How Control Systems Influence Product Innovation Processes: Examining the Role of Entrepreneurial Orientation

Accounting and Business Research

Josep Bisbe*

josep.bisbe@esade.edu
ESADE Business School - Universitat Ramon Llull
Av. Pedralbes, 60-62, 08034 Barcelona, Spain
Tel +34 932 806 162

Ricardo Malagueño

rmalag@essex.ac.uk
Essex Business School - University of Essex
Wivenhoe Park, Colchester, CO4 3SQ, UK
Tel +44 (0) 1206 874108

*Corresponding author

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Abstract

This paper yields insights into the channels through which Management Accounting and Control Systems (MACS) exert an influence on product innovation by examining the extent to which different forms of control (i.e. value systems, diagnostic control systems, interactive control systems) are directly associated with the distinct phases of innovation processes. Using survey data collected from 118 medium and large Spanish companies, we find that: (1) value systems and interactive control systems have significant main effects on the creativity, coordination and knowledge integration, and filtering (sub-)phases of innovation processes; and (2) the significance and direction of these influences vary depending on the Entrepreneurial Orientation (EO) of firms. By highlighting the relevance of EO in shaping the influence of MACS on product innovation processes, this study calls for caution in generalising the expected effects of MACS on innovation.

Keywords: management accounting, control systems, innovation, creativity, conversion ability

INTRODUCTION

Product innovation has been recognised as lying at the heart of firms' value creation, survival and growth in contemporary environments. Despite its associated uncertainty, innovation is rarely a random or a spontaneous occurrence. Rather, sustained innovation results from processes that have to be managed (Trott 2008, Tidd and Bessant 2009). Over the past two decades, a stream of research has highlighted the relevance of management accounting and control systems (henceforth MACS) to innovation management (Simons 1995, Bisbe and Otley 2004, Henri 2006, Davila *et al.* 2006, 2009, Revellino and Mouritsen 2009, Jorgensen and Messner 2009, Dunk 2011). However, while the literature on innovation has long established creativity and conversion ability as two key phases in product innovation processes (Sheremata 2000, Chandy *et al.* 2006, Tidd and Bessant 2009), research on whether and how MACS play different roles in these two distinct phases is still rather scarce and inconclusive. Some studies suggest that MACS may boost innovation efforts by encouraging creativity, for example, through the mobilisation of risk-taking values (Tushman and O'Reilly 1997, Davila *et al.* 2006, Merchant and Van der Stede 2012) or through the orientation of opportunity-seeking (Simons, 1995). Other studies highlight that MACS either do little to promote creativity or hinder it because creativity requires intrinsic motivation and freedom rather than control (Amabile 1998, Bonner *et al.* 2002). Another stream of research stresses that MACS contribute to innovation primarily by helping firms develop conversion ability (Cardinal 2001, Ditillo 2004, Mouritsen *et al.* 2009). Inconclusive findings also extend to the implications of specific forms of control. Thus, for instance, interactive control systems have been associated in some studies with the development of creative ideas and new product concepts (e.g. Henri 2006, Adler and Chen 2011) whereas other studies have pointed out their role in facilitating knowledge integration, actively changing decisions and weeding out new product concepts during project implementation (Bonner et al. 2002, Bisbe and Malagueño 2009). Although some case-based studies have explored the role of MACS across different phases of product innovation processes (e.g. Chiesa *et al.*, 2009), there is an overall dearth of large-scale empirical research examining separately – and at the same time bringing together – the implications of MACS for each distinct phase.

This paper empirically examines the influence of MACS on the different phases of innovation processes with a view to assembling and reconciling these diverse positions, and responding to recent calls for further investigation of the effects of MACS within complex innovation processes (Davila *et al.* 2006, 2009). To guide such examination, we draw on theoretical developments of the Levers of Control framework (Simons 1995, 2000, Marginson 2002, 2009) to identify and focus on specific forms of control that are consequential for innovation processes. We further draw on prior innovation theory that establishes that the influence of managerial practices on innovation processes depends on a firm's strategic disposition. In this regard, we build on the stream of literature that points to the entrepreneurial orientation (EO) of a firm (Covin and Slevin 1989, Hult *et al.* 2007, Covin and Lumpkin 2011, George 2011) as a central variable that shapes how organisational members process information and react to structural arrangements (Atuahene-Gima and Ko 2001, Avlonitis and Salavou 2007, Stam and Elfring 2008) such as MACS. We further argue that, as the EO of a firm is reflected in its values content and in its strategic uncertainties, the influence of MACS on innovation processes is likely to depend on EO. Despite the potential relevance of EO, none of the studies that have analysed the relationships between MACS and innovation has delved into the extent to which the influence of MACS on innovation processes varies across different levels of EO. We expect that bringing EO into the analysis should both enable a better understanding of the implications of MACS and help reconcile some of the apparently contradictory findings reported in prior studies.

