; Hall, 2010). A PMS designed with high PM balance provides cues to managers about the issues that need to be addressed to simultaneously achieve competing objectives, providing a context in which to discuss these issues. Combining high PM balance with intensive PM debate enables TMTs to interpret and construct meaning from performance measurement information by sharing tacit assumptions and understandings; this increases the relevance of performance measurement information for managerial work (Hall, 2010), contributing to the development of shared paradoxical frames and making contradictory tensions salient (Smith & Tushman, 2005).

Finally, in addition to the hypothesised relationships examined in this study, our results reveal that competence ambidexterity is positively associated with PM diversity. This finding is consistent with prior research which finds that firms pursuing multiple strategic priorities tend to incorporate a greater diversity of broad-scope measures into their PMSs (Dekker et al., 2013; Lillis & van Veen-Dirks, 2008). One potential explanation is offered by the multi-case study of Smith (2014). She observes that senior managers adopted a "consistently inconsistent" decision pattern to managing paradox by switching between differentiating and integrating practices. Differentiating practices involve distinguishing the unique characteristics of exploitation and exploration, and making decisions consistent with one or the other. In these cases, senior managers sought extensive "information about each domain independently of one another" (Smith, 2014, p. 74). Integrating practices emphasise the interdependencies between contradictory strategic objectives. PM diversity may therefore facilitate differentiating practices by providing a diverse range of performance measures related to each separate strategic domain, while PM balance functions to juxtapose strategic objectives and brings the underlying conflict and tension to the surface (Smith & Tushman, 2005). As PM diversity is associated with decision-making that is consistent within a particular strategic domain, it is not associated with an increase in cognitive conflict. Instead, PM diversity directly influences the ability to achieve aspects of each strategic priority that are independent of one another.

7. Conclusion

This study examines the extent to which design and use attributes of PMSs influence the ability of firms to translate competence ambidexterity into ambidextrous innovation outcomes. Specifically, this study provides evidence on the extent to which one design attribute of PMSs (i.e., balance of performance measures) and one attribute related to PMS use (i.e., use of performance measures for debate within the TMT)

conjointly contribute to generating cognitive conflict, as well as evidence on the extent to which cognitive conflict is associated with the achievement of ambidextrous innovation outcomes.

Our results suggest that cognitive conflict is positively associated with the realisation of innovation ambidexterity. However, competence ambidexterity is not a sufficient condition to activate cognitive conflict. While competence ambidexterity is associated with the choice to design PMSs with high PM balance as well as with higher levels of PM debate among the TMT, it is the interaction between PM balance and PM debate within TMTs that increases the salience of paradoxical tensions and creates cognitive conflict. It is through PMSs that cognitive conflict is generated, and it is through cognitive conflict that PMSs have a crucial role in translating competence ambidexterity into innovation ambidexterity. The role of PMSs as generators of conflict in ambidextrous firms highlights the controversial, problematising nature of MA practices in this setting.

The conclusions of this study need to be interpreted in the context of potential limitations. First, given the cross-sectional nature of the data, it is not possible to strictly infer causal relationships. The results represent necessary but not sufficient conditions for causality. Second, we cannot completely rule out an impact of common method bias on our findings, although several steps were taken to reduce the likelihood of this, and our statistical analysis suggests that it is unlikely to be a significant concern. Third, the study tests a model that captures two attributes of one type of MA practice (i.e., PMSs). Previous research has pointed to the importance of considering MA as part of packages and systems (Bedford et al., 2016; Grabner & Moers, 2013; Malmi & Brown, 2008), and it is possible that choices around the design and use of PMSs are influenced by other accounting and control practices. Future research can also examine additional attributes of accounting and control practices that may be important for achieving innovation ambidexterity. Fourth, the study relies on survey based constructs, some of which are purposely constructed for this study. Despite extensive pre-testing of the survey instrument, and demonstration of statistical validity and reliability, data based on the perceptual judgements of managers may contain noise. Finally, the study is based on data from one country and from mostly small to medium sized firms in specific innovative industries, which may limit the generalisability of results outside this setting.

