How firms translate intended ambidexterity into innovation outcomes: 
The role of performance measurement systems

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Abstract

This paper examines the extent to which design and use attributes of performance measurement systems (PMSs) influence the conversion of intended competence ambidexterity into the achievement of ambidextrous innovation outcomes. Drawing on paradox and organisational conflict literature, this study emphasises the role of cognitive conflict in shaping the relationships between PMSs and ambidexterity. Using cross-sectional survey data from a sample of 90 Irish firms, the paper investigates whether a) the balance of performance measures and b) the degree to which performance measures are used for debate and discussion among the top management team (TMT) impact on the generation and management of cognitive conflict in order to simultaneously achieve incremental and radical innovation outcomes. Findings reveal that cognitive conflict significantly drives the achievement of ambidextrous innovation outcomes. Furthermore, the results of this study indicate that intentions to develop competence ambidexterity do not generate cognitive conflict by themselves. Rather it is through the combined presence of balance in the design of a PMS and the use of performance measures for debate and discussion among the TMT that cognitive conflict is activated. Overall, the paper emphasises the relevance of the role of PMSs as conflict generators in order for ambidextrous firms to be able to realise their strategies.

1. Introduction

In the past two decades a significant stream of research has developed demonstrating the importance of organisational ambidexterity (OA) – the ability to simultaneously achieve multiple and contradictory objectives – for the long-term survival and prosperity of a firm (Birkinshaw and Gupta (2013); (Gibson & Birkinshaw, 2004; He & Wong, 2004; Jansen, Simsek, & Cao, 2012; Lubatkin, Simsek, & Veiga, 2006; Simsek, 2009). The OA literature emphasises the need for firms to simultaneously exploit existing competencies and explore new possibilities (March, 1991; Smith & Tushman, 2005) as well as to simultaneously engage in both radical and incremental forms of innovation (Benner & Tushman, 2002, 2003; Jansen, Van den Bosch, & Volberda, 2006). Central to this simultaneous achievement is the ability of the top management team (TMT) to “recognize and translate different, ambiguous, and conflicting expectations into workable strategies” (Jansen, George, Van den Bosch, & Volberda, 2008 p. 985). How the TMT effectively comprehends and manages the contradictory tensions of exploration and exploitation is therefore critical for converting these opposing objectives into realised ambidextrous innovation outcomes (i.e. both radical and
incremental innovation), yet this remains relatively unexamined (Smith, 2014; Smith & Tushman, 2005).

The management accounting literature suggests that management control systems (MCSs) are likely to be a significant factor in the ability of the TMT to achieve ambidexterity as they are central to the formulation and implementation of strategy (Langfield-Smith, 2007; Simons, 1995) and play a significant role in the management of innovation (Chenhall & Moers, 2015; Davila, Foster, & Oyon, 2009). Performance measurement systems (PMSs) are used extensively in practice (Widener, 2007) and recent literature has given particular attention to their design, use and importance in pursuing different forms of innovation (Bedford, 2015; Chiesa, Frattini, Lamberti, & Noci, 2009; Grafton, Lillis, & Widener, 2010; Ylinen & Gullkvist, 2014). However, most of these studies provide little insight into the role of PMSs in firms that simultaneously pursue multiple and contradictory objectives, with only a few papers investigating the implications of different styles of use (i.e. diagnostic and interactive) of PMSs in ambidextrous contexts (Bedford, 2015; McCarthy & Gordon, 2011). What has not been addressed is the information contents of the PMS – what is measured and reported – and how this is related to the ability of the TMT to deal with competing objectives. Additionally, existing studies provide no insight into the mechanisms through which PMSs actually enable ambidexterity outcomes to be realised.

The purpose of this study is to investigate how PMSs are implicated in translating the intentions of the TMT to develop competence ambidexterity (the simultaneous pursuit of exploitation and exploration) into realised innovation ambidexterity (producing incremental and radical innovation outcomes). To address this question we draw upon the organisational literature on paradox (Andriopoulos & Lewis, 2009, 2010; Smith, 2014; Smith & Tushman, 2005) and organisational conflict (Amason, 1996; De Dreu & Weingart, 2003; Rahim, 2015; Simons & Peterson, 2000). Ambidexterity represents a paradox as it requires the TMT to simultaneously address contradictory strategic objectives (Andriopoulos & Lewis, 2009, 2010). The effective management of firms emphasising ambidexterity requires the TMT to recognise and engage in the conflict that arises from the tension between inconsistent demands (Smith, Binns, & Tushman, 2010). We argue that the PMS plays an important role in recognizing these tensions, making them salient and managing them. Specifically, we contend that firms emphasising contradictory strategic objectives design their PMS to be balanced – that is, the information content of the PMS brings into tension incentives to exploit existing competences aimed at improving and extending existing product lines and the
simultaneous encouragement of exploration and experimentation with new products and technologies. By juxtaposing competing demands the PMS generates cognitive conflict between the TMT, enabling the identification of connections and synthesis of contradictory alternatives (Lewis, 2000; Smith, 2014). We further contend that debate and discussion around the PMS among TMT members accentuates the generation of cognitive conflict (Fredberg, 2014; Smith & Lewis, 2011) and helps manage it (Lewis, 2000).

We test our expectations using cross-sectional survey data from a sample of 90 Irish firms operating in high-tech industries. Our findings reveal that firms emphasising competence ambidexterity design their PMSs to provide a balanced representation of the organisational efforts towards incremental and radical innovation. We also show that cognitive conflict within the TMT is a critical mechanism for realising innovation ambidexterity, but that emphasising the development of competence ambidexterity is insufficient for this to occur. Rather it is precisely through the combined presence of a balanced PMS design and a high level of use of the PMS for debate and discussion among the TMT members that cognitive conflict is activated, thus emphasising a significant role for PMS in ambidextrous firms.

This study contributes to the literature in four main ways. First, we provide evidence on the design of PMSs in firms pursuing multiple and contradictory strategic objectives. This extends our understanding of PMSs in ambidextrous firms, with extant research limited to the investigation of the different styles of MCS use (Bedford, 2015). This study also adds to the literature on the determinants of performance measure choice. While prior research finds that PMSs have a higher diversity of broad-scope metrics in firms that emphasise multiple strategic priorities (Dekker, Groot, & Schoute, 2013; Lillis & van Veen-Dirks, 2008), we show that the balance between measures that incentivise incremental innovation and those that provide visibility to radical innovation is also an important consideration for ambidextrous firms.

Second, this study demonstrates that a critical role of PMSs in ambidextrous firms is the generation of cognitive conflict. Thus, it brings to the forefront the role of PMSs as conflict generators, a role that has generally been neglected in prior literature (Vaivio, 2004). The reported findings highlight the relevance of the role of PMSs as conflict generators in order for ambidextrous firms to be able to realise their strategies.

Third, the results of this study reveal that the balanced design of a PMS is insufficient in itself to create cognitive conflict within the TMT. Instead we find that cognitive conflict is
generated through the combination of both a balanced PMS design and the use of the PMS to trigger debate and discussion amongst the TMT. In doing so, this study is one of the first to show how the verbal communication of accounting information acts to complement the information characteristics of accounting information (Hall, 2010). We show that designing the PMS with balanced information content and then using the information in the PMS in debate and discussion reinforce each other to enable constructive conflict to occur amongst TMT members, which is critical for effectively managing the tensions inherent in firms attempting to achieve opposing strategic demands (Smith & Tushman, 2005).

Fourth, in examining the association between PMSs and cognitive conflict, this study extends our understanding of the mechanisms through which MCSs influence organisation level outcomes. Chenhall (2007) argues that although prior research finds that MCSs are associated with organisational outcomes, such as firm performance, there is little understanding of how this takes place. Similarly, Hall (2016) observes that even though many studies draw upon psychology theory, few attempt to empirically investigate 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. The beneficial role of cognitive conflict found in this study is consistent with evidence in the literature on its positive impact on decision making generally (e.g. Amason, 1996; Parayitam & Dooley, 2009) and more specifically its positive impact in ambidextrous firms (e.g. Smith et al., 2010; Smith, 2014).