To address these unresolved areas, this paper has two specific aims. First, it examines the main effects of three forms of control (namely (i) value systems; (ii) interactive controls; (iii) diagnostic controls) (Simons 1995, Marginson 2002, 2009) on three (sub-)phases of innovation processes: one related to (i) the creativity phase; and two sub-phases related to conversion ability (namely (ii) co-ordination and knowledge integration, and (iii) filtering) (Cooper 1998, Chandy *et al.* 2006, Pavlou and El Sawy 2006, Cooper 2008, Zahra *et al.* 2007). Our study sheds light on whether these three forms of control have significant main effects on the different (sub-)phases of the product innovation process and on whether these effects vary across specific forms of control and across (sub-)phases.[1] Second, it examines whether the significance and direction of these main effects of specific MACS on the different (sub-)phases of innovation vary depending on the EO of a firm.

In this empirical study, we address these questions by proposing relationships that are tested using a Partial Least Squares (PLS) method on survey data collected from 118 senior managers. The findings of our study make two interrelated contributions to the literature on MACS and innovation. First, unlike previous quantitative MACS literature which tends to treat innovation as a single entity or focuses on a single phase of innovation processes, we examine separately and at the same time bring together the implications of the use of MACS in the creativity phase and in the sub-phases related to conversion ability. The inclusion of variables bearing on those (sub-)phases sheds light on the generative mechanisms by which MACSs influence product innovation. Second, the paper brings EO to the forefront and investigates the relevance of EO in shaping the influence of MACS on product innovation processes. In doing so, it demonstrates that the implications of control systems for product innovation processes largely depend on the firms' EO and that low-and high-EO firms (while using a similar mix of forms of control) operate these controls differently in order to manage the product innovation processes. The paper consequently calls for caution in generalizing the expected effects of MACS on innovation processes and identifies scenarios for reconciling ambiguous or inconsistent previous findings through the explicit consideration of EO.

THEORETICAL BACKGROUND

Innovation processes: creativity and conversion ability

Product innovation refers to the introduction of novel ideas as useable and marketable goods or services that are new or provide significantly improved features or intended uses (OECD, 2005; Trott, 2008). While a vast variety of both sequential and non-sequential approaches have been proposed in the literature to describe product innovation processes (e.g. Parthasarthy and Hammond, 2002; Tidd and Bessant, 2009), most studies coincide in identifying two broad phases. [2] The first concerns the insight arising from the generation of novel and potentially useful ideas in the form of new product concepts, i.e. 'creativity' (Zhou and Shalley 2008, Hennessey and Amabile 2010) — also referred to in management literature as 'concept generation' (Sheremata 2000), 'invention' (Trott 2008) or 'ideation' (Cooper 2008) . At the organisational level, creativity is the outcome of a complex social system in which individuals and groups work together. Organisational creativity involves cognitive (e.g. identification of problems or opportunities, intelligence-gathering, mapping of new knowledge into prior knowledge, elaboration of possible answers) and social efforts (e.g. exchange of ideas, setting up of internal and external networks, legitimisation) necessary to process, synthesise and build on individual and group creativity (Thompson and Choi 2006, Zhou and Shalley 2008).