Future research could address some of these limitations by adopting a longitudinal perspective. Qualitative studies could explore the dynamics of how PMSs help firms simultaneously engage in contradictory strategies through discursive, contextual analyses. Future qualitative accounting studies might also explore the processes that underlie the generation of cognitive conflict by PMSs in ambidextrous contexts. Future

research could extend this study by examining how other types of conflict, such as affective conflict, influence the ability of senior managers to manage paradoxical demands. Additionally, as our study focuses on two specific attributes of PMSs, subsequent research might extend investigation to additional PMS attributes. One possible attribute of interest is the diversity of performance metrics. Our results indicate that PM diversity is an important design consideration for ambidextrous firms. However, as we find no association between PM diversity and cognitive conflict, the mechanisms by which it influences the realisation of ambidextrous innovation outcomes are unclear. Cognitive effects such as information overload and the instances in which managers prefer more or less complex information (Hall, 2010) would also be interesting considerations.

Notwithstanding these limitations, the findings of this study demonstrate how PMSs can play a powerful role in enabling success in ambidextrous firms. The development of arguments related to paradoxical tensions, the unpacking of the features of PMSs, and the significant joint associations found between the design and use of PMSs and cognitive conflict are important steps in furthering our understanding of the management of ambidextrous innovation and the psychological mechanisms through which PMSs impact on organisational outcomes.

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Fig. 1
Theoretical model.

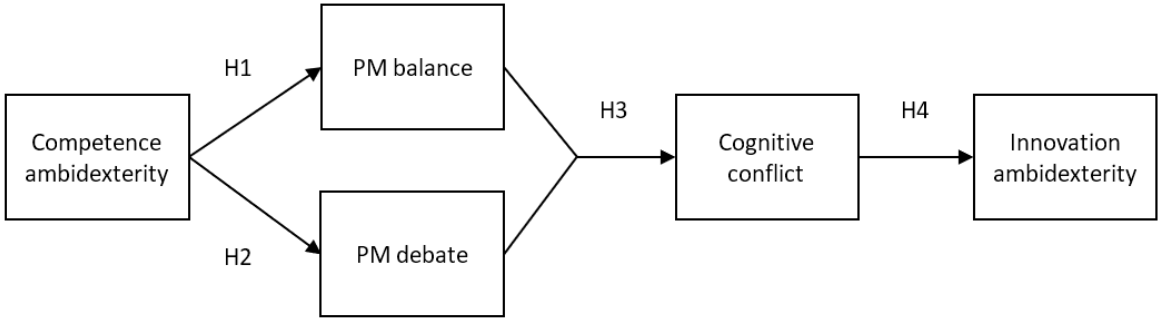
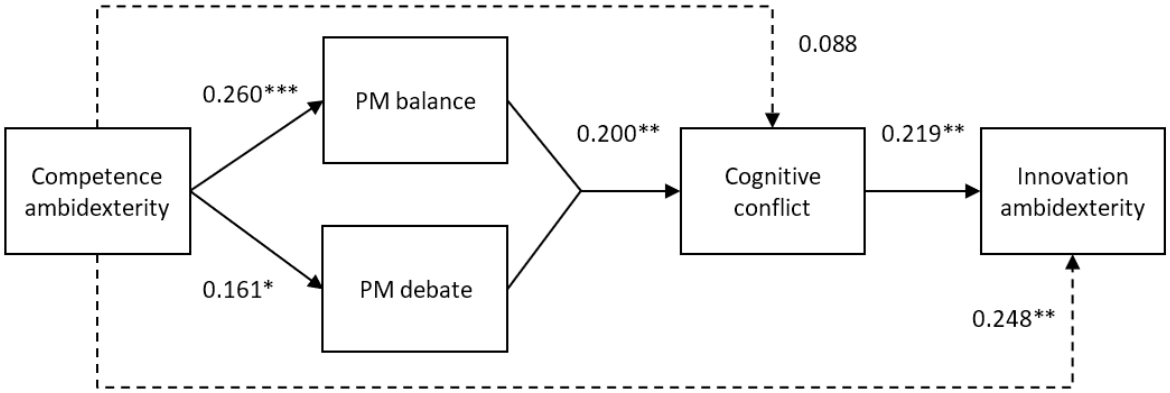


Fig. 2
Structural model.



* *p*<0.10, ** *p*<0.05, *** *p*<0.01 (one-tailed for hypothesised associations, two-tailed otherwise).
Unbroken lines represent hypothesised associations, while dashed lines represent selected non-hypothesised associations.

Table 1

Respondent demographics.

