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Interactive profit-planning systems and market turbulence:

A dynamic capabilities perspective

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ABSTRACT

This article describes, theorizes and empirically investigates the concept of interactive profit-planning systems (PPS) through the lens of the dynamic capabilities logic. With this conceptualization: interactive PPS capabilities comprise budgeting, forecasting and results-reporting routines, in which top and middle managers interact to create knowledge for sensing, seizing, and business model reconfiguring (to manage strategic business change). Survey data from 331 Australian firms is analyzed employing partial least squares structural equation modeling. The data provides support for two hypotheses: (1) greater market turbulence strengthens the positive effect of interactive PPS capabilities on business unit performance; and (2) greater market turbulence strengthens the positive effect of flexibility values (of organizational culture) on interactive PPS capabilities. Our findings show that interactive PPS capabilities function according to the salient tenets of the dynamic capabilities logic, and clarify the beneficial roles of formal cybernetic control systems and the intertwined involvement of top and middle managers in using dynamic capabilities.

Keywords: Business performance; Cybernetic management control systems; Dynamic capabilities; Hyper market turbulence; Interactive profit-planning systems; Organizational (culture) flexibility values.

1. Introduction

> *Dynamic capabilities enable business enterprises to create, deploy, and protect the intangible assets that support superior long-run business performance. The micro-foundations of dynamic capabilities—the distinct skills, processes, procedures, organizational structures, decision rules, and disciplines—which undergird enterprise-level sensing, seizing, and reconfiguring capacities are difficult to develop and deploy.* (Teece, 2007, p. 1319).

The dynamic capabilities framework (DCF) explains how, especially in highly turbulent market conditions, business performance depends upon the ability to manage strategic change (Eisenhardt and Martin, 2000; Helfat and Winter, 2011; Teece, 2007; Teece et al., 1997). Although the DCF has become one of the most prominent theoretical lenses in management research, critics argue that it is underspecified and lacks empirical grounding (Schilke et al., 2017). For example, Teece (2007, p. 1319) refers to dynamic capabilities (DCs) as "skills, processes, procedures, organizational structures, decision rules, and disciplines," without specifying the practical nature of such capabilities (Wollersheim and Heimeriks, 2016). Most scholarly discussions about DCs focus on abstract concepts with vague operationalizations (Salvato and Rerup, 2011), such that there is a lack of sufficient understanding about the constitutive elements of DCs and how they relate to business functions (Helfat and Peteraf, 2009; Wollersheim and Heimeriks, 2016).

To add specificity to this line of DCF research we focus on the commonplace phenomenon of interactive profit-planning systems (PPS). Interactive PPS are a type of formal management control system uniquely useful for managing strategic business change (Chenhall and Moers, 2015; Simons, 1995).[1] PPS contain budgeting, forecasting and results-reporting subsystems (Simons, 1995). As cybernetic management control systems, PPS can be used 'rigidly' with diagnostic PPS

[1] Management control systems are formal information-based routines that provide managers with measures to maintain or alter organizational activities in line with objectives and strategies (Simons, 1995).

routines, or ‘dynamically’ with interactive PPS routines (Davila et al., 2009; Simons, 1995). Diagnostic PPS routines represent the traditional, often implicitly assumed view, in which business unit top managers use PPS to monitor results and intervene on an exception-only basis (Simons, 1990, 1995). In contrast, interactive PPS routines involve top and middle managers discussing, debating and processing PPS information, to manage emergent business strategies and strategic change (Mintzberg, 1978; Simons, 1995, 2000). Interactive PPS routines rely on shared learning processes to tightly integrate strategic planning with budgeting and forecasting systems (Lorange and Vancil, 1976; Simons, 1991).

PPS are based on cybernetic control systems and contain information that uniquely represents the activities of an entire business model (Simons, 1995). PPS contain information about revenues and expenses, organized by: department or functional domain; geographical region; product line; and business development initiative (Simons, 1995). This wide-ranging system of business unit information disaggregates into subsystems that reflect lower levels of a managerial hierarchy and their associated accountabilities. The cybernetic control systems in PPS structure feedback and feedforward information (Berry et al., 2005). Feedforward information includes variances measured between budgets/forecasts and aspirations (Berry et al., 2005). Feedback variances are measures between actual performance and budget/forecast (Berry et al., 2005). In interactive PPS routines, by processing and discussing feedforward and/or feedback information, top and middle managers learn how to better plan and implement strategic changes, including for managing interdependencies between input markets, output markets and internal competencies (Chenhall and Moers, 2015; Simons, 1995).

The objective of this article is to describe, theorize and empirically investigate interactive PPS through the lens of DCF logic. We start with a conceptual synthesis of the interactive PPS

(Chenhall and Moers, 2015; Simons, 1995) and DCF literatures (Eisenhardt and Martin, 2000; Helfat and Winter, 2011; Teece, 2007). Using this synthesis, we conceptualize interactive PPS as capabilities that incorporate bundles of budgeting, forecasting and results-reporting routines, in which top and middle managers interact to learn and create knowledge for their sensing, seizing, and business model reconfiguration processes (to plan for and manage strategic business change). This conceptualization not only specifies how interactive PPS function as DCs but importantly recognizes that in their use, the interactions amongst top and middle managers are structured by the hierarchical accountability system in the cybernetic control systems in PPS. With this conceptualization, we advance understanding of the DCF by accounting for the role of formal cybernetic control systems and the intertwined involvement of top and middle managers in strategic planning and change. The extant DCF literature has focused on the roles of top managers (Schilke et al., 2017) in DCs use but has overlooked the roles of middle managers (Heyden et al., 2016). Our conceptualization of interactive PPS in terms of DCs specifies the intertwined roles of top and middle managers in the strategic learning, planning and change processes that constitute DCs use.

To theorize how interactive PPS capabilities function from a DCs perspective, we develop two hypotheses that form a nomological network based on salient tenets of the DCF (Schilke et al., 2017). The nomological network relates interactive PPS to antecedent, outcome and moderator variables. Regarding *Hypothesis 1*, following Eisenhardt and Martin (2000) and Teece (2007), we expect that greater market turbulence strengthens the positive effect of interactive PPS capabilities on business unit performance. Regarding *Hypothesis 2*, we expect that greater market turbulence strengthens the positive effect of flexibility values on interactive PPS capabilities. Flexibility values are an organizational culture resource (Barney, 1986, 1991), without which interactive PPS capabilities can be “too difficult to develop” (Teece, 2007, p. 1319). While there are many studies of organizational culture as an antecedent to DCs (Schilke et al., 2017), our theorizing is the first to consider how such an effect is moderated. This moderation effect captures the ‘routine dynamics’ (Feldman et al., 2016) of interactive PPS capabilities, positing that with greater market turbulence interactive PPS routinization requires a stronger conditioning effect of organizational flexibility values.

To empirically investigate interactive PPS capabilities in terms of DCs, we analyze cross-sectional survey data from 331 senior managers of Australian firms, employing partial least squares structural equation modeling (PLS-SEM) to test our two hypotheses. We operationalize interactive PPS capabilities as a latent construct, with its DCs characteristics reflected in the frequency and strategic learning intensity of interactive budgeting, forecasting and results-reporting routines. With higher routinization of interactive PPS capabilities, managers more frequently and intensively create and transfer knowledge for the purposes of planning and managing strategic business change. We develop survey measures that gauge the frequency of top and middle manager interactions, along with the strategic learning intensity of those interactions, as manifested by the degree of debate and discussion of feedback and feedforward information in relation to strategic business change (i.e., sensing, seizing and reconfiguring). We apply established instruments to measure flexibility values, business unit performance, and market turbulence. The results provide support for both hypotheses, supporting our conceptualization of interactive PPS capabilities in terms of DCs.

By specifying interactive PPS capabilities in terms of DCs and studying them in a nomological network based on DCF tenets, this article contributes to emerging efforts to add specificity to the constitutive elements of DCs. In conceptualizing how interactive PPS capabilities support the sensing, seizing and reconfiguring processes that underpin strategic planning and change in DCs, this study illustrates how strategic planning and shared learning processes can be tightly linked with budgeting and forecasting systems (Lorange and Vancil, 1976; Simons, 1991). Specifically, we advance understanding relevant to DCs by accounting for the roles of formal cybernetic control systems, along with the intertwined involvement of top and middle managers, in DCs use. Similar to how Simons's (1990, 1995) interactive PPS concepts provided a "cybernetic view" of emergent strategy-making (Mintzberg et al., 2009, p. 65), this article explicates how PPS information is systematically and interactively processed over time as it applies to DCs. Although a wide range of specific roles of middle managers in strategy processes have been researched extensively in adjacent strategic management literature (e.g., Wooldridge et al., 2008), the study of specific roles of middle managers has been conspicuously absent from the DCF literature. This article addresses some of this void by explicating how top and middle managers are both constitutive elements of the strategic planning and change processes in interactive PPS capabilities.

2. Conceptual development and hypotheses

2.1. Interactive profit-planning systems: a dynamic capabilities conceptualization

In this section, we outline a conceptual synthesis of interactive PPS in terms of DCs. Accordingly, interactive PPS are defined as capabilities that incorporate systematic learning and knowledge creation routines for sensing, seizing, and reconfiguring business models (Eisenhardt and Martin, 2000; Helfat and Winter, 2011; Teece, 2007). Sensing, seizing and reconfiguring are the three processes within DCs (Teece, 2007) that facilitate planning and managing strategic business change (Helfat and Winter, 2011; Schilke et al., 2017). According to Simons (1995), interactive PPS routines specify how top and middle managers discuss and debate strategic business change using PPS information. These routines bundle up into 'interactive PPS capabilities' (Winter, 2000) with the degree of 'routinization' (Feldman et al., 2016) of these capabilities being reflected in the frequency and strategic learning intensity of interactive PPS routines.

With more routinized interactive PPS capabilities, the forecasting and results-reporting subsystems of PPS are used more routinely (Simons, 1995), such that top and middle managers more frequently process feedback and feedforward PPS information in an interactive fashion (Frow et al., 2010). Learning processes in DCs can be motivated when business unit performance falls short of meeting aspirations (Winter, 2000), which Frow et al. (2010) have shown can be facilitated systematically during the course of a financial year through negative and positive PPS variance information. Learning processes in DCs can occur through "a series of (online) trials, interspersed or alternated with variable periods of off-line deliberation and analysis" (Winter, 2000, p. 985). Such 'off-line deliberation and analysis' characterize DCs when the learning processes are systematic and/or routine (rather than ad hoc problem solving) and when that learning creates knowledge for planning and managing strategic business change (Helfat and Winter, 2011; Winter, 2000). With greater routinization of interactive PPS capabilities, the more frequent processing of feedback and feedforward information fosters learning about dynamics between changing markets and internal capabilities, enabling the managers involved to more rapidly create knowledge for planning and managing strategic business change (Simons, 1995). This learning and knowledge creation, being "off-line deliberation and analysis" and "for the managers involved" (Winter, 2000, pp. 983, 985) is such that interactive PPS capabilities function as DCs.