The second phase is related to the organisational processes by which generated new concepts are eventually turned into useable and marketable products, i.e. 'conversion ability' (Chandy *et al.*

2006, Zahra *et al.* 2007) – also labelled as ‘implementation’ (Hennessey and Amabile 2010). Innovation literature has identified two activities or sub-phases related to conversion ability (Sheremata 2000): (i) co-ordination and knowledge integration; (ii) filtering practices (Mitchell 2006, Pavlou and El Sawy 2006, Zahra *et al.* 2007). Within conversion ability, co-ordination refers to the management of interdependencies among business resources and tasks in a synchronised manner in order to effectively lead previously generated concepts into launch and commercialisation (Pavlou and El Sawy 2006, Adler and Chen 2011). Knowledge integration refers to the reduction of disparities in (both tacit and explicit) knowledge among organisational members (Grant 1996, Zahra *et al.* 2007). Co-ordination and knowledge integration are conceptually related and have often been treated in the literature as interchangeable or as a single construct (e.g. Ditillo 2004, Atuahene-Gima 2005). Finally, filtering refers to the screening of previously generated new product concepts and the review of resource commitment to innovation efforts (Tidd and Bessant 2009). Filtering activities lead to abandonment, delay or change in the scope of the poorer generated concepts and concentrate the escalating resource commitments in truly meritorious proposals (Cooper 1998, 2008). [3]

Management Accounting and Control Systems

Management accounting and control systems (MACS) are constituted by procedures, processes, tools, and practices that managers use to ensure that the behaviours and decisions of their employees are consistent with the organisation’s objectives and strategies (Merchant 1985, Merchant and Van der Stede 2012). Researchers have developed various theoretical frameworks or typologies of MACS (e.g Simons 1995, Marginson 2002, Malmi and Brown 2008, Ferreira and Otley 2009, Merchant and Van der Stede 2012, Tessier and Otley 2012), some of which have proved particularly useful for conceptualising and empirically studying innovation-related issues. In this regard, recent literature on MACS and innovation has paid special attention to Simons’

(1995) Levers of Control (LOC) framework (e.g. Henri 2006, Widener 2007, Bisbe and Malagueño 2009, Chiesa *et al*. 2009, Adler and Chen 2011).

In the current paper, we draw upon an adaptation of the LOC framework based on Marginson (2002, 2009) that proposes two variations on the original LOC framework. First, beliefs systems and boundary systems are grouped under the label of 'Value Systems' (henceforth, VS). VS comprise the set of procedures, processes and practices that top management use to frame the firm's overall strategic purpose – as well as its behavioural and strategic domains (Marginson 2002). By emphasising VS, managers mobilise and amplify the transmission of the firm's values and delimitated domains (whatever their content is). In order to achieve such mobilisation and amplification, the firm's values, norms and domains may be articulated in positive (i.e. communicating vision and direction, stating 'who we are and what we do' as in beliefs systems) or in normative negative terms (i.e. setting constraints, stating 'who we are not and what we do not do', establishing 'no-go' areas, such as in boundary systems). Both forms of articulation are specific channels that share the common purpose of conveying messages about values and delimitated domains. No matter how they are articulated, VS do not determine by themselves the contents of the values and the domains that are set forth. The degree to which emphasis is placed on the use of VS is conceptually distinct from the contents of the values that the firm aims to transmit and is also distinct from the intended broadness of the acceptable strategic and behavioural domains. Second, we acknowledge that the communication and implementation of values may involve a variety of information-based mechanisms and procedures such as mission statements, codes of conduct, newsletters, e-mails, formal and informal oral presentations, contact with peers or social events in order to send managers and employees regular messages. We therefore open the possibility that VS systems incorporate both formal and informal components (Marginson 2009).

On the basis of these considerations we organise MACS under three headings based on the purpose of their use: (1) value systems (VS) (both formal and informal), used to mobilise a fairly stable set of assumptions, values, beliefs and norms as well as to frame the behavioural and strategic domain; (2) diagnostic control systems (DCS) (formal feedback and measurement systems based on programmed cybernetic processes and management by exception, and used to establish guidelines for corrective action); (3) interactive control systems (ICS) (formal feedback and measurement systems that top managers use to involve themselves regularly and personally in the decision activities of subordinates, to focus organisational attention on strategic uncertainties and to trigger the emergence of new initiatives and strategies).[4]