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 hypotheses development 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, and finally Section 7 concludes.

2. Theoretical framework

2.1. Organisational ambidexterity

OA refers to the capacity of an organisation to simultaneously address multiple but contradictory objectives equally well (Birkinshaw & Gupta, 2013; Simsek, 2009). As the literature on OA has developed, research has tended to conceptualise ambidexterity more specifically in terms of either the emphasis on multiple competences (ex-ante view) or the
achievement of multiple outcomes (ex-post view) (Birkinshaw & Gupta, 2013). OA research adopting an ex-ante perspective has predominantly relied upon March’s (1991) distinction between exploitation (the ability to refine and extend existing knowledge, skills and processes) and exploration (the ability to develop entirely new knowledge, skills and processes) (Atuahene-Gima, 2005), with competence ambidexterity denoting the propensity (Jansen, Tempelaar, Van den Bosch, & Volberda, 2009), intention (He & Wong, 2004) or capacity (Gibson & Birkinshaw, 2004) to pursue competence in exploitation and exploration simultaneously.

Research adopting an ex-post perspective considers ambidexterity as the simultaneous achievement of opposing organisational outcomes, such as incremental and radical innovations (He & Wong, 2004; Raisch & Birkinshaw, 2008). In the context of new products/services, incremental innovations refer to small improvements or extensions to existing products and require relatively minor changes in technology, while radical innovations are products that are completely new and involve fundamental technological changes (Atuahene-Gima, 2005; Benner & Tushman, 2003). The simultaneous achievement of both incremental and radical innovation outcomes is labelled as innovation ambidexterity (Kortmann, 2014; Lin, McDonough, Lin, & Lin, 2013).

An emerging stream of research has more comprehensively drawn on both ex-ante and ex-post conceptualisations of OA to examine how ambidextrous firms “excel at exploiting existing products to enable incremental innovation and at exploring new opportunities to foster more radical innovation” (Andriopoulos & Lewis, 2009, p. 696). Most of these studies examine the separate effects of exploitation and exploration on innovation outcomes (Atuahene-Gima, 2005; He & Wong, 2004), with only Wang and Rafiq (2014) and Kortmann (2014) investigating the association between intended competence ambidexterity and ambidextrous innovation outcomes. However, these studies are limited to the examination of the direct association between intentions and outcomes, providing little understanding as to which structures and processes allow firms to manage the contradictory demands arising from an emphasis on both exploitation and exploration and the mechanisms through which

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1 An additional issue addressed in the literature is the use of structural (e.g. Smith & Tushman, 2005) and contextual (e.g. Gibson & Birkinshaw, 2004) approaches to manage 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).
competence ambidexterity is effectively translated into realised innovation outcomes (Andriopoulos & Lewis, 2009; O'Reilly & Tushman, 2013).

2.2. Managing contradictory demands

Some insight into how firms can manage contradictory strategic agendas 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). The literature argues that the effective management of paradoxes involves embracing, rather than suppressing, tensions by framing contradictions as “both/and” possibilities rather than “either/or” options (Lewis, 2000, p 764; Smith & Lewis, 2011). If adequately made salient and harnessed, tensions arising from organisational paradoxes can be powerful and beneficial (Andriopoulos & Lewis, 2010).

Salient tensions involving paradoxes are associated with conflict (Smith & Tushman, 2005). Conflict refers to a clash 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 party (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 engage in simultaneous exploration and exploitation (Smith, 2014). Research further concludes that recognizing, exposing and engaging in conflict helps execute paradoxical strategies – including ambidextrous strategies – more effectively than avoiding or suppressing conflict (Eisenhardt & Westcott, 1988; Lewis, 2000; Smith et al., 2010; Smith, 2014; Smith & Tushman, 2005).

The literature on organisational conflict recognises that there are different forms of conflict (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 some 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).2

Despite the assumed importance of conflict as a central mechanism for translating competence ambidexterity into innovation outcomes, there is still little empirical examination of the role of conflict in ambidextrous firms or how it is generated and managed. Conflict and types of conflict have been mostly ignored in the contingency-based studies that have examined the factors that influence the effective implementation of ambidextrous strategies. Case-based paradox studies on ambidexterity have not delved into the distinction between types of conflict when they examine decision-making processes of TMTs. The absence of any consideration of the cognitive implications of paradoxical tensions and conflict applies in particular to studies which have examined the effects of MCSs in ambidextrous organisations. In this study we focus on how cognitive conflict is effectively generated within the TMT and the effects of cognitive conflict on the translation of competence ambidexterity into ambidextrous innovation outcomes. We are particularly interested in better understanding whether MCSs intervene in the generation of cognitive conflict and in the management of it to realise such translation.

2.3. Management control systems and ambidexterity

A significant body of research demonstrates the beneficial role of MCSs for managing innovation when designed and used in certain ways (Chenhall & Moers, 2015; Davila et al., 2009). Recent research has begun to examine variations in the design and use of MCSs across different types of innovation (Bedford, 2015; Cardinal, 2001; Grafton et al., 2010; McCarthy & Gordon, 2011; Ylinen & Gullkvist, 2014). However, little attention has been devoted to examining the role of MCSs in managing the contradictory demands of ambidextrous innovation strategies. In one of the few studies to do so, Bedford (2015) shows that both the

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2 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 helped translate the implementation of activity based costing management into beneficial firm outcomes.
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 in the use of MCSs will disrupt the tension needed to manage contradictory and competing demands. While Bedford (2015) highlights the importance of different uses of accounting information, what is unexamined is the nature and content of the information that is reported to the TMT which enables underlying tensions to be recognised and managed. In this study we examine the design and use of performance measurement systems (PMSs) as PMSs are fundamental to the success of organisational innovation efforts (Chenhall & Moers, 2015; Davila, Epstein, & Shelton, 2012).

In this study, the design of a PMS relates to the substantive contents of what is measured. Studies have shown that when multiple strategic priorities are emphasised (i.e. both cost leadership and differentiation) firms will choose to implement PMSs with a greater diversity of performance measures (Dekker et al., 2013; Lillis & van Veen-Dirks, 2008). It is argued that a comprehensive PMS with a wider spectrum of performance measures are effective “at balancing effort and decisions toward the multiple strategies pursued” (Dekker et al., 2013, p. 71). However, common measures related to innovation (e.g. ROI, number of new products launched, time-to-market) tend to favour an emphasis on incremental innovation which can lead to the crowding out of radical innovation efforts (Anthony, Johnson, Sinfeld, & Altman, 2008; Davila et al., 2012). This relates to the relative measurability of behaviours that lead to increasing the efficiency of existing products and operations compared to the more intangible nature of exploratory activities that increase the probability of success in the future (McCarthy & Gordon, 2011). 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). In the next section we argue that the balance of performance metrics is the critical design choice for firms pursuing ambidexterity.