With higher levels of routinization of interactive PPS capabilities, the inherent strategic learning can relate to all three strategic business change processes articulated by Teece (2007), namely, sensing, seizing, and reconfiguring. As summarized by Schilke et al. (2017), these three processes for planning and managing strategic change in DCs are: (1) sensing new opportunities (and threats) from the business environment; (2) making strategic choices and investing in business models for seizing those opportunities; and (3) coordinating the reconfiguration (or transformation) of the organization and its strategy as new opportunities and threats are sensed. Depending on the specific firm context and business function of DCs, these three processes can overlap and play complementary roles – especially in environments of significant change (Drnevich and Kriauciunas, 2011; Pettus et al., 2009; Schilke et al., 2017; Teece, 2007).

Of Teece's (2007) three processes for planning and managing strategic business change, seizing is the centerpiece in interactive PPS capabilities. Interactive budgeting and forecasting routines coordinate and integrate the subunits and activities of a business unit in accordance with the strategic choices of top management (e.g., Barki and Pinsonneault, 2005; Simons, 1995). Seizing can involve making many decisions, for example: the technologies and features to embed in products and services; the (re)design of the revenue and cost structure of the business; the incorporation of technologies in competitive business models; and which market segments to target (Teece, 2007). In interactive budgeting and forecasting routines, decision-making can involve the timing and magnitude of resource allocations and performance goals for seizing opportunities and mitigating threats. Seizing reflects "management's hypotheses about what customers want and how an enterprise can best meet those needs" requiring that top management choose a business model that "articulates" the value proposition, defining the structure of the value chain, and estimating the cost structure and profit potential (Teece, 2007, p. 1329). With higher routinization of interactive PPS capabilities, feedback and feedforward information can be processed interactively by top and middle managers to frequently test "management's hypotheses" about the business strategies and business model.

Teece (2007, p. 1344) notes that the disaggregation into sensing, seizing and reconfiguration is performed "at least analytically". Within routinized interactive PPS capabilities, the three processes are argued to substantially overlap. The information in a PPS can provide managers with broad representations of the actual and anticipated subunits and activities of an entire business model and its value chain context (Simons, 1995). PPS provides unique information processing resources for sensing what business model paths should be seized, and reconfigured if needed. Sensing involves identifying and shaping opportunities, such that the firm must scan, search, and explore across technologies and markets (Teece, 2007). Reconfiguring entails business model redesign and implementation processes that are decentralized to middle managers but also integrated by top management (Teece, 2007). As Schilke et al. (2017) note, sensing and reconfiguring processes are especially likely to overlap, and with higher routinization of interactive PPS capabilities we also expect these overlaps to coincide with seizing processes.

The centralized coordination of reconfiguration by top management requires that they make business model changes: to seize newly sensed opportunities and to take action that allays newly sensed threats (Schilke et al., 2017; Teece, 2007; Teece et al., 1997). In interactive PPS capabilities, sensing processes, for example, might refer to market innovation opportunities or threats, stemming from competitive dynamics or developments in customer or input markets (Simons, 1995). These sensing processes can emerge from information contributed interactively by middle managers for analyzing cost and revenue feedback variances – which, when favorable/unfavorable, could indicate newly emerging opportunities/threats. Feedback-related information contributed interactively by middle managers can provide evidence for top managers to test their hypotheses about current seizing specifications, including how effectively those seizing hypotheses are embedded in budgets or forecasts. Middle managers can also contribute their sensing ideas for consideration during the setting of budgets and forecasts. These overlapping strategic change processes reflect Simons's (1995, p. 20) view that with interactive PPS capabilities "strategies emerge over time, intended strategies are often superseded" and business strategy "formulation and implementation are often intertwined."

In addition to the learning that characterizes the sensing, seizing and reconfiguring processes and comes with the processing of feedback and feedforward information through interactive PPS capabilities, these capabilities also exemplify the intertwined roles of middle and top managers in DC use. Simons (1995) views the involvement of top managers in interactive PPS capabilities as based on strategic uncertainties, being top management's emerging perceptions of contingencies and threats that might invalidate existing business strategies and initiatives. Strategic uncertainties cannot be monitored on a management-by-exception basis with diagnostic PPS capabilities because they remain in a state of flux (Simons, 1995). In Simons' (1991, 1995) view, top managers have the strategic choice of involving themselves in interactive PPS routines to process information (Galbraith, 1977) to manage their perceived strategic uncertainties. This view however problematically assumes that middle managers will automatically contribute bottom-up emergent strategy-making information (Mintzberg, 1978) when called upon to do so by top managers in an interactive PPS capability. This problem is especially salient given the hierarchical accountability systems inherent in the formal cybernetic control systems in PPS.

To analyze the intertwined involvement of middle and top managers, we conceptualize middle managers as contributors of capability gap information, which is based on their capability gap knowledge and related ideas. Capability gap knowledge stems from the situated operational experiences of middle managers. Capability gaps are propositions for and about action (Lavie, 2006; Wilden and Gudergan, 2015) that are of a practical nature (Mintzberg, 1978). The localized experiential knowledge-base of middle managers is needed to generate effective capability gap ideas (Hargadon and Fanelli, 2002; Nonaka, 1994). Being experienced 'at a distance' from the supervision of top managers, capability gap knowledge can be covertly withheld rather than offered interactively (Goodall and Roberts, 2003). Given the agency inherent in operational experience (Hargadon and Fanelli, 2002) capability gap knowledge and ideas cannot be assumed to flow automatically from middle managers to top managers. Capability gap information is too far removed from the direct experience of top management for them to detect if middle managers were to withhold it from interactive PPS capabilities (Goodall and Roberts, 2003; Nonaka et al., 2000).

The distinction between strategic uncertainties and capability gaps acknowledges the fundamentally different vantage points and business unit experiences of top and middle managers (Nonaka, 1994; Zollo and Winter, 2002). In interactive PPS capabilities, top managers articulate their emerging strategic uncertainties, intertwined with middle managers articulating their emerging capability gap perceptions. With the face-to-face debate and discussion of these articulations, the interacting managers learn and create new knowledge about strategic business change (Nonaka, 1994). The withholding of capability gap information by middle managers would suppress interactive PPS routines and limit the capacity to routinize interactive PPS capabilities over time. Capability gap information is needed for interactive learning using feedback and feedforward information, to make sense of how and why existing business model seizing paths might be ineffective. These centralized–decentralized learning and knowledge flow dynamics require flexibility in how managers think and interrelate (Nonaka, 1994; Teece, 2007; Teece et al., 1997).

For interactive PPS capabilities to develop over time, the routine dynamics (Feldman et al., 2016) require non-defensive interactive managerial participation (Argyris and Schön, 1996; Simons, 1995). Given the hierarchical accountability system inherent in the cybernetic control systems in PPS, non-defensive participation is required for the interactivity needed to synthesize and reconcile top management's knowledge of emerging strategic uncertainties with middle management's emerging knowledge of capability gaps. Middle managers are unlikely to contribute their situated knowledge and ideas to interactive PPS routines if they face threats of intolerance, blame, or inflexibility related to any resulting unfavorable performance feedback variances in the future (Argyris and Schön, 1996; Simons, 1995). Without flexibility in organizational learning processes, managers are likely to engage in defensive behaviors that suppress PPS interactivity – such as casting blame, reducing commitment, refusing to participate in problem solving, or entering into unproductive conflicts (Argyris and Schön, 1996; Simons, 1995).

In summary, a more routinized PPS capability entails greater frequency and strategic learning intensity of interactive PPS routines, in which top and middle managers process feedback and feedforward information to create knowledge for sensing, seizing and reconfiguring. Flexibility is needed for the routinization of these interactive learning processes into interactive PPS capabilities over time, so that top and middle managers can progressively and systematically create emergent knowledge about strategic uncertainties and capability gaps.

2.2. Hypotheses development

In this section, we develop two hypotheses that form a nomological network based on the DCF (Schilke et al., 2017). The DCF suggests that business performance effects of DCs occur through the strategic change produced to operating capabilities (Di Stefano et al., 2014; Helfat and Winter, 2011; Wilden and Gudergan, 2015). DCs can also be analyzed in terms of direct effects on business performance (Drnevich and Kriauciunas, 2011; Teece et al., 1997; Wilden et al., 2013) in a nomological network that includes the moderation effects of market turbulence (Schilke et al., 2017). In regards to *Hypothesis 1*, we expect that greater market turbulence strengthens the positive effect of interactive PPS capabilities on business unit performance. While business performance is the most commonly studied consequence of DCs, organizational culture is one of the most commonly studied antecedents (Schilke et al., 2017). Therefore, as basis for *Hypothesis 2*, we study flexibility values as an antecedent to interactive PPS capabilities. Flexibility values are an organizational culture resource (Barney, 1986, 1991) without which interactive PPS capabilities are "too difficult to develop" (Teece, 2007, p. 1319), because of the inertial and path-dependent nature of organizational culture (Barney, 1991). DCF literature suggests that, as market turbulence heightens, DC processes require even greater organizational flexibility to overcome rigid framing biases and organizational rigidities (Ambrosini et al., 2009; Teece, 2007). *Hypothesis 2* accordingly postulates that greater market turbulence strengthens the positive effect of flexibility values on interactive PPS capabilities.

According to the DCF (Eisenhardt and Martin, 2000; Teece, 2007), market turbulence comprises three categories of perceived change in the external environment (see also Volberda, 1996, 1998). Low market turbulence means that markets are predictable, static, and simple. With moderate market turbulence, markets have mid-range unpredictability and they may be dynamic or complex. Hyper market turbulence concerns markets that are very unpredictable, dynamic, and complex. The differentiating feature of these three categories of market turbulence is the degree of external unpredictability – which is the same distinction that Eisenhardt and Martin (2000) apply to categorize environments as stable, moderately dynamic, or high-velocity. In general, with greater market turbulence, managers perceive more unpredictability in their external markets (Eisenhardt and Martin, 2000; Volberda, 1996, 1998).