Panel A: Industry		
	Frequency	%
Medical equipment	37	41.1
Pharmaceuticals	2	2.2
Information technology	18	20.0
Food and drink	10	11.1
Electronics	2	2.2
Telecommunications	5	5.6
Other	16	17.8
Total	90	
Panel B: Firm size		
	Frequency	%
20–50	19	21.1
51–100	15	16.7
101–250	19	21.1
251–500	13	14.4
501–1000	13	14.4
>1000	11	12.2
Total	90	

Table 2

Descriptive, reliability and average variance extracted statistics.

	Mean	Standard deviation	Theoretical range	Min.	Max.	Cronbach's alpha	Composite reliability	AVE
Competence ambidexterity (COMAMB)	61.91	25.48	1–125	12.32	125.00	–	–	–
Innovation ambidexterity (INNAMB)	104.56	82.35	1–343	7.00	343.00	–	–	–
PM balance (PMBAL)	6.09	0.76	1–7	3.29	7.00	–	–	–
PM debate (PMDEB)	5.31	1.31	1–7	1.33	7.00	0.875	0.922	0.799
Cognitive conflict (COGCON)	2.58	0.66	1–5	1.00	4.50	0.813	0.876	0.640
PM diversity (PMDIV)	7.55	3.00	1–14	2.00	13.71	–	–	–
TMT diversity (TMTDIV)	3.87	0.82	1–5	1.00	5.00	0.813	0.880	0.711
Firm size (SIZE)	5.34	1.58	n/a	3.00	10.65	–	–	–
Industry (PRODUCT)	0.82	0.38	0–1	0.00	1.00	–	–	–

Table 3

Measurement model cross-loadings.

Item	COGCON	PMDEB	TMTDIV
COGCON1	**0.681**	0.056	–0.214
COGCON2	**0.825**	–0.005	–0.171
COGCON3	**0.850**	0.087	–0.139
COGCON4	**0.834**	–0.162	–0.132
PMDEB1	–0.061	**0.944**	0.120
PMDEB2	–0.008	**0.930**	0.100
PMDEB3	0.094	**0.436**	0.043
PMDEB4	0.052	**0.791**	0.091
TMTDIV1	–0.129	0.059	**0.754**
TMTDIV2	–0.207	0.046	**0.855**
TMTDIV3	–0.161	0.152	**0.911**

COGCON = cognitive conflict of top management team, PMDEB = debate on performance measures among the top management team, TMTDIV = diversity of top management team members. Bold values denote the factor with the highest loading of the item.

Table 4

Correlation matrix.

	COMAMB	INNAMB	PMBAL	PMDEB	COGCON	PMDIV	TMTDIV	SIZE	
Competence ambidexterity (COMAMB)	–								
Innovation ambidexterity (INNAMB)	0.479	–							
PM balance (PMBAL)	0.246	0.095	–						
PM debate (PMDEB)	0.142	0.254	0.012	0.894					
Cognitive conflict (COGCON)	–0.088	0.107	–0.006	–0.007	0.800				
PM diversity (PMDIV)	0.495	0.557	0.075	0.240	–0.170	–			
TMT diversity (TMTDIV)	0.192	0.176	–0.113	0.117	–0.201	0.224	0.843		
Firm size (SIZE)	–0.145	–0.005	0.007	0.295	0.196	–0.051	–0.122	–	
Industry (PRODUCT)	–0.089	0.051	–0.222	–0.076	–0.031	0.261	0.053	–0.058	–

The diagonal of the correlation matrix reports the square-root of the average variance extracted for reflective constructs. All correlations above 0.21 are significant at $p < 0.05$.

Table 5

PLS structural model results.

Independent variables	Dependent variables				
	PMBAL	PMDEB	PMDIV	COGCON	INNAMB
COMAMB	0.260	0.161	0.507	0.088	0.248
	(2.699)***	(1.422)*	(5.692)***	(0.603)	(2.321)**
PMBAL	–	–	–	–0.048	0.001
				(0.345)	(0.019)
PMDEB	–	–	–	0.135	0.110
				(0.947)	(1.128)
PMBAL * PMDEB	–	–	–	0.200	–
				(1.802)**	
COGCON	–	–	–	–	0.219
					(1.925)**
PMDIV	–	–	–	–0.160	0.438
				(0.980)	(3.902)***
PMDIV * PMBAL	–	–	–	–0.199	–
				(1.209)	
PMDIV * PMDEB	–	–	–	–0.110	–
				(0.667)	
TMTDIV	–0.151	0.129	0.117	–0.129	0.061
	(1.582)	(1.292)	(1.128)	(0.810)	(0.540)
TMTDIV * PMBAL	–	–	–	–0.017	–
				(0.085)	
TMTDIV * PMDEB	–	–	–	0.142	–
				(0.502)	
SIZE	0.015	0.331	0.055	0.141	–0.017
	(0.167)	(3.557)***	(0.549)	(1.021)	(0.175)
SIZE * PMBAL	–	–	–	–0.063	–
				(0.319)	
SIZE * PMDEB	–	–	–	0.178	–
				(1.073)	
PRODUCT	–0.190	–0.049	0.303	0.080	–0.031
	(2.476)**	(0.536)	(3.569)***	(0.638)	(0.324)
R^2	12.3%	13.9%	35.3%	19.8%	42.3%