Entrepreneurial Orientation

Entrepreneurial Orientation (EO) refers to a firm-level general and lasting direction of thought, inclination, or disposition to engage in behaviour that leads to change in an organisation or the marketplace (Lumpkin and Dess 1996, Covin and Lumpkin 2011, Dess *et al.* 2011, George 2011). According to a dispositional conceptualisation of the construct, EO is distinguished by characteristics such as the proclivity to take risks and the inclination to be pro-active relative to the pursuit of new market opportunities (Covin and Slevin 1989, Atahuene-Gima and Ko 2001, Voss *et al.* 2005, Hult *et al.*, 2007, Stam and Elfring 2008). Under this dispositional conceptualisation, EO refers to a subset of the multiple dimensions that constitute the contents of an organisational culture.[5] Firms with a strong EO are therefore characterised by a strong risk-taking propensity by top management and an interest in being ahead of competitors. They are often referred to in the literature as entrepreneurial companies. Firms with a weak EO orientation are instead characterised by little risk-taking propensity and a tendency to follow the leaders. They have been labelled in the literature as conservative companies (Miller and Friesen 1982, Covin and Slevin 1989, Atuahene-Gima and Ko 2001, Avlonitis and Salavou 2007).

Previous research has highlighted that EO shapes the way organisational members process information and react to the environment and structural arrangements (Atahuene-Gima and Ko 2001). Hence, prior studies have pointed out the implications of EO for variables such as organisational learning (Anderson *et al.* 2009), level of radicalness of innovation outputs (Avlonitis and Salavou 2007), strategic adaptation (Garrett and Covin 2007) and organisational performance (Stam and Elfring 2008). As MACS are a structural arrangement, this suggests a potentially significant role of EO in shaping how MACS influence the various phases of product innovation processes.

THEORETICAL DEVELOPMENT AND FORMULATION OF HYPOTHESES

We next draw up a group of hypotheses that examine the direct effects of VS, ICS and DCS on creativity (H1), on co-ordination and knowledge integration (H2) and on filtering (H3). Several of these hypotheses capture expected differences in the form and strength of these relationships across levels of EO.[6]

MACS and creativity

In organisational creativity processes, knowledge of the transformation process is imperfect, the ability to measure outcomes is low and divergent views abound (Abernethy and Brownell 1997, Zhou and Shalley 2008). In this context, VS are likely to be linked to the transmission of the company beliefs that guide organisational search, the delineation of the strategic domain for engaging in creative processes (Simons 1995) and the clarification of the degrees of freedom within the creative space (Adler and Chen 2011). Thus, the more emphasis is placed on VS, the more the messages about values, strategic domains and degrees of freedom regarding creativity will be clarified, transmitted and amplified, resulting in a reduction of uncertainty (Davila 2000), as well as in the promotion of a shared understanding about the role of creativity in the firm (Turner and Makhija 2006).

However, VS emphasis does not determine the mobilisation of creativity messages. The significance and direction of the consequences of energising these messages is likely to be related to the EO-driven value contents. In entrepreneurial firms, organisational culture centres on core values and attitudes such as proclivity to take risks, experimentation, proactivity towards marketplace opportunities and tolerance of failure (Hult *et al.* 2007, Covin and Lumpkin 2011). In these high-EO firms, the implication of increasingly emphasising the delineation of the acceptable domain of activity through VS is not to progressively narrow down the creative space. Rather, its purpose is to insist on and specify more clearly and precisely what are the terms of the firm's high proclivity towards the generation of new product concepts. Thus, VS foster shared interpretations on the purpose and scope of search while preventing staff from being overwhelmed by opportunities. Regardless of whether messages are articulated in inspirational, prescriptive or proscriptive terms, a major emphasis on VS in entrepreneurial firms should help amplify the message that experimentation as well as alteration of current patterns and creativity are welcome and should also clarify that the strategic domain and creative space are broad. In entrepreneurial firms, a smaller emphasis on VS would entail that the messages about values and strategic domains regarding creativity are less mobilised and as a result the impetus towards creativity is realized to a lesser extent. Hence, the greater the emphasis on VS in entrepreneurial firms, the stronger the drive to come up with creative ideas. In contrast, in conservative firms, the content of corporate culture is characterised by little risk-taking propensity and a tendency to follow the leaders (Miller and Friesen 1982, Covin and Slevin 1989, Atuahene-Gima and Ko 2001, Avlonitis and Salavou 2007; Hult et al. 2007). Greater emphasis on VS in this context is likely to amplify messages stressing efficiency and expressing little interest in turning on the experimentation and alteration of current patterns that are needed to come up with new product concepts. The more emphasis is placed on VS in these low-EO firms, the more it will be amplified and clarified that the strategic domain and the creative space are narrow. Greater emphasis on VS is therefore unlikely to be reflected in a stronger internalisation of values and attitudes that encourage creativity. In sum, we expect that