We predict that greater market turbulence results in a stronger positive effect of interactive PPS capabilities on business performance. The overriding proposition of the DCF is that without DCs a firm cannot prosper – especially in conditions of hyper market turbulence (Dixon et al., 2014; Eisenhardt and Martin, 2000; Gelhard et al., 2016; Teece, 2007; Wilden et al., 2013). Prior research also shows that the impact of interactive PPS capabilities on business performance is strengthened by strategic dynamism and competitive intensity (Abernethy and Brownell, 1999; Bedford, 2015; Bisbe and Otley, 2004; Chenhall and Moers, 2015; Simons, 1995). The business performance advantages of DCs are more pronounced when they are difficult to develop and if they create non-substitutable value (Teece, 2007). Interactive PPS capabilities are difficult to develop because they require learning and they rely on non-tradable resources (Barney, 1991) such as: an appropriate organizational culture (Schilke et al., 2017); a skilled top management team (Simons, 1995); and committed middle managers (Frow et al., 2010). The value created by interactive PPS capabilities is non-substitutable given the unique information processing framework provided by PPS.

Although the effectiveness of DCs is questionable in low market turbulence, their effectiveness for enhancing business performance increases with greater market turbulence (Eisenhardt and Martin, 2000; Helfat and Winter, 2011; Schilke et al., 2017; Teece, 2007). With greater market turbulence, the value-creation potential of a business model erodes more quickly, such that business performance depends more on DCs (Teece, 2007). A more routinized interactive PPS capability increases the frequency and intensity with which top management develops knowledge of strategic uncertainties by interacting with middle managers. With such a higher flow of capability gap knowledge and ideas from middle managers, top managers can also interactively transfer their emerging knowledge more intensively back to those middle managers, who in turn can dynamically reframe their emerging knowledge of capability gaps and ideas. Therefore, based on this DC nature of interactive PPS capabilities, we predict:

Hypothesis 1: Greater market turbulence strengthens the positive effect of interactive PPS capabilities on business performance.

With flexibility needed for the learning processes within interactive PPS capabilities, flexibility values of organizational culture are a basis for interactive PPS capabilities. An organizational culture encapsulates "shared values (that define what is important) and norms that define appropriate attitudes and behaviors for organizational members (for how to feel and behave)" (O'Reilly and Chatman, 1996, p. 160).[2] Flexibility values are inertial and path dependent because they are historically and socially constructed, making them difficult to change deliberately – especially in the short term (Barney, 1991). Flexibility values can provide latent capacities that managers can draw from when needed (Weber and Dacin, 2011); for example, when market turbulence increases managers can behave flexibly, but when market turbulence is low they can leave it as latent resource. Whereas flexibility values evolve relatively slowly (Denison and Mishra, 1995), the level of market turbulence can shift quickly and unpredictably (D'Aveni et al., 2010; Tushman and Anderson, 1986; Volberda, 1998). We expect that the strength of the positive effect of flexibility values upon interactive PPS capabilities is moderated by market turbulence.

Management control systems literature also provides several reasons to expect that flexibility values have a positive effect on interactive PPS capabilities. Organizational culture is a

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[2] Of the three aspects of organizational culture identified by Schein (2010) – artifacts, values, and assumptions – values tend to be studied quantitatively with survey-based methods (O'Reilly et al., 2014).

determinant of the ways in which management control systems are used, because it affects information processing, communication, motivation, attention, and judgment (Birnberg and Snodgrass, 1988; Henri, 2006a; Norris and O'Dwyer, 2004; O'Connor, 1995). Simons (1994) explicitly excludes organizational culture from his theorizing but acknowledges that interactive PPS require a "positive informational environment that encourages information sharing" (Simons, 1995, p. 158). Furthermore, interactive PPS rest on flexible, open communication processes (Chenhall, 2007; Henri, 2006a, 2006b) and the underlying learning processes require an organizational culture that promotes flexible organizational enquiry (Argyris and Schön, 1996; Henri, 2006b; Simons, 1995). Flexibility values enable top managers to use management control systems dynamically; to direct organizational attention and support strategic decision-making (Henri, 2006a). Heinicke et al. (2016) also find that flexibility values facilitate interactive use of management control systems.[3]

Flexibility values suggest a willingness to modify expectations and pursue innovative ideas and new knowledge (Denison and Mishra, 1995; Schein, 2010). They indicate a mode of shared commitment and beliefs, such that when individuals interact they heedfully respect adaptation and innovation efforts that others contribute (Denison and Mishra, 1995; Schein, 2010; Weber and Dacin, 2011). Flexibility values increase the capacity for proactive efforts to perceive opportunities and solve problems, especially when managers face complex business model problems (Denison and Mishra, 1995; Schein, 2010). Flexibility values can thereby enable the articulation and debate of strategic information in interactive PPS capabilities. The articulation of ideas for adaptation and

[3] The results in Heinicke et al. (2016) relate to medium-sized businesses. However, they use a competing values framework (Cameron and Freeman, 1991) and model organizational culture on a continuum, from stability to flexibility values. This application may be problematic though, because stability and flexibility values realistically should be viewed as orthogonal dimensions (Hartnell et al., 2011; Van Vianen, 2000). Prior research indicates that the two concepts are highly correlated and orthogonal (e.g., Denison and Mishra, 1995; Fey and Denison, 2003).

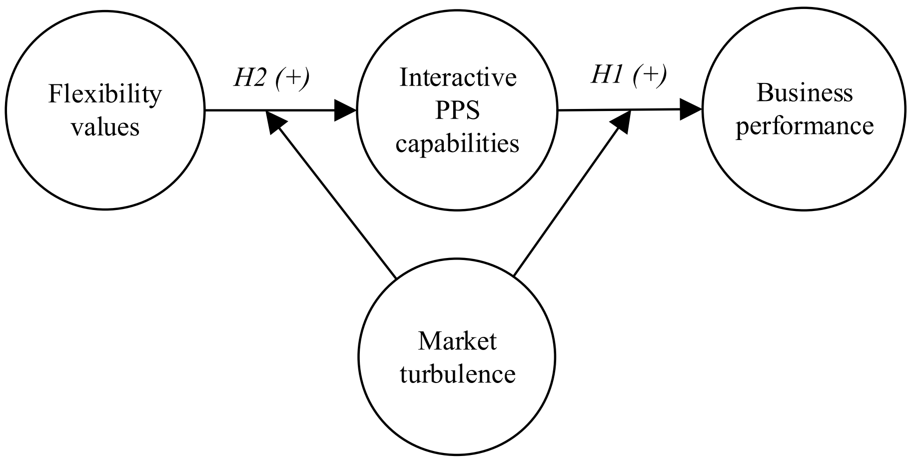
for knowledge about strategic issues allows this information to be transferred to other managers, who receive it with a receptive mindset and thus create the flow of emergent strategic knowledge needed for interactive PPS capabilities to routinize over time.

Greater market turbulence is expected to strengthen the positive effect of flexibility values on interactive PPS capabilities, because of the higher ambiguity in strategic uncertainties and the increased riskiness of capability gap ideas (Eisenhardt and Martin, 2000; March, 1991; Nonaka, 1994). With greater market turbulence, business model adaptation and organizational innovation requires knowledge creation processes that go beyond simple business model refinements and incremental enhancements, to instead be processes that foster divergent business model changes (Eisenhardt and Martin, 2000; Helfat and Raubitschek, 2000). In such conditions, top management relies on middle managers to articulate capability gap ideas based upon their rapidly occurring decentralized experience (Eisenhardt and Martin, 2000; Teece, 2007). Greater market turbulence likely creates more capability gaps (Ambrosini et al., 2009; Lavie, 2006; Wilden and Gudergan, 2015) along with greater risks associated with any seizing and reconfiguring responses to those gaps (March, 1991; Teece, 2007). Due to these greater risks that accompany greater market turbulence, the requirement for flexibility values becomes even stronger, to prevent middle managers from defensively withholding their capability gap ideas (Argyris and Schön, 1996). Flexibility values mitigate fears that middle managers may be held rigidly accountable for capability gap ideas that they contribute in interactive PPS capabilities that could lead to unfavorable feedback variances in the future (Argyris and Schön, 1996; Simons, 1995). Unfavorable feedback variances are more likely with greater market turbulence (March, 1991; Rumelt, 1987; Schumpeter, 1950), and so we predict:

Hypothesis 2: Greater market turbulence strengthens the positive effect of organizational flexibility values on interactive PPS capabilities.

The theoretical model overview in Figure 1 illustrates the two hypotheses. The next section outlines the research method used to empirically assess the hypotheses.

Figure 1
Theoretical model overview



3. Research method

3.1. Sample selection and data collection

Surveys are the dominant research method in the DCF literature (Schilke et al., 2017). We used a cross-sectional research method with a survey of Australian firms, developed and administered according to Dillman's (2007) total design method, featuring multi-contact, mixed-mode mail and web-based questionnaires. To enhance content validity, 21 practitioners and two researchers in the focal topic areas checked the clarity, wording, and questionnaire layout, across three pretesting phases: (1) one-on-one meetings to develop new scales for the interactive PPS capabilities construct; (2) tests of the mail mode; and (3) tests of the web-based mode. The survey distribution took place over a six-week period in early 2008 (before the global financial crisis). In the first survey round, we sent target respondents a cover letter, questionnaire, completion notification postcard, and return envelope by mail. In round two, they received an email if available and a follow-up contact by mail otherwise. The respondents were contacted four times, assured anonymity, and offered a summary report of the findings.

The unit of analysis is the firm or business unit, defined as a fully autonomous entity or a subunit of a larger firm (Henri, 2006b). The target respondents were senior managers, including top managers of the business unit and their direct reports (see Table 1). Three sampling criteria were used. First, a firm had to earn at least AUD 20m in annual revenue and employ at least 150 people, because the business strategy-related variables may not apply to smaller firms (Henri, 2006a). Second, the top manager had to have been in their job for at least one year, because the appointment of a new top manager tends to disrupt management control system practices (Simons, 1994). Third, a firm had to be at least three years old, because interactive PPS are unlikely to be in use during the business start-up phase (Simons, 1995).