COMAMB = competence ambidexterity, INNAMB = innovation ambidexterity, PMBAL = balance of performance measures, PMDEB = debate on performance measures among the top management team, PMDIV = diversity of performance measures, COGCON = cognitive conflict of top management team, TMTDIV = diversity of top management team members, SIZE = natural logarithm of the number of employees, PRODUCT = value of 1 if the firm is product oriented and 0 otherwise.
Each cell reports the structural path coefficient (*t*-value). Blank cells indicate untested paths.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$ (one-tailed for hypothesised associations, two-tailed otherwise).

Appendix A

Survey items

Competence exploitation

1. Upgrading current knowledge and skills for familiar products/services and technologies
2. Investing in enhancing skills in exploiting mature technologies in your industry that improve productivity of current product/service innovation operations
3. Enhancing competencies in searching for solutions to customer problems that are near to existing solutions
4. Upgrading skills in product/service development processes in which the firm already possesses significant experience
5. Strengthening knowledge and skills for projects that improve efficiency of existing product/service innovation activities

Competence exploration

1. Acquiring entirely new skills that are important for product/service innovation (such as identifying emerging markets and technologies; coordinating and integrating R&D, marketing, manufacturing, and other functions; managing the product development process)
2. Learning product/service development skills and processes entirely new to your industry (such as product design, prototyping new products, timing of new product introductions)
3. Acquiring product/service technologies and skills entirely new to the organisation
4. Learning new skills in key product/service innovation-related areas (such as funding new technology, staffing R&D function, training and development of R&D, and engineering personnel for the first time)
5. Strengthening product/service innovation skills in areas where it had no prior experience

Incremental innovation

1. The organisation I lead has frequently introduced new incremental products/services in the last 3 years
2. Compared with major competitors, my organisation has introduced more incrementally new products/services in the last 3 years
3. The percentage of total sales from new incremental product/service innovations implemented in my organisation in the last 3 years, was greater than major competitors
4. Please indicate the approximate % of total sales from incremental products/services introduced in the last 3 years by the organisation you lead (<5%, 5–10%, 11–15%, 16–20% >20%)*

Radical innovation

1. The organisation I lead has frequently introduced radically new products/services into markets that are totally new to the firm in the last 3 years
2. Compared with major competitors, my organisation has introduced more radically new products/services in the last 3 years
3. The percentage of total sales from new radical product/service innovations implemented in my organisation in the last 3 years, was greater than major competitors.
4. Please indicate the approximate % of total sales from radical products/services introduced in the last 3 years by the organisation you lead (<5%, 5–10%, 11–15%, 16–20%, >20%)*

Cognitive conflict

1. How much do members of your senior management team disagree about the content of strategic decisions?
2. To what extent are there differences of professional opinion among members of your senior management team?
3. How frequently are there disagreements about ideas among members of your senior management team?

4. How often do people in your senior management team disagree regarding this organisation's strategic decisions?

PM debate

1. Performance measures are often discussed in meetings of the senior management team
2. Performance measures are frequently used to debate assumptions
3. Performance measures rarely encourage discussion of action plans (reverse coded)
4. Performance measures are debated among members of the senior management team

TMT diversity

1. The members of my team vary widely in their areas of expertise
2. The members of my team have a variety of different backgrounds and experiences
3. The members of my team have skills and abilities that complement each other

Performance measures that do not increase the visibility of radical innovation

1. Number of new products/services launched
2. Percentage of revenue from new products/services (launched in last year, last 3 years or last 5 years)
3. Number of products/services first to market
4. Lead time over competition
5. Average time to market for new products/services
6. Return on innovation investment
7. Total number of new patents granted each year

Performance measures increasing the visibility of radical innovation

1. Headcount or FTE specifically devoted to more radical type innovation projects
2. Financial resources specifically devoted to more radical type innovation projects (e.g., R&D spending or percentage of budget devoted to these projects)
3. Number of new patents for more radical type projects granted each year
4. Portfolio of products analysed by risk of different innovation projects
5. Portfolio of products analysed by breakeven time of different innovation projects
6. Portfolio of products analysed by stage of development of different innovation projects
7. Portfolio of products analysed by type of innovation projects (e.g., incremental, radical, breakthrough)

* Items removed from analysis.