Another stream of literature has emphasised the relevance of patterns of use of PMSs (and other MCSs) for successful innovation, by examining how managers use them in an enabling, interactive and learning-oriented manner (Ahrens & Chapman, 2004; Bisbe & Otley, 2004; Henri, 2006a; Jorgensen & Messner, 2010; Simons, 1995). This research demonstrates that the relevance of PMS for innovation is not solely a function of its

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3 A Performance Measurement System (PMS) refers to a multi-dimensional set of performance measures that support the decision-making and control activities of managers (Henri, 2006a; Neely, Gregory, & Platts, 2005).
information characteristics and form of presentation, but also highly dependent on whether and how managers use this information (Hall, 2010; Simons, 1999). Interpersonal communication and intensive forms of information exchange such as critical debate and discussion are important for coordination and knowledge integration when facing 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 intended competence ambidexterity into realised innovation ambidexterity by enabling and managing TMT cognitive conflict. First, we argue that an emphasis on competence ambidexterity will increase the level of cognitive conflict experienced by the TMT (H1). Second, we expect that TMTs that experience greater cognitive conflict are more effective in realising innovation ambidexterity (H2). Third, we contend that firms pursuing competence ambidexterity will tend to design a PMS that is balanced between performance measures that incentivise incremental innovations and those that give visibility to radical innovations (H3). Fourth, we expect that balanced PMS will trigger cognitive conflict between TMT members (H4), and that this association will be greater for TMTs that have higher levels of debate and discussion around performance measures (H5). Finally, we argue that the more intensive the use of PMS for debate and discussion, the more positive the association between cognitive conflict and innovation ambidexterity (H6). An overview of the theoretical model is presented in Fig. 1.4

3.1. Ambidexterity and cognitive conflict

The intention to simultaneously develop competencies in exploitation and exploration represents an organisational paradox (Andriopoulos & Lewis, 2009, 2010; Smith & Tushman, 2005; Smith & Lewis, 2011). The presence of this paradox is expected to create significant conflict between TMT members as the short-term, efficiency focus of exploitation is at odds

4 The first two hypotheses play an auxiliary role in our model as they are reasonably well developed in the broader management literature and do not involve accounting constructs. Yet, we include them in our model as they provide crucial context for the hypotheses involving accounting constructs (H3 to H6). Furthermore, even in the management literature, they have been subject to little large-scale empirical examination.
with the long-term, experimental emphasis of exploration (Jansen et al., 2008; Smith et al., 2010). Senior managers, with varying responsibilities and agendas, are likely to have judgemental differences regarding the allocation of limited resources, the prioritisation of opposing objectives, and the alternatives available to realise these objectives (Smith, 2014). These task-related differences relate to the level of cognitive conflict experienced (Amason, 1996; Amason & Schweiger, 1994; Rahim, 2015; Simons & Peterson, 2000). We therefore predict that the more pronounced the intention to simultaneously pursue exploitation and exploration, the more the TMT will experience cognitive conflict. Hence we hypothesise:

**H1. Competence ambidexterity is positively associated with cognitive conflict.**

The strategic decision making behaviors of the TMT are important determinants of an organisation’s success (Hambrick & Mason, 1984). The effectiveness of the decisions reached by a TMT and the overall effectiveness of the organisation are influenced by the level and type of conflict present in the TMT decision making process (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, resource distraction and cognitive overload, which impair satisfaction and team performance (e.g. . However, organisational conflict literature tends to assert that these negative effects are generally outweighed 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. This confrontation provides the opportunity for identifying and openly contrasting opposing positions (Amason & Schweiger, 1994), which enhances the awareness of perceptual diversity and judgemental differences over how to best achieve the organisation’s goals (Chenhall, 2004). Further, it fosters shared understandings of the strategic issues being discussed (Simons and Petersen, 2000), 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, overlooking critical evaluation, falling into confirmatory biases in team decision-making and inhibiting the creation and dissemination of new ideas (De Dreu, 2006).5

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) have referred to the need for TMT to embrace conflict in order to be able to manage paradoxical tensions (Smith & Lewis, 2011). 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 actually realise ambidextrous innovation outcomes. Hence, we formalise our expectation as:

**H2.** Cognitive conflict is positively associated with innovation ambidexterity.

### 3.2. PMS design: Balance of performance measures

Prior research finds that firms pursuing multiple strategic priorities tend to adopt broader sets of performance measures covering a more diverse range of key success factors (Lillis & van Veen Dirks, 2008; Dekker et al., 2013). However, designing a PMS with a greater diversity of performance measures may be problematic for firms pursuing ambidexterity. While innovation measures that are typically incorporated into a PMS (e.g. return on innovation investment, number of new products, patent filings) capture efforts towards both incremental and radical innovations, they tend to incentivise investments in incremental innovations over radical innovations (Anthony et al., 2008; Davila et al., 2012).6

For example, while the metric ‘number of new products’ encapsulates both incremental and

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5 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 primarily 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.

6 The TMT in ambidextrous firms may in fact prefer simplified accounting information. For instance, Hall (2010) argues that “the process of developing knowledge of the work environment is promoted by managers engaging with simpler information that challenges existing points of view” (p. 304).
radical new products, its use may incentivise the prioritisation of projects which will lead to a greater number of new products in the shorter term over projects with longer term potential to contribute to an increase in the measure. The risk of exploitation crowding out exploration efforts has been recognized by the OA literature (Atuahene-Gima, 2005; Levinthal & March, 1993). Smith and Tushman (2005) and O’Reilly and Tushman (2013) point out that the difficulty in achieving OA is that there is a greater certainty of short-term success with exploitation, while exploration is inherently risky and has more uncertain payoffs. This coupled with cognitive preferences for consistency and certainty means that TMTs will tend to make resource allocation and investment decisions that favour exploitation over exploration (Levinthal & March, 1993). An imbalance in performance measures is likely to magnify these biases. This is demonstrated by Benner and Tushman (2002, 2003) who observe that the development of metrics associated with process management and control tends to increase both incremental innovations and their share of total innovations, crowding out radical innovation. Radical innovation projects can also fail because of the orientation of KPIs to process efficiency, outputs and near-term gains, whereas KPIs suitable for radical innovation should instead be oriented more towards resources devoted to it and learning(Kupper, Lorenz, Maurer, & Wagner, 2013).

Thus, we expect firms that simultaneously invest in developing competence in both exploitation and exploration will aim to design their PMS in a way that counteracts tendencies towards the crowding out of radical innovation. We predict that these firms will design the substantive contents of their PMS so that they represent a balance between measures which incentivise incremental innovation and those which increase the visibility of radical innovation (henceforth, “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 PMS to the portfolio’s mix of incremental and radical innovation (Davila et al., 2012) and the requirement to define distinct goals to motivate both incremental and radical innovation (Smith & Tushman, 2005). In sum, we expect that firms with greater ambidexterity intentions will tend to design more balanced sets of performance measures. We formalise this as:

**H3.** Competence ambidexterity is positively associated with PM balance.
Developing shared cognitive frames that embrace and juxtapose contradictory assumptions and expectations are an important channel by which latent paradoxical tensions are made salient (Smith, 2014; Smith & Tushman, 2005). Paradoxical framing means that opposing views are held and explored simultaneously enabling the TMT to build a “collective acknowledgement of the tensions and conflicts between their contrasting agendas” (Smith & Tushman, 2005, p. 531). By bringing different perspectives and opposing issues to the surface, the development of paradoxical frames increases the likelihood of the TMT having judgemental differences and clashing positions regarding the potential alternatives available to the firm. Shared paradoxical frames also shift the perspective of the TMT from selecting between competing priorities to exploring how opposing objectives can be realised simultaneously (Lüscher & Lewis, 2008). This reduces the threat of competition between individual agendas and encourages positive conflict between the TMT concerning how different courses of action might be mutually beneficial (Murnighan & Conlon, 1991; Smith & Tushman, 2005). Paradoxical frames are therefore likely to result in cognitive conflict amongst TMT members.

PMSs are an important mechanism for managerial learning and cognitive framing (Chenhall, 2005; Hall, 2011; McKinnon & Bruns Jr, 1992). Hall (2011) investigates the association between comprehensive PMSs, defined as those which incorporate an integrated and diverse range of metrics, and managerial mental model building and confirmation. Hall finds that apart from managers in small firms and those with a short tenure, a comprehensive PMS reinforces existing cognitive representations rather than helping to challenge existing points of view and fostering new ways of thinking. To create tension with existing cognitive structures managers need to be presented with “new and potentially contradictory information” (Hall, 2011, p. 70). Similarly, the development of paradoxical frames requires that the mental models of managers are persistently challenged (Smith & Tushman, 2005). While some degree of diversity of performance measures is likely to be necessary (Lillis & van Veen-Dirks, 2008; Dekker et al., 2013), we argue that it is the balance of performance measures that is the critical design element of PMS for developing shared paradoxical frames and generating cognitive conflict between members of the TMT.