Table 1
Respondents by role

	n	%
CFO/Finance director	91	27.5
CEO/Managing director	86	26.0
Senior finance manager	77	23.3
Business unit head	38	11.5
Other senior manager	39	11.8
Total	331	100

We used a stratified sampling approach to ensure a sufficient sample for the different market turbulence subgroups. Among the 978 micro-industries in the Standard Industrial Classification system, we selected 40, following consultation with three equities researchers from investment banks. We then purchased mailing list data about these 40 target micro-industries. Of the 1,723 target firms on the mailing list, 57 were unreachable, and 20 responses were duplicates. Ultimately, we gathered responses from 546 business units, for a response rate of 32.8%. After removing 28 invalid responses and 187 that did not meet the sampling criteria, the final sample constituted 331 firms.[4] Table 2 details the sample, based on industry classification and across the three market turbulence subgroups.[5]

Table 2
Respondents by industry

	Full sample (n = 331)		Hyper turbulence (n = 49)		Moderate turbulence (n = 235)		Low turbulence (n = 47)	
	n	%	*n*	%	*n*	%	*n*	%
Manufacturing	113	34.1	10	20.4	97	41.3	6	12.8
Services	82	24.8	10	20.4	60	25.5	12	25.5
Wholesale trade	29	8.8	2	4.1	18	7.7	9	19.1
Finance, insurance & real estate	25	7.6	12	24.5	12	5.1	1	2.1
Mining	23	6.9	1	2.0	14	6.0	8	17.0
Construction	20	6.0	3	6.1	11	4.7	6	12.8
Retail Trade	16	4.8	5	10.2	10	4.3	1	2.1
Agriculture, forestry and fishing	12	3.6	2	4.1	7	3.0	3	6.4
Transport, communications & utilities	11	3.3	4	8.2	6	2.6	1	2.1
	331	100.0	49	100.0	235	100.0	47	100.0

3.2. Construct measures

We used existing construct measures when possible but developed a new instrument for the interactive PPS capabilities construct, following conventional scale design and administration procedures (Dillman, 2007; Netemeyer et al., 2003; Tourangeau et al., 2000). Appendix A contains the construct questionnaire items.

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[4] Of the 28 invalid responses: 12 respondents had been in their business unit for less than one year; 2 respondents were insufficiently senior or underexposed to profit planning in their firm; and 14 responses were incomplete. Among the 187 responses that did not meet the sampling criteria: 150 did not meet the minimum size criteria; 25 firms had top manager tenure of less than one year; and 12 firms were less than three years old.

[5] The stratified sample was based on 40 micro-industries, but the survey instrument featured a broader set of industries that respondents could identify.

3.2.1. Market turbulence (MARK-TURB)

The DCF is clear about the need to distinguish low, moderate, and hyper (or extreme) levels of change in business environments (Eisenhardt and Martin, 2000; Teece, 2007). Our use of survey instrumentation accords with the 'perceived environmental uncertainty' methodology, which argues that firms respond to the environment as it is interpreted by the decision makers, and that its unperceived characteristics do not affect either the decisions or the actions of management (e.g., Daft and Weick, 1984). The market turbulence construct mainly reflects the distinguishing feature of unpredictability in an external business environment. Following an exhaustive literature review, we operationalize market turbulence according to three categories (see Volberda, 1996, 1998), as we defined previously: *low turbulence*, *moderate turbulence*, and *hyper turbulence*. This operationalization depends on three conventional dimensions to describe the external environment: (1) unpredictability, being the extent to which cause-and-effect relationships among competitive forces are unclear; (2) dynamism, reflecting the rate and rapidity of change; and (3) complexity, indicating the heterogeneity and range of a firm's activities (from simple to complex) (Volberda, 1996, 1998). In turn, we apply this operationalization to three market elements considered in the DCF literature: technology, customer, and competitor (e.g., Bogner and Barr, 2000; Eisenhardt and Martin, 2000; Helfat and Raubitschek, 2000). For the nine measures of market turbulence, we adapted scales from Desarbo et al. (2005) and used nine-point Likert type scales (1 = "Strongly Disagree" to 9 = "Strongly Agree").

With Volberda's (1996, 1998) operationalization, we split the sample into three subgroups. First, firms for which the average unpredictability score across the three market element measures was in the high range ($\geq$ 6.33 and $\leq$ 9.0) were categorized as operating within hyper turbulent environments. Second, firms with low ($\geq$ 1.0 and $\leq$ 3.67) average scores for all three levels were categorized as operating with low market turbulence. Third, all remaining firms were assigned to the moderate market turbulence category. The resulting subgroups consist of: 47 (14.2%) low turbulence firms; 235 (71.0%) moderate turbulence firms; and 49 (14.8%) hyper-turbulence firms.

3.2.2. Organizational flexibility values (FLEX)

Embedded in current organizational behaviors, organizational flexibility values provide specific cognitive and behavioral scripts that can be called on, as needed, and expressed in idiosyncratic forms when members interact, such that they structure habits of thinking, mental models, and shared meanings (Weber and Dacin 2011). To operationalize organizational flexibility values, extant measures seek evidence of such phenomena in existing organizational structures, processes, and capabilities (Denison and Mishra 1995; Weber and Dacin 2011). We operationalize flexibility values using Denison and Mishra's (1995) instrument.[6] The two-dimensional latent operationalization includes: (1) collective involvement, measured with nine reflective items in three categories (team orientation, capability development, and employee empowerment); and (2) adaptability/innovation, measured with nine reflective items, again in three categories (creating change, customer focus, and organizational learning). These 18 reflective indicators use nine-point Likert scales (1 = "Strongly Disagree" and 9 = "Strongly Agree"). According to the hierarchical PLS procedures stipulated by Wetzels et al. (2009), we generated two latent variable scores for the hypothesis testing: *collect-involv* and *adapt-innov*.[7]

3.2.3. Business performance (PERF)

The DCF typically conceptualizes superior business performance in the form of Schumpeterian rents (Rumelt, 1987; Schumpeter, 1950), which reflect adaptive (or evolutionary)

[6] Flexibility values, as measured, manifest in organizational structures and processes – none of which explicitly relate to profit-planning systems (which would be invalid for this study).

[7] FLEX could be modeled as a third-order model, but for parsimony in reporting measurement validity and reliability, we retained the second-order model. Sensitivity tests confirmed that it had no impact on the results.

and innovative (or entrepreneurial) fitness (Teece, 2007). Given that this concept cannot be measured readily, we took a measure of a generally accepted consequence of superior business performance, namely, business performance relative to rival firms (Arend, 2003). Such relative measures control for differences in performance due to industry, the environment, or strategy effects (Garg et al., 2003). As the key indicators, we use profitability, sales growth, and market share (Kaplan and Norton, 1996; Slater and Olson, 2000), measured with three survey questions adopted from Babakus et al. (1996). Respondents were asked to consider their business unit's performance over the past two years (Slater and Olson, 2000), consistent with evidence of contemporaneous business performance effects from DCs (Daneels, 2008). The measurement model is reflective (Tippins and Sohi, 2003) and includes nine-point Likert scales (1 = "Much Worse" and 9 = "Much Better").

3.2.4. Interactive profit-planning systems capabilities (INTER)

Bisbe et al. (2007) stressed the need to refine the operationalization and measurement of interactive PPS. We engaged in an extensive process to develop our survey instrument, drawing on Bisbe et al.'s (2007) proposed five-dimensional operationalization. At the time, four different sets of Likert scales had been used in five separate studies; all were unidimensional and reflective, with reliability and validity analyses using correlation analysis, factor analysis, and Cronbach's alpha values (Abernethy and Brownell, 1999; Bisbe and Otley, 2004; Davila, 2000; Henri, 2006a; Van der Stede, 2000; Widener, 2007). Many items overlapped conceptually with four of the dimensions from Bisbe et al.'s (2007) operationalization; collectively, the empirical evidence indicated a reflective (latent) model, not an emergent (formative) model.[8]

[8] The fifth dimension of Bisbe et al.'s (2007) operationalization (facilitative leadership style of top managers) was excluded, for two reasons. First, we sought to advance an accepted meaning of the construct (Bisbe et al., 2007), but this fifth dimension lacked accepted status in prior literature. For a dimension to be accepted as part of an emergent construct, there must be agreement within the research community about its validity, because there is no other way to

Through a thematic analysis of published interactive PPS research, we developed measurement models and scales to operationalize the four latent dimensions (Bisbe et al., 2007). A draft set of 24 items and associated definitions for the measurement instrument served as the starting point for two rounds of pre-testing and one round of pilot testing. The design and development of the Likert scales was informed by Netemeyer et al. (2003). Eventually, we obtained a set of 16 Likert scales, with four items for each of the four dimensions, all designed to be reflective. The pre-testing procedures also indicated several refinements to the terminology to describe the four dimensions (Bisbe et al., 2007), such that the dimension labels are: (1) senior management interaction frequency; (2) senior and middle manager interaction frequency; (3) degree of face-to-face challenge and debate; and (4) degree of focus on strategic business change.

The questionnaire included extensive definitions. Senior management is "the business unit top manager and his/her direct reports." Middle management is "below the senior management team." Using Simons' (1995, p. 109) definition:

> A profit-plan outlines the planned sales revenue, expenses and net income—usually by month. Profit-plans are typically set annually (e.g. as part of the annual budget), and may be updated with forecasts. *Profit-planning* is an activity that undertakes and compares budgeted, forecasted and actual revenue and expenses by revenue and cost category.

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test such validity (Jarvis et al., 2003). Second, consistent with the assumptions of a latent construct model, only a sample of dimensions was required (given the high correlations among dimensions that reflect the defining feature), compared with the census of dimensions needed for an emergent model (Jarvis et al., 2003). Furthermore, *ex post*, a bifactor model performed in SPSS AMOS 22 on this study's data set provided support for the latent construct model. A bifactor model (Reise, 2012) allows all 16 items to load directly on an overall factor (INTER), as well as on the four domain-specific factors (*snr-frq*, *mid-frq*, *chall*, and *strat*). Uniquely, it can measure a single common latent factor but also model and control for variance that arises due to additional common factors. In the bifactor model, each of the 16 items loaded much more strongly on the overall general factor INTER than on a domain-specific factor. It also achieved adequate fit (root mean square error of approximation = .09, confirmatory fit index = .93, goodness-of-fit index = .90) (Byrne, 2010). Thus, the bifactor model supported a latent construct model.

Nine-point Likert scales (1 = "Strongly Disagree" to 9 = "Strongly Agree") were applied to the items in Appendix A. Applying the hierarchical procedures stipulated by Wetzels et al. (2009), we generated four latent variable scores for use in the PLS models: *snr-frq*, *mid-frq*, *chall*, and *strat*.

3.3. Non-response and common method biases

To assess non-response bias, we compared early and late respondents (Armstrong and Overton, 1977). The Mann-Whitney U-tests revealed no significant differences in the test or indicator variables between early and late respondents; non-response bias was not a major concern. We could not check for this bias by comparing the target sample with the actual response sample though, because the commercial mailing lists provided data at the corporate level, while our responses came from the business unit level.

We also applied several procedures to mitigate the potential for common method bias. To reduce respondent's evaluation apprehension, the survey was anonymous (Podsakoff et al., 2003). To reduce the potential effects of media preferences (e.g., email filters, email avoidance), we contacted all target respondents via email and mail, and the independent sample tests confirm the homogeneous distribution of indicator scores across online and hardcopy surveys. Harman's one-factor test of the 49 construct measures resulted in nine factors with eigenvalues greater than 1, and the first factor explained 29.4% of the total variance. We thus find no evidence of common method variance due to single source bias (Podsakoff and Organ, 1986).