> *H1a: The emphasis firms place on value systems is positively associated with organisational creativity in entrepreneurial firms but not in conservative firms.*

Interactive controls activate face-to-face dialogues as well as challenging and sense-making debates on the data generated by formal feedback and measurement systems (Simons 1995, 2000). Senior managers may deploy ICS to inject relevant information on environment and internal effectiveness into thinking by creative teams (Davila *et al.*, 2009). As the dialogue and debate induced by ICS promote the open exchange of ideas and the flow of information among individuals throughout the organisation (Henri 2006), ICS are likely to facilitate shared interpretations (Turner and Makhija 2006) about the organisation's creative space. Personal involvement with ICS by senior managers should also help in building internal pressure to break down narrow search routines, stimulate opportunity-seeking, and encourage the emergence of initiatives (Simons 1995, Henri 2006). Furthermore, managers can use ICS to deliver feedback in an informational style that helps people learn, develop, build on each other and eventually improve their creative capabilities (Zhou and Shalley 2008). As a result, we expect ICS to expand and orient opportunity identification, idea preparation and the eventual generation of new product concepts in complex social settings (Simons 1995, Henri 2006, Adler and Chen 2011) so that the greater the emphasis on ICS, the higher the level of organisational creativity.

The central object of the dialogues and debates induced by ICS are the strategic uncertainties of the firm, which become recurring issues in the organisational agenda (Simons 1995, 2000). In conservative firms, key strategic uncertainties relate to the need to avoid the risk of drifting into complete loss of creative will power. In these low-EO firms, senior managers are interested in focusing internal pressure on overcoming complacency. Through their personal involvement with ICS, senior managers prompt organisational members to seek opportunities for the generation of new product concepts, provide guidance on where to search for opportunities to those who find them hard to identify, and may legitimise the sparse internally-driven efforts that pursue the generation of new product concepts (Bisbe and Otley 2004). We therefore expect the positive influence of great emphasis on ICS on organisational creativity to be particularly strong in conservative firms. In contrast, in high EO firms, strategic uncertainties do not primarily arise from organisational complacency, or from the tendency to drift into loss of creative will-power (Miller and Friesen 1982, Covin and Slevin 1989, Atuahene-Gima and Ko 2001, Avlonitis and Salavou 2007, Bisbe and Malagueño 2009). The issues that ICS bring to the forefront of dialogues and debates are therefore less likely to relate to fostering new product concepts than is the case in low

EO firms. Consequently, even if ICS have the potential to facilitate the breaking down of narrow search routines and the emergence of initiatives, we expect that in entrepreneurial firms, the influence of ICS on organisational creativity would be attenuated in comparison with conservative firms. Thus,

> *H1b: There is a positive association between the emphasis firms place on interactive control systems and organisational creativity in both conservative and entrepreneurial firms but this association is stronger in conservative firms.*

Some prior studies claim that DCS may help companies identify trends, assess internal capabilities, and make transparent the organisational goals and so can flag where creative effort would be useful (Davila *et al.,* 2009, Adler and Chen 2011). However, another stream of research highlights that DCS adopt cybernetic models that are primarily concerned with sticking to pre-established plans and whose mechanistic approach to decision-making prevents companies from being aware of changing circumstances and the need to introduce new patterns (Simons 1995, Henri 2006, Widener 2007, Mundy 2010). We posit that DCS on their own tend to elicit automatic responses that do not produce the rich discussion and learning that is needed to deal with the complexities and uncertainties of creative processes (Henessy and Amabile 2010). We formalise the expected absence of such direct effect as:

> *H1c: The emphasis firms place on diagnostic control systems is not associated with organisational creativity in product innovation processes.*

MACS and co-ordination and knowledge integration

Prior studies have emphasised the dual Co-ordination and Knowledge Integration role (CKI) played by MACS (Davila 2000, Ditillo 2004, Bruhl *et al.* 2010, Merchant and van der Stede 2012).