PMSs that are balanced encourage the development of paradoxical frames as they provide juxtaposing accounts of the resources, actions and outcomes of efforts towards

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7 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 a lens that drives cognitive efforts (Smith & Lewis, 2011) and through which managers filter information and direct attention (Smith & Tushman, 2005).
incremental and radical innovation. Information presented in a balanced PMS is likely to result in challenges to existing points of view and differences of opinion regarding how to achieve conflicting organizational objectives. This suggests that simultaneously monitoring and receiving feedback about the achievement of opposing goals through a balanced PMS will be a source of cognitive conflict within TMTs. Previous qualitative research has pointed to this provocative role of PMS in advance conflicting arguments at grass roots level (Vaivio, 2004) An imbalance in performance measures, however, will present more consistent and coherent information that encourages managers to avoid tensions between contrasting goals and suppress judgemental differences and opinions on how to address them. Instead, by enabling a juxtaposition of opposing forces (Smith & Tushman, 2005), we expect that a PMS designed to include balanced performance measures will make these contradictions more salient, encourage paradoxical framing, and consequently increase the level of tension experienced by the TMT concerning how to achieve multiple inconsistent objectives simultaneously. As a result, we expect that the degree of balance in the PMS between measures which incentivise incremental innovation and those which increase the visibility of radical innovation will positively influence the level of cognitive conflict in TMTs. Hence:

**H4.** PM balance is positively associated with cognitive conflict.

### 3.3. Use of PMS: PM debate among the TMT

The accounting literature points to the potential for accounting information to provide an organising rationale around which dialogue and debate on strategic issues can occur (Chenhall & Moers, 2015; Hall, 2010). Through dialogue and debate the meanings and consequences of accounting information come to be known and connected to specific managerial problems and issues (Hall, 2010). Vaivio’s (2004) findings point to the importance of a platform for ‘speaking out’ (p. 53) conflicting views about problematized issues.

Dialogue between managers is particularly important in ambiguous and equivocal contexts that involve complex problem solving as this requires the transfer of tacit information (Daft & Lengel, 1986; Ditillo, 2004). Verbal communications around the interpretation of accounting information can “enable more tacit information exchange and potentially make [accounting information] much more relevant to managerial work” (Hall, 2010, p. 307). Building on these arguments about the importance of talk and debate, we
examine whether the extent to which PMS are used for debate and discussion among TMT members influences the ability of a balanced PMS to generate cognitive conflict and the achievement of ambidextrous outcomes.

We expect that the more the TMT use a PMS for debate, the more PM balance will increase managers’ awareness of the need to simultaneously achieve diverging objectives (Fredberg, 2014) and intensify the perceived tensions between opposing organisational goals (Smith & Lewis, 2011). The higher the level of debate and discussion between TMT members with different perspectives, the more likely it is that inconsistencies in the understandings of PMS information between managers are surfaced, increasing the extent to which balanced PMSs influence the extent of cognitive conflict experienced by the TMT. Research also emphasises the importance of dialogue in accentuating the salience of paradoxes (Calton and Payne (2003). Smith (2014) observes in firms managing paradoxical demands that “juxtaposing domains in conversation forced leaders to confront issues between them” (p. 76). While the design of a balanced PMS provides cues about opposing strategic domains, dialogue and debate amongst the TMT provides the opportunity for managers to share diverging perspectives and assumptions about its meaning and implications (Hall, 2010; Simons, Pelled, & Smith, 1999). Thus, the extent to which the design of a balanced PMS impacts on cognitive conflict will be enhanced by the extent to which the PMS is used for debate and discussion among the TMT (hereafter “PM debate”). We formalise this expected effect as follows:

H5. The higher the level of PM debate the more positive the association between PM balance and cognitive conflict.

Cognitive conflict is expected to improve the quality, and facilitate implementation, of TMT decisions (Amason, 1996; Chenhall, 2004; Jehn, 1995; Parayitam & Dooley, 2009); but this positive relationship is likely to be more pronounced when active conflict management is in place. In teams using active conflict management, members openly voice their concerns and differences of opinion are vigorously debated and discussed. Although Peterson (1999) finds that decision speed and the level of satisfaction with decision outcomes may decrease when team members have high, as opposed to moderate, levels of opportunity to express opinions and disagreements, most research argues that active conflict management incorporating debate and discussion has a positive effect on the relationship between
cognitive conflict and team effectiveness (DeChurch and Marks, 2001). This is consistent with O’Reilly and Tushman (2008) who contend that effective management of the inevitable conflicts that arise in ambidextrous firms requires “strategic debate” (Burgelman, 2002). Frequent, face-to-face communication amongst managers is also argued to “overcome different frames of references,” “clarify ambiguous issues to change understanding in a timely manner” (Daft & Lengel, 1986, p. 560) and foster “strategic understanding that in turn enable ambidexterity” (Cao, Simsek, & Zhang, 2010, p. 1276).

We expect the level of use of the PMS for debate and discussion among TMT to have an important role in managing cognitive conflict, in shaping the responses to it, and in eventually achieving the desired innovation ambidexterity. When facing cognitive tension, managers “typical and often first reactions are defensive, clinging to past understandings” which inhibit the capacity of the TMT to rethink existing positions and identify interrelationships between contradictory alternatives (Lewis, 2000, p. 763). Debate and discussion trigger managers’ reflection (Smith & Lewis, 2011) and accentuates their chances of revising their underlying logic and escaping paralysis (Lewis, 2000). Debate and discussion of the PMS among TMT enables sharing divergent attitudes and frames of reference concerning strategic issues (De Haas & Kleingeld, 1999) and deploys the attention-focusing role of a PMS (Dossi & Patelli, 2008; Henri, 2006b; Simons, 1991) A vigorous debate on PMSs by the TMT provides the opportunity for dialectically styled interactions and a means for contrasting opposing positions on how to deal with paradoxes associated with ambidexterity (Amason, 1996). This activates and enhances the ability of the TMT to take advantage of the perceptual differences between managers over how best to achieve ambidexterity intentions by identifying, confronting and synthesising a variety of viewpoints into more effective decision outcomes (Chenhall, 2004). Focusing debate around the PMS is important as solving complex problems “requires teams to communicate content that is relevant, objective, and clear so that members can see the validity” of their own and others’ views and ideas, thereby increasing the potential of the TMT to integrate and combine a multitude of perspectives (Gardner, Gino, & Staats, 2012, p. 1002; Lubatkin et al., 2006).

We consequently expect that a high level of use of a PMS for debate and discussion among TMT members enhances the predicted positive association between cognitive conflict and actual innovation ambidexterity. Thus we predict:
H6. The higher the level of PM debate the more positive the association between cognitive conflict and innovation ambidexterity.

4. Research method

4.1 Sample selection and data collection

Data for this study were collected using a cross-sectional questionnaire. The target population consisted of Irish firms, defined as legal entities that are independent or subunits of a larger organisation, operating in high-tech industries including medical equipment, electronics, pharmaceuticals, environmental technologies and information technology. 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 strategy variables of interest were applicable, and that a formal PMS was in place, firms were required to have a minimum size of 20 employees and to have operated for at least 3 years. The targeted 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 identified through a number of sources. Firms were initially identified from the membership list of the Irish Business and Employers’ Confederation (IBEC) 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, the FAME listing of medical device companies, and an online listing of IT firms in Ireland (makeITinIreland.ie). 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.8 Reminder emails were sent weekly for three weeks to those

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8 The format of the online version and the paper version of the questionnaire were substantively identical.
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). Firms that did not meet 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. Firms that reported having no say in innovation investment decisions were excluded. Removal of these firms resulted in a usable sample of 90 firms. Demographic information for the usable sample is shown 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.