3.4. Partial least squares structural equation modeling

By testing the data for univariate and multivariate normality, we can determine the appropriateness of parametric versus non-parametric testing procedures (Bollen and Stine, 1990; Ringle et al., 2012). The Kolgomorov-Smirnov univariate tests and charting analysis reveal that most of the data are univariate non-normal. Mardia's test of multivariate kurtosis produces an index of 337.2 and critical ratio of 54.0, indicating multivariate non-normality (Byrne, 2010). Accordingly, we used PLS-SEM (Hair et al., 2017, 2018; Sarstedt et al., 2016), which relies on general, soft distributional assumptions and non-parametric prediction-oriented model evaluation measures (Chin, 1998; Wold, 1982). It is particularly suitable for testing moderation effects with differently sized subgroups (Chin and Dibbern, 2010). We used SmartPLS Version 3.00 (Ringle et al., 2015) with 1,000 samples for bootstrapping, adopting prevailing guidelines for assessing and reporting PLS-SEM results (Chin, 2010; Ringle et al., 2012).

To test the hypothesized moderating effects of market turbulence, we split the sample into three subgroups (*hyper-turb*, *mod-turb, low-turb*). The check for statistically significant differences in the subgroups relied on PLS multi-group analysis (PLS-MGA) procedures, which is appropriate because the subgroups are of substantially different sizes (Henseler et al., 2009; Sarstedt et al., 2011).

We used hierarchical PLS-SEM modeling (Wetzels et al., 2009) to produce latent construct scores for the two dimensions of FLEX and the four dimensions of INTER. Table B1 (Appendix B) contains the averages and standard deviations for the market turbulence items, which identify the three subgroups and thus are not part of the PLS-SEM measurement model evaluation. To check the adequacy of the reflective measurement models for FLEX, INTER, and PERF, we considered individual item reliability, convergent validity, and discriminant validity (Chin, 1998; Hulland, 1999).

First, individual item reliability depends on the item's loading on its construct. In Table B2 (Appendix B), with some exceptions in the low market turbulence subgroup, all loadings are greater than .70 and significant at $p < .01$ (Chin, 1998; Hulland, 1999). Table B1 also contains the means for the measurement items and dimension average scores; we note satisfactory consistency in the dimension measures across subgroups. Thus, we do not identify any meaningful concerns about individual item reliability.

Second, Table B3 (Appendix B) features the convergent validity results; with one minor exception in the low turbulence subgroup, all Cronbach's alphas are greater than .70 (Chin, 1998; Nunnally, 1978). The composite reliability measures are greater than .70 (Chin, 1998; Fornell and Larcker, 1981). With one minor exception in the low turbulence subgroup, all average variances extracted (AVE) are greater than .50 (Fornell and Larcker, 1981). We thus find support for convergent validity.

Third, Chin (1998) outlined two procedures to assess discriminant validity: cross-loadings and the AVE matrix. As reported in Table B4 (Appendix B), the cross-loading test requirements are fully met: no indicator has a higher correlation on a latent variable than on the one it was intended to measure, and each block of indicators did not load higher on its respective latent variable than did indicators for other latent variables (Chin, 1998). As Table B5 (Appendix B) shows, the requirements for discriminant validity are fully met; the values of the square root of the AVE are greater than all correlations between each construct and all other constructs (Chin, 1998; Fornell and Larcker, 1981).[9]

Finally, we conducted subgroup tests of moderation, and so we needed to check for any underlying heterogeneity (beyond that of the subgrouping variable) that could cause the moderation outcomes (Carte and Russell, 2003). Two sets of evaluations relied on available items

[9] Following Henseler et al. (2015), we also assessed discriminant validity using the heterotrait–monotrait ratio correlations, all of which were below the conservative critical value of .85, providing further evidence of discriminant validity. As another robustness check for the quality of the measurement data, we performed a principal components exploratory factor analysis (Hair et al., 2006) for each of the four constructs, in SPSS 22. For all four constructs (MARK-TURB, FLEX, PERF, and INTER), the items loaded above .50 on the corresponding first factor (Hair et al., 2006). For MARK-TURB, the eigenvalue is 4.2 with 47.0% of variance explained. For FLEX, it is 8.7 with 48.1% of variance explained. For PERF, the eigenvalue is 2.5 with 78.6% of variance explained, and for INTER, the eigenvalue is 8.0 with 49.8% of variance explained.

in the survey. First, we assessed subgroup homogeneity in terms of business unit size, because size can systematically influence organizational practices and performance (Donaldson, 2001). In the full sample (n = 331), the median revenue is AUD 175m, and median employment is 500. Independent sample Mann-Whitney U-tests confirmed that the three market turbulence subgroups do not significantly differ statistically in their median revenues or employee numbers. Second, we evaluated industry distribution and ownership structures. As Table 2 reveals, the greatest differences in industry distribution across the three subgroups relate to: (1) manufacturing; (2) services; and (3) finance, insurance, and real estate. Across the three subgroups, we find some minor variations in the distributions of ownership structures, depending on whether they were: (1) listed on the Australian Stock Exchange; (2) privately held in Australia; or (3) foreign owned. A PLS model (n = 331) with the three industry items and the three ownership items as dummy control variables, together with logged employee and revenue control variables, sought to test whether the control variables exerted any impacts on the effects of FLEX on INTER, or of INTER on PERF. None of these effects of the eight control variables was statistically significant ($p > .10$). Thus, we find no adverse effects for the subgroup moderating tests due to the eight control variables.

4. Results

The hypotheses assessment results are presented in Table 3.[10]

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[10] Using omission distances of 7 and 15, all measures of the cross-validated redundancy Q^2 were greater than 0, indicating that all endogenous constructs in all models offer predictive relevance (Chin, 1998).

Table 3
Hypotheses assessment results

	Full sample (n=331)	Hyper-turb. (n=49)	Mod-turb. (n=235)	Low-turb. (n=47)	Hyper-turb. *minus* Mod-turb.	Hyper-turb. *minus* Low-turb.	Mod-turb. *minus* Low-turb.
Path					***Path diff.***	***Path diff.***	***Path diff.***
H1: INTER → PERF	0.31***	0.52***	0.30***	0.19	0.22**	0.33	0.11
H2: FLEX → INTER	0.58***	0.76***	0.55***	0.31**	0.21**	0.45***	0.24**
R^2							
PERF	0.10	0.27	0.09	0.03			
INTER	0.33	0.57	0.31	0.09			

One-tailed significance levels: * p < 0.10; ** p < 0.05; *** p < 0.01.

Regarding *Hypothesis 1*, which predicts that market turbulence moderates the positive effect of interactive PPS capabilities on business performance, the paths from INTER to PERF are as follows: low market turbulence $\beta = .19$ (*n.s.*); moderate market turbulence $\beta = .30$ ($p < .01$); and hyper market turbulence $\beta = .52$ ($p < .01$). The path differences increase between the moderate and hyper market turbulence subgroups by .22 ($p < .05$). Thus, *Hypothesis 1* receives support: the strength of the effect of interactive PPS capabilities on business performance increases with the shift from moderate to hyper market turbulence. The findings for low market turbulence are inconclusive though, possibly due to insufficient sample size.[11] Alternatively, as was discussed in our hypothesis development, PPS capabilities (and DCs more generally) might be ineffective in low turbulence (Eisenhardt and Martin, 2000; Teece, 2007; Volberda, 1996).

With *Hypothesis 2*, we predicted that market turbulence moderates the positive effect of organizational flexibility values on interactive PPS capabilities. As reported in Table 3, the paths

[11] To test for sufficient statistical power for assessing the two hypotheses based on the PLS-SEM estimations, we used G*Power 3.1.3 software (Faul et al., 2009). The tests identified the following minimum sample size requirements with a 5% probability of error: hyper turbulence n = 31, moderate turbulence n = 111, low turbulence n = 104, and total sample n = 104. These requirements are met, except for the low turbulence subgroup. Thus, there may be insufficient statistical power for assessing the hypotheses for the low turbulence subgroup.

from FLEX to INTER are as follows: low market turbulence $\beta = .31$ ($p < .05$); moderate market turbulence $\beta = .55$ ($p < .01$); and hyper market turbulence $\beta = .76$ ($p < .01$). The path differences increase, between the low and moderate market turbulence subgroups by .24 ($p < .05$) and between the moderate and hyper market turbulence subgroups by .21 ($p < .05$). Thus, *Hypothesis 2* receives support; the positive effect of flexibility values on interactive PPS capabilities is moderated by market turbulence.[12,13]

5. Discussion and conclusion

This article sheds new light on what can constitute a component of a firm's DCs by describing interactive PPS capabilities in terms of DCs and by studying them in a DCF-based nomological network. We developed a conceptual foundation that bears out interactive PPS in terms of DCs, with the degree of routinization of interactive PPS capabilities reflected in the

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[12] *Hypotheses 1* and *2* imply indirect effects of organizational flexibility values on business performance, mediated through interactive PPS capabilities. Hence, supplementary indirect effects analyses were carried out, as follows: low market turbulence $\beta = .06$ (*n.s.*); moderate market turbulence $\beta = .17$ ($p < .01$); and hyper market turbulence $\beta = .40$ ($p < .01$); and the overall sample $\beta = .18$ ($p < .01$). In linking *Hypotheses 1* and *2*, these results further substantiate the DC nature of interactive PPS capabilities in the contexts of moderate and hyper market turbulence. To assess for mediation, as implied in the hypotheses development, the direct effect of FLEX on PERF must also be included (Baron and Kenny, 1986). Such a PLS-SEM model for the overall sample produced the following estimates: FLEX → INTER ($\beta = .58, p < .01$); FLEX → PERF ($\beta = .41, p < .01$) and INTER → PERF ($\beta = .08, p < .10$), thereby supporting partial mediation. Further mediation assessment – that would incorporate additional effects – for subgroups was constrained by their sample sizes. Using the G*Power 3.1.3 software (Faul et al., 2009) implies that the following increased minimum sample size requirements would be required in consideration of a 5% probability of error: hyper turbulence $n = 61$, moderate turbulence $n = 175$, low turbulence $n = 445$, and the total sample $n = 158$. These requirements are only met for the sample of firms operating in moderate turbulence and the overall sample. For moderate turbulence, the PLS-SEM estimates are: FLEX → INTER ($\beta = .55$, $p < .01$); FLEX → PERF ($\beta = .46$, $p < .01$) and INTER → PERF ($\beta = .04, p < .10$). Mediation analysis for hyper turbulence cannot be performed because of a strong risk of Type II error, due to the strong correlations between the predictor variables and the dependent variable, coupled with small sample size (Hoyle and Kenny, 1999). This risk of a Type II error is a severe problem that can only be overcome with a much larger sample size (Hoyle and Kenny, 1999). Finally, mediation analysis is not performed for the low turbulence context, given that the actual sample size ($n = 47$) is less than required ($n = 445$).