Appendix B

Exploratory factor analysis of reflective construct items.

	INCREM	RADIC	EXPLOIT	PMDEB	TMTDIV	COGCON	EXPLORE
EXPLORE1	–0.169	0.090	0.136	–0.070	–0.353	0.068	**–0.457**
EXPLORE2	–0.039	0.131	0.135	–0.046	–0.062	–0.077	**–0.549**
EXPLORE3	0.194	–0.043	–0.095	–0.009	–0.046	–0.006	**–0.759**
EXPLORE4	–0.079	0.104	0.235	0.088	0.143	–0.023	**–0.733**
EXPLORE5	–0.070	0.061	0.197	0.053	–0.071	0.035	**–0.647**
EXPLOIT1	0.117	0.046	**0.455**	0.022	0.067	–0.120	–0.354
EXPLOIT2	0.004	0.004	**0.410**	–0.103	0.155	–0.168	–0.226
EXPLOIT3	0.037	0.069	**0.685**	–0.119	–0.031	0.065	–0.084
EXPLOIT4	0.105	–0.101	**0.894**	0.030	–0.073	0.065	–0.034
EXPLOIT5	–0.059	0.030	**0.842**	0.004	–0.033	–0.007	0.065
INCREM1	**0.470**	0.098	0.025	–0.246	0.078	0.095	–0.068
INCREM2	**0.994**	0.000	–0.004	0.053	–0.131	0.021	–0.052
INCREM3	**0.593**	0.364	0.186	0.067	0.045	–0.083	0.116
INCREM4*							
RADIC1	0.017	**0.573**	–0.083	0.034	–0.020	0.079	–0.475
RADIC2	0.202	**0.744**	–0.127	–0.046	–0.073	0.023	–0.183
RADIC3	0.040	**0.981**	0.079	–0.062	–0.018	0.002	0.111
RADIC4*							
COGCON1	0.137	–0.070	0.095	–0.017	0.094	**0.614**	–0.007
COGCON2	–0.025	–0.049	–0.028	–0.036	0.028	**0.730**	0.034
COGCON3	–0.113	0.054	–0.050	–0.126	–0.011	**0.763**	–0.035
COGCON4	0.024	0.105	0.015	0.190	0.005	**0.794**	0.003
PMDEB1	0.060	0.045	0.125	**–0.886**	–0.001	–0.109	0.037
PMDEB2	0.062	0.139	0.028	**–0.852**	–0.002	–0.062	0.009
PMDEB3	–0.020	0.021	0.043	**–0.389**	–0.034	0.070	0.057
PMDEB4	–0.035	–0.122	–0.121	**–0.780**	0.011	0.012	–0.073
TMTDIV1	–0.012	–0.019	–0.020	–0.015	**–0.711**	–0.017	–0.007
TMTDIV2	0.058	–0.042	0.002	0.053	**–0.890**	–0.051	–0.093
TMTDIV3	0.039	0.064	0.050	–0.052	**–0.666**	–0.055	0.075
Eigenvalue	6.79	3.09	2.68	2.43	2.09	1.37	1.06
Variance explained (%)	25.1%	11.5%	9.9%	9.0%	7.8%	5.1%	3.9%
Cronbach's alpha	0.82	0.91	0.85	0.81	0.81	0.81	0.85
KMO sampling adequacy	0.69						
Bartlett's test of sphericity	0.00						

Maximum likelihood extraction with oblimin rotation.

* These items loaded on a separate factor and were dropped from the analysis.

EXPLORE = competence exploration, EXPLOIT = competence exploitation, INCREM = incremental innovation, RADIC = radical innovation, COGCON = cognitive conflict of the top management team, PMDEB = debate on performance measures among the top management team, TMTDIV = diversity of top management team members.