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 Harman's single factor test was conducted on the survey items used to form the constructs. The unrotated factor solution returned thirteen factors with the variance accounted by the first factor (26.4%) well below half the total explained variance (76.2%), suggesting that single-source bias is not a significant concern.

4.2 Variable measurement

The questionnaire was pilot tested with five TMT members in firms operating in high-tech 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. The questionnaire items are detailed in Appendix A. Descriptive statistics are reported in Table 2, together with reliability and validity statistics for reflective constructs.
Intended competence ambidexterity is assessed in terms of the firm’s intention to invest in exploitation and exploration 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 competencies over the previous three years, we adapted the construct to measure the ex-ante objectives of the firm to develop these skills and competencies (He & Wong, 2004). Five items are used for both exploitation and exploration. Factor analysis results reported in Appendix B reveal that the ten items load as expected on two factors representing the intended development of exploitation and exploration competencies. The Cronbach alphas of both constructs are 0.85, well above acceptable minimum thresholds for construct reliability (Nunnally, 1978).

Early OA research operationalised ambidexterity as either a balance between exploitation and exploration or as a synergistic combination (He & Wong, 2004). However, recent research maintains that while these two dimensions are related, they represent distinct aspects of ambidexterity (Cao et al., 2009; Simsek, 2009). This literature indicates that OA is achieved through balancing high levels of exploitation and exploration rather than achieving balance at any level. Following this research we measure intended competence ambidexterity as the interaction of its balanced dimension (the absolute difference between exploitation and exploration scores) and its combined dimension (the multiplication of exploitation and exploration scores).

Achieved innovation ambidexterity is assessed in terms of radical and incremental innovation outcomes over the previous three years. Each construct is measured through four 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, factor analysis results indicate that three of the four items for radical innovation load on one factor, while three of the four incremental innovation items load on another 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 alphas for the three-item constructs of radical and incremental innovation are 0.91 and 0.82 respectively. To ensure consistency with the operationalisation of intended competence ambidexterity, achieved innovation ambidexterity is constructed as the interaction of the balanced (the absolute difference between radical and incremental innovation) and combined dimensions (the multiplication of radical and incremental innovation) of ambidexterity outcomes (Cao et al., 2009).
Cognitive conflict is a reflective construct measured using four items developed by Simons and Peterson (2000). This measure is based on Jehn (1995) and is tailored to the senior management team context. The four items load on a single factor with a Cronbach alpha of 0.81.

PM balance is a purpose developed instrument as there was no pre-existing construct to assess the relative balance between performance measures that incentivise different types of innovation. An initial list of metrics that were likely to incentivise incremental innovations, or increase the visibility of radical innovations, 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 pre-testing, top managers were questioned about the importance of the metrics and the actions that they incentivise. Based on the literature review and pre-testing feedback, a total of seven metrics were identified as incentivising incremental 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, revenue/output based metrics and input based metrics such as number of patents tend to incentivise 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 incentivise incremental innovation was calculated as the average of the scores measuring the importance given to each of these seven items.

In contrast, metrics which increase the visibility of activity in the radical innovation space provides information to managers to ensure that the organisation maintains an appropriate balance between investments aimed at producing incremental improvements in the short-term and those investments into 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 and Cooper et al. (2001) point to the importance of a portfolio approach to the management of a mix of innovation types. Based on the literature and our pretesting, we identified seven metrics which increase the visibility of radical innovation (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 increase visibility of radical innovation is calculated as the average of the scores measuring the importance given to each of these seven items. PM balance is operationalised as the absolute difference between the average of the scores of metrics incentivising incremental innovation and the average of the scores of metrics increasing visibility of radical innovation.

PM debate 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 this construct has been acknowledged as one of the constitutive dimensions of interactive use of control systems (Bisbe, Batista-Foguet, & Chenhall, 2007; Simons, 1995), we reviewed prior research that assesses this dimension (Chong & Mahama, 2014; Henri, 2006a; Marginson, McAulay, Roush, & Van Zijl, 2010; Marginson, McAuley, Rousch, & van Zijl, 2014; Naranjo-Gil & Hartmann, 2007; Su, Baird, & Schoch, 2015). Based on the items related to debate and discussion applied in these studies, we develop a four item measure to capture the degree of use of PM for debate and discussion among the TMT. All four items load on a single factor which returns a Cronbach 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 (Lillis & van Veen Dirks, 2008; Dekker, 2013), we include a control variable to capture the diversity of performance measures used by the firm. Following Dekker et al. (2013) and Henri (2006b), measurement diversity is operationalised as the mean score across all fourteen metrics. Consistent with previous studies on ambidexterity, we additionally control for firm size (Fernhaber & Patel, 2012; Kortmann, 2014; Lin et al., 2013), environmental dynamism (Jansen et al., 2012; Jansen et al., 2009; Patel, Messersmith, & Lepak, 2013), and organisational slack (Atuahene-Gima, 2005). Firm size is measured as the natural log of full time employees. Environmental dynamism is operationalised using the five item construct employed by Atuahene-Gima.

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9 In advance of this question, it was detailed in the survey that incremental innovations refer to innovations which lead to small improvements to existing products, services or business processes and radical innovations refer to innovations which lead to fundamental changes such as the creation of entirely new products, services or markets.
(2005) and previously developed by Jaworski and Kohli (1993). The five items load on a single factor with a Cronbach alpha of 0.79. Organisational slack is assessed using the three item measure from Atuahene-Gima (2005). All items load on a single factor with a Cronbach alpha value of 0.70.

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 explicitly 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.

<Insert Table 3 about here>

As displayed in Table 2, multi-item reflective constructs show acceptable reliability with Cronbach 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 indicator 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 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.

<Insert Table 4 about here>

<Insert Table 5 about here>

Results of the PLS structural model are reported in Table 5. In addition to the hypothesised relationships, the structural model controls for other non-hypothesised
associations including the direct effect of intended competence ambidexterity on actual innovation ambidexterity.

H1 predicts a positive relationship between intended competence ambidexterity and cognitive conflict. Table 5 shows that the structural path coefficient is insignificant and thus H1 is not supported ($\beta = 0.115$, n.s.). H2 expects a positive relationship between cognitive conflict and the level of achieved innovation ambidexterity. The results indicate a positive and significant association providing support for H2 ($\beta = 0.185$, $p < 0.05$). The results are also consistent with H3, which predicts a positive relationship between intended competence ambidexterity and the balance between performance measures that incentivise incremental innovation and those that provide visibility to radical innovation ($\beta = 0.274$, $p < 0.01$).

The results reveal a more complex association than hypothesised between cognitive conflict and both PM balance and PM debate. No support is found for H4 which expects a positive relationship between PM balance and cognitive conflict ($\beta = -0.071$, n.s.). However, the interaction between PM balance and PM debate does have a positive and significant association with cognitive conflict ($\beta = 0.218$, $p < 0.05$). Although the positive interaction term is consistent with H5, the insignificant direct paths between both PM balance and PM debate on cognitive conflict indicates that neither increases cognitive conflict in isolation. Instead, the findings reveal that both are simultaneously required to increase the level of cognitive conflict between members of the TMT. No support is provided for H6, which predicts a significant moderating effect of PM debate on the association between cognitive conflict and achieved innovation ambidexterity ($\beta = 0.236$, n.s.). Figure 2 displays the hypothesised associations that are supported by our findings.