[13] For exploratory and robustness assessment, the interaction effects of INTER and FLEX in relation to the dependent variable PERF were also estimated, producing the following product indicator coefficients: low market turbulence $\beta =$ .10 ($p = .30$); moderate market turbulence $\beta = .01$ ($p = .46$); hyper market turbulence $\beta = .03$ ($p = .40$); and the overall sample $\beta = .00$ ($p = .48$). Thus, there is no evidence for such interaction effects; though caution should be applied in regards to these estimates for low turbulence and hyper turbulence subgroups.

frequency and strategic learning intensity of interactive PPS routines. With higher levels of PPS capability routinization, top and middle managers more frequently process budgeting, forecasting and results-reporting information in an interactive fashion – for learning and creating knowledge for planning and managing strategic business change (ostensibly for sensing, seizing and business model reconfiguration). We then theorized interactive PPS capabilities in terms of DCs and developed two hypotheses that embed interactive PPS in a nomological network based on salient tenets of the DCF (Schilke et al., 2017). The nomological network relates interactive PPS capabilities to antecedent, outcome and moderator variables, to explicate how interactive PPS capabilities should function as DCs. Indicating that interactive PPS capabilities do indeed provide the benefits of DCs; we find that the positive marginal effect of interactive PPS capabilities on business performance grows with heightened market turbulence (*Hypothesis 1*). Indicating that interactive PPS capabilities exhibit the 'difficult to develop' aspect needed for DCs; we find a positive marginal effect of flexibility values on the use of interactive PPS capabilities that grows with greater market turbulence (*Hypothesis 2*). These findings provide support for our conceptualized DCs nature of interactive PPS capabilities.

The unique nature of interactive PPS capabilities allows studying two aspects that we argue are important in DCs use: formal cybernetic control systems, and the intertwined involvement of top and middle managers. The cybernetic control systems used in PPS capabilities structure feedback variance information and feedforward variance information, which map to the accountability structure of a business unit managerial hierarchy. With more highly routinized interactive PPS capabilities, these information systems more systematically link top and middle managers in sensing, seizing and business model reconfiguring processes. In interactive PPS capabilities, top management's knowledge of business model strategic uncertainties co-emerges with middle manager’s capability gap knowledge and ideas. Just as the interactive PPS concept contributed a “cybernetic view” of emergent strategy-making (Mintzberg et al., 2009, p. 65), this study proposes a ‘cybernetic DC perspective’.

The cybernetic and intertwined top and middle manager aspects provide novel insights to the topical area of DC routine dynamics (Feldman et al., 2016; Schilke et al., 2017). Without middle managers contributing their capability gap information, a capacity for higher routinization of interactive PPS capabilities would be limited. Middle managers have unique organizational vantage points from which they accumulate situated experience that forms their capability gap knowledge and ideas (Nonaka, 1994; Zollo and Winter, 2002). Given the agency inherent in such situated experience (Nonaka et al., 2000), coupled with the hierarchical accountability systems inherent in PPS information, middle managers could covertly withhold their capability gap information. This covert withholding is likely if middle managers fear being held rigidly accountable for negative PPS feedback variances that could eventuate from unsuccessful seizing attempts of their capability gap ideas (Argyris and Schön, 1996; Simons, 1995). As is evident from the positive effect of flexibility values with *Hypothesis 2*, the routinization of interactive PPS capabilities relies on flexible learning processes, so that the intertwined knowledge of strategic uncertainties and capability gaps in interactive PPS routines can emerge through the idiosyncratic uses of PPS capabilities over time. In light of the calls to add specificity to the DCF literature to overcome its often abstract nature, this study proposes a highly specified account of how organizational flexibility can be a critical aspect of the distributed learning and knowledge creation processes in DCs use (Teece et al., 1997; Teece, 2007).

The flexibility-enabled routine dynamics of interactive PPS capabilities become more pronounced as market turbulence heightens. There are two aspects to the novelty of this finding.

First, effective interactive PPS capabilities are more routinized in hyper market turbulence than in moderate market turbulence. In hyper market turbulence, DCs rely less on leveraging existing knowledge and rely more on rapidly creating new, situation-specific knowledge (Eisenhardt and Martin, 2000). In hyper market turbulence, top management's knowledge of strategic uncertainties needs to be more frequently and intensively synthesized and reconciled with capability gap knowledge provided by middle managers. Second, interactive PPS capabilities routinization depends on flexibility values more strongly as market turbulence intensifies, because, adapting March (1991), capability gap ideas become riskier - and thereby more likely to lead to possible unfavorable PPS performance feedback variances. This moderated effect is evidence that the nature of knowledge and idea flows between top and middle managers differs between moderate and hyper market turbulence. With hyper market turbulence and higher routinization of interactive PPS capabilities, ostensibly there are relatively more sensing and reconfiguring related ideas contributed by middle managers, for interactively informing seizing choices made through budgets and forecasts. This insight offers a foundation for future research to study learning and knowledge flow roles of middle and top managers, including in terms of explicit sensing, seizing and reconfiguring processes.

One possible avenue for further research is to use the 'organizational drivetrain' lens, which Di Stefano et al. (2014) offered as a framework to reconcile and integrate the two contradictory perspectives about DCs routinization (Schilke et al., 2017). The first perspective, following Eisenhardt and Martin (2000), posits that as market turbulence intensifies to a hyper level, DCs become less routinized and 'simpler'. In contrast, the second perspective, following Teece et al. (1997), posits that instead DCs become more routinized and 'more complicated'. Our study aligns with the Teece et al. (1997) perspective, with effective interactive PPS capabilities being more routinized and more complicated (in terms of the characteristics of the information processed interactively) in hyper market turbulence. The organizational drivetrain lens (Di Stefano et al., 2014) provides a potentially useful basis to link simple and complicated elements within a hierarchy of DCs (Schilke et al., 2017; Winter, 2000).

This article also provides several novel insights and future research implications for the management control systems literature (see, for example, Chenhall, 2007; Otley, 2016). Hyper market turbulence is an under-studied context in the management control system literature (Chenhall, 2007). Where the DCF has been referred to in the management control systems literature the linkages have been tangential and piecemeal. No previous article has conceptualized management control systems practices in terms of DCs.[14] This is surprising because management control systems research has a tradition of integrating new insights from the strategic management literature (Chenhall, 2007) as well as having a contemporary focus on: innovation; creativity; entrepreneurship; flexibility; organizational dynamism; and organizational learning and knowledge creation (e.g., Chenhall and Moers, 2015; Davila et al., 2009; Ditillo, 2004; Gimbert et al., 2010; Kolehmainen, 2010; Micheli and Manzoni, 2010; Simons, 1995; Widener, 2014). Future interactive control systems research could investigate the roles of differentially situated managers (e.g., functionally) and analyze a greater variety of strategic roles and knowledge flow contributions of middle managers (see, for example, Wooldridge et al., 2008) and also of top managers. Top managers typically have business model related knowledge that is broad,

[14] While several studies of interactive management control systems have referred to DCs (e.g., Davila et al., 2009; Henri, 2006b; Grafton et al., 2010; Wouters and Wilderom, 2010), the linkages have been relatively tangential. While Henri (2006b) studies interactive uses of management control systems as antecedents of DCs, we contribute the perspective in which they are DCs themselves. Also, although Teece (2007) discussed management control systems (in the form of performance measurement systems), it was as a universally adoptable ‘best-practice’, without any of the ‘difficult to develop or deploy’ properties required of DC use.

conceptual and envisaged, while middle managers have knowledge that is more detailed and specific to functional areas and operational experiences (D'Aveni et al., 2010; Nonaka, 1994).

We also note several potential limitations of this research. First, although our measurement model for interactive PPS capabilities corresponds with our conceptualization of these capabilities in terms of DCs, further research is needed to delve deeper into the specific processes of sensing, seizing and reconfiguring. In investigating routines that provide additional evidence of how certain interactive PPS routines relate to selected processes of DCs, further research could also apply an organizational drivetrain lens (see Di Stefano et al., 2014), to study interactive PPS 'micro-routines' in consideration of DCs residing in other functional areas of a firm. Second, the research design is cross-sectional. Without a longitudinal research design, it is difficult to establish causality. However, the strong theoretical foundation provides some confidence in the effects we have identified. Third, with a survey method, there is a risk of common method bias; though Harman's one-factor analysis indicated it was not an issue, and its presence actually would have produced consistent effects rather than the moderating effects we have established. Fourth, the sample size for the low market turbulence subgroup was insufficient, and so some of the empirical findings are limited to the moderately and hyper turbulent conditions. Fifth, we collected the data only in Australia, and the data set spans many industries. Further studies with a limited number of industries might help identify more industry-specific differences, and data from other countries would help validate the findings. A sixth possible limitation concerns the applicability of our dataset to the world today. Although future replication studies could further verify our conclusions, hyper market turbulence has been documented in academic literature for over thirty years (e.g., McCann and Selsky, 1984; Teece, 2007; Teece et al., 1997). Some scholars (e.g., D'Aveni et al., 2010) predict hyper market turbulence will become more prevalent due to globalization and technological disruption, and so DCs (such as interactive PPS capabilities) may be even more important in the contemporary business world. Notwithstanding these limitations, this article offers a highly specified, empirically grounded account of a previously overlooked manifestation of DCs, one that clarifies the distinctive roles of cybernetic control systems and the intertwined involvement of top and middle managers.

Finally, this paper has implications for managerial practice. Budgetary control systems are often viewed as counterproductive for businesses facing environmental turbulence and requiring innovation, entrepreneurship and flexibility (Chenhall and Moers, 2015; Otley and Soin, 2015). The interactive PPS capabilities perspective is in stark contrast to the 'beyond budgeting' literature that is relatively prominent in practice and argues that budgeting systems should be abandoned, especially in firms that face market turbulence (see for example Libby and Lindsay, 2010). From an interactive PPS capabilities perspective, budgeting systems need to be used along with forecasting systems during the course of a budget year (Simons, 1995). Top managers need to be careful to involve themselves as 'interactive facilitative leaders' when there is a need for a high degree of interactive PPS routinization (Bisbe et al., 2007; Simons, 1995). Thus, the use of interactive PPS capabilities uniquely allows senior management to involve middle managers when determining and leading strategic change within their business.

Appendix A.

Questionnaire items

Market turbulence (MARK-TURB)	
mark-pred	It is very difficult to predict any customer changes in this marketplace.
mark-rate	In our kind of business, customers' product preferences change quite a bit over time.
mark-compl	There are many, diverse market events that impact our business's operations.
tech-pred	It is very difficult to forecast where the technology in our industry will be in two to three years.
tech-rate	The technology in our industry is changing rapidly.
tech-compl	There are many, diverse technological events that impact our business's operations.
comp-pred	It is very difficult to predict any changes in who might be our future competitors.
comp-rate	One hears of new competitive moves almost every day.
comp-compl	There are many, diverse competitor events that impact our business's operations.
Flexibility values (FLEX)	
Collect-involv	
team1	Working in this organization is like being part of a team.
team2	This organization relies on horizontal control and coordination to get work done, rather than hierarchy.
team3	Teams are the primary building blocks of this organization.
capdev1	This organization is constantly improving compared with its competitors in many dimensions.
capdev2	This organization continuously invests in the skills of employees.
capdev3	The capability of people is viewed as an important source of competitive advantage.
empow1	Decisions are usually made at the level where the best information is available.
empow2	Information is widely shared so that everyone can get information he or she needs when it is needed.
empow3	Everyone believes that he or she can have a positive impact.
Adapt-innov	
change1	This organization is very responsive and changes easily.
change2	This organization responds well to competitors and other changes in the external environment.
change3	This organization continually adopts new and improved ways to work.
custom1	Customer comments and recommendations often lead to changes in this organization.
custom2	Customer input directly influences our decisions.
custom3	The interests of the final customer rarely get ignored in our decisions.
learn1	We view failure as an opportunity for learning and improvement.
learn2	This organization encourages and rewards those who take risk.
learn3	We make certain we coordinate our actions and efforts between different areas in this organization.
Business performance (PERF)	
Sales	Sales growth, relative to your major competitors
Markshare	Market share, relative to your major competitors
Profit	Profitability, relative to your major competitors

Questionnaire items (continued)

Interactive profit-planning systems capabilities (INTER)[15,16]	
Snr-frq	*Senior management interaction frequency*
snrfrq1	Senior managers meet and discuss profit-planning information very frequently (e.g., weekly).
snrfrq2	Senior managers are continually involved in profit-planning activities.
snrfrq3	Senior managers constantly interact with peers in profit-planning activities.
snrfrq4	Senior managers very often attend presentations of profit-planning information.
Mid-frq	*Senior and middle management interaction frequency*
midfrq1	Middle managers constantly interact with senior managers in profit-planning activities.
midfrq2	Middle managers very often present profit-planning information to senior managers.
midfrq3	Middle and senior managers meet and discuss profit-planning information very frequently (e.g., weekly).
midfrq4	Middle managers are continually involved in profit-planning activities with senior managers.
Chall	*Degree of face-to-face challenge and debate*
chall1	Profit-planning meetings always include consideration of multiple alternatives and scenarios.
chall2	Profit-planning meetings always investigate progress made for delivering on expectations.
chall3	Every profit-planning meeting involves intensive review and revision of action plans.
chall4	Every profit-planning meeting has in-depth discussion of why results differ from expectations.
Strat	*Degree of focus on strategic business change*
strat1	Significant business development opportunities are a key focus in every profit-planning meeting.
strat2	Strategic business changes are always assessed in profit-planning meetings.
strat3	Business critical threats are always an important discussion point in profit-planning meetings.
strat4	The sustainability of our business strategies is a key theme in profit-planning meetings.

[15] The questionnaire included the following definitions:

(1) *senior management* are 'the business unit top manager and his/her direct reports';

(2) *middle management* are 'below the senior management team';

(3) a '*Profit-plan* outlines the planned sales revenue, expenses and net income - usually by month. Profit-plans are typically set annually (e.g. as part of the annual budget), and may be updated with forecasts. Profit-planning is an activity that undertakes and compares budgeted, forecasted and actual revenue and expenses by revenue and cost category" (from Simons, 1995, p. 109).

[16] The construct model is latent (i.e., 'higher-order reflective') as conceptualized and operationalized. The planning and management of strategic change reflected in each of the items reflect sensing, seizing and reconfiguring processes. Further to the specific ways of referring to sensing, seizing and/or reconfiguring, additional aspects that matter specifically to our study and that can characterize DCs use are captured in this measurement model. *Snr-frq* and *Mid-frq* reflect the frequency of interactive PPS routines, while *Chall* and *Strat* reflect the strategic learning intensity. For *Chall*: *chall1* and *chall3* are for feedforward information; and *chall2* and *chall4* are for results and feedback information. For *Strat* the four items ostensibly reflect overlapping processes of sensing, seizing and reconfiguring. As summarized by Schilke et al. (2017) these processes are: the *sensing* of new opportunities (and threats) from the business environment; making strategic choices and investing in business models for *seizing* those opportunities; and coordinating the *reconfiguration* of the organization and its strategy as new opportunities and threats are 'sensed'.

Appendix B: Evaluation of measurement models

Table B1

Descriptive statistics: Market turbulence

Construct / survey items	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)
	Mean (scores range: 1–9)				**Std. dev. (scores range: 1–9)**			
mark-pred	6.55	4.25	2.96	4.41	1.37	1.68	1.22	1.87
mark-rate	6.00	5.13	2.91	4.95	2.06	2.00	1.46	2.13
mark-compl	6.86	6.06	3.77	5.85	1.71	1.74	1.34	1.90
tech-pred	7.47	4.41	2.53	4.60	1.37	1.86	1.12	2.18
tech-rate	6.78	5.80	2.89	5.53	2.05	1.91	1.31	2.17
tech-compl	6.80	4.99	2.60	4.92	1.87	1.88	1.01	2.11
comp-pred	7.08	4.22	2.49	4.40	1.10	1.76	1.00	2.03
comp-rate	5.96	4.19	2.11	4.16	2.44	2.00	1.01	2.22
comp-compl	6.78	5.06	2.49	4.95	1.66	1.67	0.91	1.97

Table B2
PLS paths/loadings and descriptive statistics

Construct / survey items	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)
	Paths / Loadings				**Mean (scores range: 1–9)**				**Std. dev. (scores range: 1–9)**			
INTER					***6.93***	***6.14***	***5.91***	***6.22***	***1.50***	***1.34***	***1.19***	***1.38***
Snr-frq	*0.95*	*0.90*	*0.93*	*0.91*	*7.19*	*6.29*	*6.16*	*6.40*	*1.68*	*1.60*	*1.65*	*1.65*
snrfrq1	0.71	0.77	0.76	0.77	7.06	5.67	5.30	5.82	2.18	2.46	2.64	2.50
snrfrq2	0.88	0.83	0.84	0.84	7.78	6.88	6.83	7.01	1.50	1.78	1.93	1.79
snrfrq3	0.93	0.81	0.77	0.83	7.06	6.39	6.23	6.47	1.94	1.85	2.00	1.90
snrfrq4	0.85	0.77	0.67	0.77	6.88	6.21	6.28	6.32	2.39	1.94	2.10	2.04
Mid-frq	*0.87*	*0.82*	*0.81*	*0.83*	*6.30*	*5.48*	*5.05*	*5.54*	*1.87*	*1.77*	*1.73*	*1.81*
midfrq1	0.87	0.87	0.87	0.88	6.78	5.81	5.51	5.91	2.36	2.07	2.13	2.15
midfrq2	0.80	0.86	0.76	0.84	6.31	5.77	5.47	5.81	1.87	2.05	2.17	2.05
midfrq3	0.90	0.81	0.84	0.83	5.71	4.80	4.32	4.86	2.43	2.19	2.27	2.27
midfrq4	0.87	0.89	0.75	0.87	6.39	5.55	4.91	5.59	1.99	1.99	2.03	2.03
Chall	*0.95*	*0.90*	*0.69*	*0.90*	*6.96*	*6.27*	*6.20*	*6.36*	*1.52*	*1.46*	*1.32*	*1.47*
chall1	0.82	0.73	0.67	0.74	6.63	6.09	6.26	6.19	1.83	1.81	1.73	1.80
chall2	0.87	0.84	0.64	0.83	7.45	6.78	6.89	6.89	1.50	1.65	1.45	1.61
chall3	0.83	0.80	0.85	0.80	6.55	5.82	5.04	5.82	1.98	1.88	1.88	1.93
chall4	0.86	0.86	0.85	0.86	7.20	6.40	6.60	6.54	1.89	1.92	1.88	1.92
Strat	*0.92*	*0.84*	*0.76*	*0.85*	*7.27*	*6.51*	*6.25*	*6.59*	*1.45*	*1.43*	*1.24*	*1.44*
strat1	0.80	0.74	0.66	0.74	7.16	6.54	6.60	6.64	1.65	1.73	1.80	1.74
strat2	0.88	0.80	0.69	0.80	7.27	6.41	5.98	6.47	1.63	1.85	1.70	1.83
strat3	0.87	0.82	0.75	0.82	7.08	6.59	6.34	6.63	1.90	1.91	1.72	1.89
strat4	0.85	0.77	0.59	0.77	7.57	6.51	6.09	6.60	1.66	1.80	2.04	1.86
PERF					***6.46***	***6.27***	***6.09***	***6.27***	***1.82***	***1.32***	***1.32***	***1.40***
sales	*0.95*	*0.89*	*0.67*	*0.90*	*6.61*	*6.25*	*6.15*	*6.29*	*1.88*	*1.47*	*1.46*	*1.54*
markshar	*0.97*	*0.89*	*0.89*	*0.91*	*6.24*	*6.21*	*6.17*	*6.21*	*1.93*	*1.50*	*1.54*	*1.57*
profit	*0.85*	*0.83*	*0.88*	*0.82*	*6.51*	*6.34*	*5.96*	*6.31*	*2.09*	*1.58*	*1.67*	*1.68*

Paths / loadings underlined are significant at $p < 0.05$. All other loadings significant at $p < 0.01$

Table B2 (continued)