As a robustness test we use an alternate operationalisation of the intended competence ambidexterity and achieved innovation ambidexterity constructs. Following Wang and Rafiq (2014) and Kortmann (2014) the ambidexterity constructs are operationalised as second-order reflective constructs. Assessments of the measurement model (unreported) return validity and reliability statistics above minimum thresholds. The structural model results are shown in

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10 As mentioned in footnote 5, 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.
Table 6. Tests of hypotheses are consistent with those reported in Table 5. The only significant difference is the path from intended competence ambidexterity and achieved ambidexterity innovation, which is insignificant in Table 6. This emphasises the importance of the design and use of the PMS in translating ambidexterity intentions into realised innovation outcomes.

<Insert Table 6 about here>

6. Discussion

The findings of this study reveal several relevant aspects of how PMSs intervene in the realisation of ambidextrous strategies. First, results provide evidence on how firms pursuing ambidexterity design their PMSs. We find that the intention to develop competence ambidexterity is associated with a choice of performance measures that provide a balanced representation of the resources, activities and outcomes of efforts directed towards incremental and radical innovation. This finding contributes to the emerging research on the role of MCSs in ambidextrous firms. Prior research shows that a balance between the diagnostic and interactive uses of accounting information increases performance in ambidextrous firms (Bedford, 2015). Our study extends this research by showing that balance is important not only in choices about how to use accounting information, but also in the design choices regarding what is measured and incorporated into the strategic decision-making processes of senior managers.

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 amongst 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 consistent as well 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 & Tushman, 2005; Smith et al., 2010; Smith, 2014; Smith & Lewis, 2011). 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 achieve 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 intended competence
ambidexterity does not generate cognitive conflict on its own but requires certain
organisational processes and practices. 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 ambidexterity
intentions into innovation outcomes through the generation of cognitive conflict. The role of
PMS as generators of conflict, and the deployment of their controversial, problematising
nature has generally been neglected in the literature (see Vaivio, 2004 for an exception which
focuses on the role of PMS in provoking organisational learning and articulation of local
knowledge at grass roots level). Our study suggests that the use of PMSs to provoke the
articulation of different and opposing points of view is crucial to realise 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
management accounting practices influence organisational level outcomes. Hall (2016)
oberves that while some studies draw on psychology theories to explain the effects of
management accounting on organisational outcomes, most do not incorporate the cognitive
processes that form the basis of the theory into empirical models. In this study we empirically
demonstrate how the design and use of PMS help to translate competence ambidexterity into
innovation outcomes by generating cognitive conflict between the TMT.

Fourth, we provide 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 only when
PM balance is combined with TMT debate and discussion 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 as 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 balanced PM design provides cues to managers about the issues that need to be addressed to create or maintain an effective balance between competing objectives, providing a context in which to discuss these issues. In turn, vigorous debate enables managers to interpret and construct meaning from the information by sharing tacit assumptions and understandings, which increases the relevance of PM information for managerial work (Hall, 2010), enabling the development of shared paradoxical frames and magnifying the salience of contradictory tensions that are reflected in a balanced PMS (Smith and Tushman, 2005).

However, we find no support for our expectation that higher levels of PM debate would help to manage conflict amongst the TMT, thereby enhancing the positive influence of cognitive conflict on achieved innovation ambidexterity. This lack of support may be due to certain negative effects counteracting the potential benefits of increased discussion and debate around PM. Benefits such as greater reflection (Smith & Lewis, 2011), revision of underlying logics (Lewis, 2000) and attention-focusing (Dossi & Patelli, 2008; Henri, 2006b) might be partially offset by increased frustration and delays in arriving at a mutually acceptable decision (Peterson, 1999). It is plausible that in order to enhance the relationship between cognitive conflict and innovation ambidexterity, conflict management is handled primarily through approaches that involve processes and instruments other than PMS (DeChurch and Marks, 2001).

Finally, our results reveal that intended 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 manage a paradox by switching between differentiating and integrating practices. Differentiating involves 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 emphasises 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 bring 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 it 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 convert their intentions to develop competence ambidexterity into innovation ambidexterity. Specifically, this study provides evidence on the extent to which one design attribute of PMSs (i.e. balance of performance measures) and one use attribute of PMSs (i.e. use of performance measures for debate and discussion among the TMT) contribute to generating and managing cognitive conflict, as well as to 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 achievement of innovation ambidexterity. However, the intention to develop ambidexterity competence does not generate cognitive conflict on its own. Intended ambidexterity competence drives balanced PMS designs, and the interaction between PM balance and PM debate within TMTs makes paradoxical tensions more salient and generates cognitive conflict. It is through PMSs that cognitive conflict is generated, and it is through cognitive conflict that PMSs have a crucial role in converting their intentions to develop competence ambidexterity into realised innovation ambidexterity. The role of PMSs as generators of conflict in ambidextrous firms highlights the controversial, problematising nature of management control systems in that 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 draw 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 paper tests a model that captures two attributes of one single type of management control practice (PMS). Previous research has pointed to the importance of considering management controls as packages and systems (Bedford, Malmi, & Sandelin, 2016; Grabner & Moers, 2013; Malmi
and it is likely that choices around design and use of PMSs are influenced by other control practices. Fourth, the study relies on survey based constructs, some of which are purpose 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 high tech 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 ambidexterity studies could explore the dynamics of how PMSs help firms simultaneously engage in contradictory strategies through discursive, contextual methods. Future qualitative accounting studies might also contribute by exploring what are the dynamic processes that underlie the generation of cognitive conflict by PMSs in ambidextrous environments. Future studies could also 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 only one type of MCS (i.e. PMS), subsequent research might extend investigation to additional PMS’s attributes or other types of MCS. 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 achievement of ambidexterity 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 to investigate.

Notwithstanding these limitations, the findings of this study demonstrate how performance measurement systems can play a powerful role in enabling success in ambidextrous firms. The introduction of arguments related to paradoxical tensions, the unpacking of the features of PMSs and the significant 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 processes through which PMSs impact on organisational outcomes.
Fig. 1
Theoretical model.

Intended competence ambidexterity → PM balance

PM balance → Cognitive conflict

Cognitive conflict → Achieved innovation ambidexterity

H1
H2
H3
H4
H5
H6
Fig. 2
Structural mode (only significant hypothesised relationships represented).
Table 1
Respondent demographics

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<th>Panel A: Industry</th>
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Table 2
Descriptive, reliability and average variance extracted statistics

<table>
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<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Theoretical range</th>
<th>Min.</th>
<th>Max.</th>
<th>Cronbach alpha</th>
<th>Composite reliability</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM balance (PMBAL)</td>
<td>6.09</td>
<td>0.77</td>
<td>1–7</td>
<td>3.29</td>
<td>7.00</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>PM diversity (PMDIV)</td>
<td>7.55</td>
<td>3.00</td>
<td>1–14</td>
<td>2.00</td>
<td>13.71</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>PM debate (PMDEB)</td>
<td>5.40</td>
<td>1.18</td>
<td>1–7</td>
<td>2.40</td>
<td>7.00</td>
<td>0.807</td>
<td>0.867</td>
<td>0.632</td>
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<tr>
<td>Cognitive conflict (COGCON)</td>
<td>2.58</td>
<td>0.66</td>
<td>1–5</td>
<td>1.00</td>
<td>4.55</td>
<td>0.814</td>
<td>0.877</td>
<td>0.642</td>
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<tr>
<td>Intended competence ambidexterity (AMBCOM)</td>
<td>61.91</td>
<td>25.48</td>
<td>1–125</td>
<td>12.32</td>
<td>125.00</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Achieved innovation ambidextrous (AMBINN)</td>
<td>95.53</td>
<td>74.01</td>
<td>1–343</td>
<td>11.48</td>
<td>343.00</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Environmental dynamism (ENVDYN)</td>
<td>3.02</td>
<td>0.77</td>
<td>1–5</td>
<td>1.30</td>
<td>5.00</td>
<td>0.785</td>
<td>0.854</td>
<td>0.544</td>
</tr>
<tr>
<td>Organisational slack (SLACK)</td>
<td>2.33</td>
<td>0.92</td>
<td>1–5</td>
<td>1.00</td>
<td>5.00</td>
<td>0.703</td>
<td>0.831</td>
<td>0.623</td>
</tr>
<tr>
<td>Firm size (SIZE)</td>
<td>5.34</td>
<td>1.58</td>
<td>n/a</td>
<td>3.00</td>
<td>10.65</td>
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Table 3
Measurement model cross-loadings