PLS paths/loadings and descriptive statistics

Construct / survey items	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)
	Paths / Loadings				**Mean (scores range: 1–9)**				**Std. dev. (scores range: 1–9)**			
FLEX					***7.14***	***6.44***	***6.28***	***6.52***	***1.19***	***1.10***	***1.14***	***1.15***
Collect-involv	*0.97*	*0.94*	*0.97*	*0.95*	*7.33*	*6.67*	*6.63*	*6.76*	*1.24*	*1.21*	*1.07*	*1.21*
team1	0.81	0.85	0.67	0.81	7.45	7.11	7.02	7.15	1.24	1.67	1.67	1.61
team2	0.70	0.63	0.52	0.64	6.96	6.16	5.91	6.24	1.73	1.87	1.94	1.88
team3	0.81	0.78	0.67	0.77	7.61	7.03	6.89	7.10	1.34	1.62	1.63	1.60
capdev1	0.87	0.76	0.63	0.76	7.06	6.55	6.53	6.62	1.59	1.51	1.59	1.54
capdev2	0.84	0.77	0.52	0.75	7.57	6.44	6.38	6.60	1.46	1.60	1.68	1.64
capdev3	0.90	0.78	0.51	0.77	7.84	7.34	7.45	7.43	1.53	1.47	1.43	1.48
empow1	0.87	0.65	0.84	0.72	7.22	6.51	6.47	6.61	1.56	1.56	1.69	1.60
empow2	0.87	0.76	0.75	0.78	7.18	6.40	6.47	6.53	1.58	1.66	1.47	1.64
empow3	0.76	0.80	0.77	0.79	7.06	6.46	6.53	6.56	1.43	1.52	1.67	1.54
Adapt-innov	*0.96*	*0.93*	*0.91*	*0.93*	*6.95*	*6.22*	*5.93*	*6.28*	*1.25*	*1.16*	*1.35*	*1.23*
change1	0.85	0.75	0.79	0.78	6.61	5.84	5.43	5.89	1.75	1.83	2.05	1.87
change2	0.86	0.76	0.81	0.78	6.80	6.38	6.04	6.40	1.76	1.59	2.02	1.69
change3	0.80	0.79	0.74	0.79	7.27	6.37	5.98	6.45	1.50	1.54	1.81	1.61
custom1	0.72	0.73	0.69	0.73	7.31	6.46	5.72	6.48	1.77	1.52	2.20	1.72
custom2	0.70	0.66	0.63	0.68	7.51	6.51	6.11	6.60	1.53	1.55	1.96	1.65
custom3	0.70	0.62	0.78	0.67	7.69	6.84	6.81	6.96	1.43	1.53	1.80	1.58
learn1	0.77	0.72	0.65	0.72	6.39	5.91	5.83	5.97	1.69	1.68	1.88	1.72
learn2	0.64	0.65	0.68	0.67	6.24	5.53	5.00	5.56	1.87	1.84	1.99	1.89
learn3	0.80	0.68	0.51	0.66	6.69	6.11	6.45	6.24	1.46	1.69	1.47	1.64

Paths / loadings underlined are significant at $p < 0.05$. All other loadings significant at $p < 0.01$

Table B3
Convergent validity

Construct / latent variable	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)	Hyper-turb. (*n*=49)	Mod-turb. (*n*=235)	Low-turb. (*n*=47)	All (*n*=331)
	Composite reliability				**AVE**				**Cronbach's α**			
INTER	**0.96**	**0.92**	**0.87**	**0.92**	**0.62**	**0.74**	**0.62**	**0.75**	**0.94**	**0.88**	**0.80**	**0.89**
Snr-frq	0.91	0.87	0.85	0.88	0.71	0.63	0.58	0.64	0.86	0.81	0.76	0.82
Mid-frq	0.92	0.92	0.88	0.92	0.74	0.73	0.65	0.73	0.88	0.88	0.82	0.88
Chall	0.91	0.88	0.84	0.88	0.71	0.65	0.58	0.65	0.87	0.82	0.75	0.82
Strat	0.91	0.86	0.77	0.86	0.72	0.61	0.46	0.61	0.87	0.79	0.61	0.79
FLEX	**0.96**	**0.93**	**0.94**	**0.94**	**0.86**	**0.87**	**0.86**	**0.88**	**0.92**	**0.85**	**0.88**	**0.87**
Collect-involv	0.96	0.94	0.93	0.94	0.69	0.57	0.44	0.57	0.94	0.90	0.83	0.91
Adapt-innov	0.93	0.90	0.90	0.91	0.58	0.50	0.50	0.52	0.91	0.88	0.87	0.88
PERF	0.95	0.90	0.86	0.91	0.70	0.76	0.70	0.78	0.91	0.84	0.81	0.85

Table B4
Discriminant validity: Cross-loading of measurement items

	Hyper-turb. (*n=49*)			Mod-turb. (*n*=235)			Low-turb. (*n=47*)			All (*n*=331)		
Construct / items	INTER	FLEX	COMP	INTER	FLEX	COMP	INTER	FLEX	COMP	INTER	FLEX	COMP
INTER												
snrfrq1	**0.63**	0.29	0.13	**0.66**	0.35	0.18	**0.76**	0.04	0.07	**0.68**	0.33	0.15
snrfrq2	**0.84**	0.64	0.42	**0.75**	0.38	0.21	**0.77**	0.30	-0.13	**0.77**	0.42	0.20
snrfrq3	**0.92**	0.77	0.57	**0.75**	0.46	0.21	**0.75**	0.21	0.05	**0.78**	0.48	0.25
snrfrq4	**0.80**	0.55	0.42	**0.67**	0.33	0.17	**0.52**	0.21	-0.10	**0.68**	0.37	0.20
midfrq1	**0.82**	0.53	0.36	**0.76**	0.36	0.20	**0.69**	0.18	0.26	**0.77**	0.39	0.24
midfrq2	**0.64**	0.42	0.14	**0.70**	0.27	0.10	**0.59**	0.05	0.27	**0.68**	0.28	0.13
midfrq3	**0.70**	0.43	0.14	**0.70**	0.35	0.18	**0.76**	0.21	0.25	**0.71**	0.37	0.17
midfrq4	**0.83**	0.63	0.38	**0.76**	0.40	0.12	**0.63**	0.21	0.21	**0.76**	0.43	0.19
chall1	**0.72**	0.55	0.31	**0.65**	0.38	0.24	**0.44**	0.10	-0.12	**0.64**	0.38	0.19
chall2	**0.92**	0.72	0.49	**0.81**	0.45	0.18	**0.52**	0.26	0.10	**0.79**	0.48	0.21
chall3	**0.70**	0.50	0.34	**0.70**	0.36	0.17	**0.69**	0.05	0.21	**0.71**	0.37	0.20
chall4	**0.85**	0.68	0.51	**0.73**	0.41	0.12	**0.63**	0.16	-0.09	**0.74**	0.44	0.15
strat1	**0.69**	0.57	0.52	**0.64**	0.40	0.29	**0.41**	0.30	0.22	**0.63**	0.42	0.32
strat2	**0.79**	0.79	0.69	**0.61**	0.36	0.22	**0.52**	0.06	0.12	**0.64**	0.41	0.29
strat3	**0.82**	0.70	0.47	**0.66**	0.44	0.27	**0.54**	0.22	0.04	**0.68**	0.46	0.28
strat4	**0.81**	0.59	0.32	**0.62**	0.42	0.29	**0.31**	0.07	0.22	**0.62**	0.42	0.26

Table B4 (continued)
Discriminant validity: Cross-loading of measurement items

	Hyper-turb. (*n=49*)			Mod-turb. (*n*=235)			Low-turb. (*n=47*)			All (*n*=331)		
Construct / items	INTER	FLEX	COMP	INTER	FLEX	COMP	INTER	FLEX	COMP	INTER	FLEX	COMP
FLEX												
team1	**0.49**	0.76	0.63	**0.41**	0.81	0.29	**0.47**	0.62	-0.12	**0.43**	0.76	0.28
team2	**0.45**	0.66	0.47	**0.30**	0.56	0.28	**0.15**	0.45	0.10	**0.32**	0.57	0.30
team3	**0.52**	0.81	0.72	**0.35**	0.70	0.28	**0.31**	0.62	-0.12	**0.39**	0.70	0.29
capdev1	**0.66**	0.87	0.78	**0.38**	0.74	0.55	**0.08**	0.65	0.15	**0.40**	0.75	0.54
capdev2	**0.78**	0.82	0.46	**0.33**	0.72	0.32	**-0.04**	0.59	-0.22	**0.38**	0.73	0.28
capdev3	**0.69**	0.88	0.68	**0.38**	0.73	0.39	**0.13**	0.49	0.00	**0.41**	0.72	0.42
empow1	**0.72**	0.84	0.64	**0.46**	0.66	0.36	**0.28**	0.75	-0.01	**0.49**	0.71	0.36
empow2	**0.82**	0.85	0.51	**0.49**	0.72	0.23	**0.15**	0.68	-0.15	**0.52**	0.74	0.24
empow3	**0.63**	0.74	0.59	**0.46**	0.75	0.33	**0.33**	0.71	-0.04	**0.48**	0.75	0.33
change1	**0.59**	0.86	0.53	**0.33**	0.65	0.35	**0.19**	0.74	-0.15	**0.37**	0.70	0.31
change2	**0.64**	0.89	0.58	**0.32**	0.66	0.42	**0.17**	0.79	-0.13	**0.36**	0.72	0.37
change3	**0.55**	0.73	0.41	**0.39**	0.74	0.38	**-0.03**	0.69	-0.32	**0.39**	0.74	0.28
custom1	**0.51**	0.63	0.47	**0.27**	0.64	0.26	**0.16**	0.58	-0.16	**0.33**	0.64	0.24
custom2	**0.40**	0.61	0.47	**0.23**	0.57	0.25	**0.09**	0.51	0.05	**0.27**	0.59	0.26
custom3	**0.42**	0.64	0.47	**0.25**	0.56	0.22	**0.12**	0.74	0.07	**0.29**	0.62	0.25
learn1	**0.58**	0.77	0.56	**0.42**	0.69	0.34	**0.11**	0.68	-0.21	**0.41**	0.70	0.33
learn2	**0.40**	0.62	0.58	**0.43**	0.61	0.36	**0.21**	0.65	-0.01	**0.42**	0.63	0.36
learn3	**0.47**	0.73	0.45	**0.42**	0.72	0.24	**0.10**	0.58	-0.15	**0.40**	0.70	0.23
PERF												
Sales	**0.57**	0.75	0.95	**0.22**	0.38	0.89	**-0.04**	0.09	0.57	**0.27**	0.42	0.90
Markshare	**0.44**	0.65	0.97	**0.23**	0.36	0.90	**0.13**	-0.04	0.87	**0.25**	0.35	0.92
Profit	**0.39**	0.58	0.85	**0.27**	0.48	0.82	**0.09**	-0.13	0.87	**0.28**	0.42	0.82

Table B5
Discriminant validity and latent variable correlation matrix

		Hyper-turb. (*n*=49)			Mod-turb. (*n*=235)			Low-turb. (*n*=47)			All (*n*=331)		
		1	2	3	1	2	3	1	2	3	1	2	3
1	PERF	**0.92**			**0.87**			**0.82**			**0.88**		
2	FLEX	0.73**	**0.96**		0.48**	**0.93**		-0.08	**0.94**		0.45**	**0.94**	
3	INTER	0.52**	0.76**	**0.92**	0.30**	0.55**	**0.86**	0.19	0.30*	**0.79**	0.31**	0.57**	**0.87**

Diagonal items are square root of AVE
Two-tailed significance levels: * $p < 0.05$; ** $p < 0.01$.

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