<table>
<thead>
<tr>
<th>Item</th>
<th>COGCON</th>
<th>PMDEB</th>
<th>ENVDYN</th>
<th>SLACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>COGCON1</td>
<td>0.707</td>
<td>0.042</td>
<td>0.108</td>
<td>−0.171</td>
</tr>
<tr>
<td>COGCON2</td>
<td>0.810</td>
<td>−0.009</td>
<td>0.161</td>
<td>−0.040</td>
</tr>
<tr>
<td>COGCON3</td>
<td>0.836</td>
<td>0.092</td>
<td>0.084</td>
<td>−0.131</td>
</tr>
<tr>
<td>COGCON4</td>
<td>0.845</td>
<td>−0.173</td>
<td>0.117</td>
<td>−0.094</td>
</tr>
<tr>
<td>PMDEB1</td>
<td>−0.063</td>
<td>0.946</td>
<td>0.022</td>
<td>0.238</td>
</tr>
<tr>
<td>PMDEB2</td>
<td>−0.012</td>
<td>0.948</td>
<td>0.068</td>
<td>0.188</td>
</tr>
<tr>
<td>PMDEB3</td>
<td>0.094</td>
<td>0.507</td>
<td>0.052</td>
<td>−0.110</td>
</tr>
<tr>
<td>PMDEB4</td>
<td>0.054</td>
<td>0.697</td>
<td>0.154</td>
<td>0.117</td>
</tr>
<tr>
<td>ENVDYN1</td>
<td>0.113</td>
<td>0.102</td>
<td>0.518</td>
<td>0.068</td>
</tr>
<tr>
<td>ENVDYN2</td>
<td>0.112</td>
<td>0.191</td>
<td>0.791</td>
<td>0.064</td>
</tr>
<tr>
<td>ENVDYN3</td>
<td>0.120</td>
<td>0.137</td>
<td>0.742</td>
<td>0.052</td>
</tr>
<tr>
<td>ENVDYN4</td>
<td>0.074</td>
<td>−0.177</td>
<td>0.816</td>
<td>0.002</td>
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<td>ENVDYN5</td>
<td>0.114</td>
<td>−0.063</td>
<td>0.780</td>
<td>0.008</td>
</tr>
<tr>
<td>SLACK1</td>
<td>−0.127</td>
<td>−0.044</td>
<td>0.151</td>
<td>0.868</td>
</tr>
<tr>
<td>SLACK2</td>
<td>−0.067</td>
<td>0.379</td>
<td>−0.029</td>
<td>0.807</td>
</tr>
<tr>
<td>SLACK3</td>
<td>−0.131</td>
<td>0.131</td>
<td>−0.042</td>
<td>0.682</td>
</tr>
</tbody>
</table>

COGCON = Cognitive conflict of top management team, PMDEB = debate on performance measures among the top management team, ENVDYN = Environmental dynamism, SLACK = Organisational slack. Bold values denote the factor with the highest loading of the item.
<table>
<thead>
<tr>
<th></th>
<th>PMBAL</th>
<th>PMDIV</th>
<th>PMDEB</th>
<th>COGCON</th>
<th>AMBCOM</th>
<th>AMBINN</th>
<th>ENVDYN</th>
<th>SLACK</th>
<th>SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM balance (PMBAL)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>PM diversity (PMDIV)</td>
<td>0.075</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>PM debate (PMDEB)</td>
<td>–0.017</td>
<td>0.230</td>
<td>0.795</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Cognitive conflict (COGCON)</td>
<td>–0.015</td>
<td>–0.164</td>
<td>–0.005</td>
<td>0.801</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Intended competence ambidexterity (AMBCOM)</td>
<td>0.246</td>
<td>0.495</td>
<td>0.128</td>
<td>–0.083</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Achieved innovation ambidexterity (AMBINN)</td>
<td>0.095</td>
<td>0.557</td>
<td>0.245</td>
<td>0.116</td>
<td>0.479</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Environmental dynamism (ENVDYN)</td>
<td>0.053</td>
<td>0.151</td>
<td>0.064</td>
<td>0.142</td>
<td>0.281</td>
<td>0.206</td>
<td>0.737</td>
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<tr>
<td>Organisational slack (SLACK)</td>
<td>0.044</td>
<td>0.281</td>
<td>0.169</td>
<td>–0.136</td>
<td>0.289</td>
<td>0.239</td>
<td>0.039</td>
<td>0.789</td>
<td>–</td>
</tr>
<tr>
<td>Firm size (SIZE)</td>
<td>0.007</td>
<td>–0.051</td>
<td>0.278</td>
<td>0.181</td>
<td>–0.145</td>
<td>–0.005</td>
<td>0.005</td>
<td>0.216</td>
<td>–</td>
</tr>
</tbody>
</table>

The diagonal of the correlation matrix reports the square-root of the average variance extracted for reflective constructs.
Table 5
PLS structural model results

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Intended competence ambidexterity</th>
<th>PM balance</th>
<th>PM diversity</th>
<th>Cognitive conflict</th>
<th>Achieved innovation ambidexterity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intended competence ambidexterity</td>
<td>-</td>
<td>0.274</td>
<td>0.437</td>
<td>0.115</td>
<td>0.184</td>
</tr>
<tr>
<td>PM balance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.071</td>
<td>0.001</td>
</tr>
<tr>
<td>PM diversity</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.109</td>
<td>0.390</td>
</tr>
<tr>
<td>PM debate</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.032</td>
<td>0.099</td>
</tr>
<tr>
<td>PM balance * PM debate</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.218</td>
<td>-</td>
</tr>
<tr>
<td>PM diversity * PM debate</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.404</td>
<td>-</td>
</tr>
<tr>
<td>Cognitive conflict</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.185</td>
</tr>
<tr>
<td>Cognitive conflict * PM debate</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.236</td>
</tr>
<tr>
<td>Firm size</td>
<td>-0.220</td>
<td>0.057</td>
<td>-0.023</td>
<td>0.251</td>
<td>-0.070</td>
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<td>Environmental dynamism</td>
<td>0.278</td>
<td>-0.023</td>
<td>0.020</td>
<td>0.221</td>
<td>0.004</td>
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<td>Organisational slack</td>
<td>0.325</td>
<td>-0.045</td>
<td>0.166</td>
<td>-0.191</td>
<td>0.083</td>
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<td>R²</td>
<td>20.8%</td>
<td>6.5%</td>
<td>26.8%</td>
<td>29.4%</td>
<td>47.5%</td>
</tr>
</tbody>
</table>

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 and two-tailed otherwise)
Table 6
PLS structural model results with ambidexterity modelled as a higher order construct

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Intended competence ambidexterity</th>
<th>PM balance</th>
<th>PM diversity</th>
<th>Cognitive conflict</th>
<th>Achieved innovation ambidexterity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intended competence ambidexterity</td>
<td>–</td>
<td>0.308</td>
<td>0.481</td>
<td>0.099</td>
<td>0.055</td>
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<tr>
<td></td>
<td></td>
<td>(2.901)**</td>
<td>(4.650)**</td>
<td>(0.675)</td>
<td>(0.471)</td>
</tr>
<tr>
<td>PM balance</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–0.051</td>
<td>–0.052</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.488)</td>
<td>(0.621)</td>
</tr>
<tr>
<td>PM diversity</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–0.075</td>
<td>0.551</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.581)</td>
<td>(6.403)**</td>
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<td>PM debate</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–0.015</td>
<td>0.100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.111)</td>
<td>(0.998)</td>
</tr>
<tr>
<td>PM balance * PM debate</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.220</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>(2.178)**</td>
<td></td>
</tr>
<tr>
<td>PM diversity * PM debate</td>
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<td>–</td>
<td>0.407</td>
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<td></td>
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<td>(1.170)</td>
<td></td>
</tr>
<tr>
<td>Cognitive conflict</td>
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<td>–</td>
<td>–</td>
<td>0.159</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1.814)**</td>
</tr>
<tr>
<td>Cognitive conflict * PM debate</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.188</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1.104)</td>
</tr>
<tr>
<td>Firm size</td>
<td>–</td>
<td>–0.216</td>
<td>–0.037</td>
<td>0.279</td>
<td>–0.127</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.887)*</td>
<td>(0.385)</td>
<td>(2.682)**</td>
<td>(1.285)</td>
</tr>
<tr>
<td>Environmental dynamism</td>
<td>0.289</td>
<td>–0.022</td>
<td>0.036</td>
<td>0.176</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>(2.705)**</td>
<td>(0.192)</td>
<td>(0.396)</td>
<td>(1.314)</td>
<td>(0.366)</td>
</tr>
<tr>
<td>Organisational slack</td>
<td>0.317</td>
<td>–0.020</td>
<td>0.178</td>
<td>–0.232</td>
<td>0.101</td>
</tr>
<tr>
<td></td>
<td>(3.019)**</td>
<td>(0.171)</td>
<td>(1.800)*</td>
<td>(2.158)**</td>
<td>(1.240)</td>
</tr>
</tbody>
</table>

\[ R^2 \]

20.8%  6.5%  26.8%  29.4%  47.5%

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 and two-tailed otherwise)
Appendix A
Survey items

**Intended 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

**Intended 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

**Achieved 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%)*

**Achieved 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

**Environmental dynamism**
1. The actions of local and foreign competitors in our major markets were changing quite rapidly
2. Technological changes in our industry were rapid and unpredictable
3. The market competitive conditions were highly unpredictable
4. Customers’ product preferences changed quite rapidly
5. Changes in customers’ needs were quite unpredictable

**Organisational slack**
1. We have uncommitted resources that can quickly be used to fund new strategic initiatives
2. We are able to obtain resources at short notice to support new strategic initiatives
3. We have substantial resources at the discretion of management for funding new strategic initiatives.

**Performance measures incentivising incremental 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 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

Factor analysis of reflective construct items

| EXPLORE1 | 0.531 | -0.053 | 0.089 | -0.197 | -0.023 | 0.009 | 0.189 | -0.103 |
| EXPLORE2 | 0.597 | 0.038 | 0.022 | -0.138 | 0.094 | -0.072 | 0.068 | -0.113 |
| EXPLORE3 | 0.764 | 0.013 | -0.009 | 0.054 | -0.013 | -0.001 | -0.187 | 0.096 |
| EXPLORE4 | 0.730 | 0.094 | -0.094 | -0.034 | 0.007 | 0.005 | 0.016 | -0.208 |
| EXPLORE5 | 0.655 | 0.079 | -0.065 | -0.084 | -0.031 | 0.009 | 0.036 | -0.167 |
| EXPLOIT1 | 0.350 | 0.184 | -0.004 | 0.058 | -0.100 | -0.132 | -0.230 | -0.462 |
| EXPLOIT2 | 0.244 | 0.013 | 0.123 | 0.074 | 0.084 | -0.116 | -0.062 | -0.388 |
| EXPLOIT3 | 0.151 | 0.162 | 0.122 | -0.014 | 0.056 | 0.039 | -0.114 | -0.601 |
| EXPLOIT4 | 0.143 | -0.025 | -0.005 | 0.045 | 0.019 | 0.050 | -0.098 | -0.782 |
| EXPLOIT5 | -0.040 | -0.039 | -0.041 | -0.135 | 0.151 | 0.006 | 0.165 | 0.884 |
| INCREM1 | 0.067 | 0.021 | 0.270 | -0.088 | 0.220 | 0.125 | -0.496 | 0.087 |
| INCREM2 | 0.008 | -0.042 | -0.008 | -0.160 | 0.000 | 0.016 | -0.826 | 0.002 |
| INCREM3 | -0.070 | 0.058 | -0.021 | -0.242 | 0.021 | -0.071 | -0.737 | -0.139 |
| INCREM4* | 0.441 | 0.126 | -0.070 | -0.596 | 0.124 | 0.065 | -0.053 | 0.075 |
| RADIC1 | 0.167 | -0.017 | 0.037 | -0.791 | 0.003 | 0.002 | -0.229 | 0.065 |
| RADIC2 | -0.025 | 0.029 | 0.074 | -0.820 | -0.044 | -0.012 | -0.246 | -0.115 |
| RADIC4* | -0.019 | -0.003 | 0.042 | 0.096 | -0.180 | 0.615 | -0.148 | -0.151 |
| COGCON1 | -0.086 | 0.100 | -0.011 | -0.001 | 0.111 | 0.721 | 0.088 | 0.047 |
| COGCON2 | 0.090 | -0.053 | 0.116 | -0.046 | 0.012 | 0.774 | 0.139 | 0.059 |
| COGCON3 | 0.014 | 0.009 | -0.223 | -0.045 | 0.023 | 0.820 | -0.106 | 0.002 |
| COGCON4 | -0.026 | -0.052 | 0.857 | -0.063 | 0.074 | -0.086 | -0.066 | -0.128 |
| PMDEB1 | 0.021 | -0.029 | 0.874 | -0.130 | 0.049 | -0.050 | -0.052 | -0.020 |
| PMDEB2 | -0.068 | 0.025 | 0.414 | -0.086 | -0.210 | 0.045 | 0.055 | -0.111 |
| PMDEB3 | 0.024 | 0.112 | 0.749 | 0.167 | 0.088 | 0.028 | -0.042 | 0.147 |
| PMDEB4 | -0.146 | 0.441 | 0.070 | -0.060 | 0.059 | 0.034 | 0.006 | -0.038 |
| ENVdyn1 | 0.185 | 0.658 | 0.203 | 0.121 | 0.020 | 0.030 | 0.048 | 0.026 |
| ENVdyn2 | 0.067 | 0.594 | 0.118 | -0.020 | -0.015 | 0.029 | 0.013 | 0.020 |
| ENVdyn3 | 0.005 | 0.872 | -0.232 | 0.006 | -0.040 | -0.061 | -0.001 | 0.037 |
| ENVdyn4 | 0.073 | 0.692 | -0.130 | -0.014 | -0.052 | 0.018 | -0.055 | -0.040 |
| SLACK1 | -0.020 | 0.158 | -0.203 | -0.016 | 0.830 | -0.042 | -0.109 | -0.039 |
| SLACK2 | 0.062 | -0.092 | 0.255 | -0.108 | 0.664 | 0.013 | 0.089 | -0.073 |
| SLACK3 | -0.054 | -0.067 | 0.012 | 0.146 | 0.433 | -0.055 | -0.122 | -0.268 |

Eigenvalue: 7.24 3.23 3.06 2.46 2.12 1.92 1.42 1.05

Variance explained (%): 22.6% 32.7% 42.3% 50.0% 56.6% 62.6% 67.0% 70.3%

Cronbach’s alpha: 0.85 0.79 0.81 0.91 0.70 0.81 0.82 0.85

KMO sampling adequacy: 0.67

Bartlett’s test of sphericity: 0.00

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

EXPLORE = emphasis on intended competence exploration, EXPLOIT = emphasis on intended competence exploitation, INCREM = achieved incremental innovation, RADIC = achieved radical innovation, COGCON = cognitive conflict of the top management team, PMDEB = debate on performance measures among the top management team, ENV dyn = environmental dynamism, SLACK = organisational slack.
References