The literature holds that MACS are particularly instrumental in fostering CKI where complexity and interdependencies are high (Adler and Chen 2011) and knowledge of the transformation process is imperfect (Ditillo 2004, Turner and Makhija 2006), as it is the case in activities related to conversion ability in product innovation processes (Trott 2008, Tidd and Bessant 2009). We expect that these statements on generic MACS apply to each of the three forms of control identified in this study. Hence, VS should enhance the ability of organisational members involved in innovation projects to become aware of how one's work affects the work of others, to build a collective mind (Weick and Roberts 1993) and to foster knowledge transfer between units and knowledge integration (Simons 1995, Ditillo 2004, Mundy 2010).

ICS also have the potential to foster CKI inasmuch as they elaborate formal data that becomes an important and recurring agenda in discussions between managers and subordinates as well as among co-workers. By ensuring that the data from ICS is the focus of regular attention throughout the whole organisation, ICS break down the functional and hierarchical barriers that might restrict the information flows needed for conversion ability and lessen the risks of cross-functional conflict (Simons 1995, Henri 2006). Senior managers can use ICS to combine their global knowledge with local managerial knowledge (Mundy 2010) and thus help effectively manage the interdependencies between local responses to changing conditions. The resulting continuous challenging of and debate around data, assumptions and action plans that is associated with ICS facilitates knowledge dissemination. Moreover, allocation of resources, assignment of tasks and synchronisation of activities should all be carried out in the light of the strategic uncertainties highlighted by ICS (Simons 1995).

Finally, DCS may also help product development teams and managers to check whether developments are on track and help provide inputs for effective management of interdependencies and allocation of resources across functions and activities. Even if the understanding of the transformation process in innovation projects is imperfect, some pre-set standards on time, cost, quality or other parameters are common in innovation projects (Hertenstein and Platt 2000, Bremser and Barsky 2004, Godener and Soderquist 2004). Senior managers can use the formal deliverables provided by project managers to detect variances regarding these parameters and trigger action on an exception basis in order to improve synchronisation and foster knowledge transfer so that these variances are eventually corrected (Cooper 1998, 2008, Jorgensen and Messner 2009). All in all, and in contrast with our expectations regarding the other two phases under study, we expect that three identified forms of control are positively associated with CKI regardless of EO, so that:

> *H2: The emphasis firms place on (a) value systems, (b) interactive control systems and (c) diagnostic control systems is positively associated with co-ordination and knowledge integration activities in product innovation processes.*

MACS and filtering

In conservative firms, organisational culture endorses the idea new product launches to tap new market opportunities should be undertaken reluctantly and only as a last resort in response to challenges (Miller and Friesen 1982, Covin and Slevin 1989, Atuahene-Gima and Ko 2001, Avlonitis and Salavou 2007). It can then be expected that in these low-EO firms, the greater theemphasis placed on VS, the more the message will be conveyed and amplified that organisational members should scrutinise all attempts to push generated concepts throughout the conversion phase. As a result, in low-EO firms, VS should be associated with greater filtering of initiatives. In the case of entrepreneurial firms, on the one hand, the clearer delimitation of the strategic domain that comes from a stronger emphasis on VS may provide arguments for weeding out previously generated concepts once they enter the conversion phase. However, on the other hand, a greater emphasis on VS in a high-EO context amplifies and mobilizes messages indicating that the firm is keen to accommodate variation and promotes experimentation, risk taking and pioneering and is therefore inclined to accept coarser filtering of previously generated concepts. Given the conflicting direction of these arguments, we do not predict an association between VS and filtering in high-EO firms. Thus, *H3a: The emphasis firms place on value systems is positively associated with filtering activities in product innovation processes in conservative firms but not in entrepreneurial firms.*

In firms with high EO, a significant source of strategic uncertainty is the risk of going overboard on innovation and overshooting the point of diminishing returns as a result of excessive, poorly oriented or wasteful generation of new product concepts (Miller and Friesen 1982, Atahuene-Gima and Ko 2001, Avlonitis and Salavou 2007, Bisbe and Malagueño 2009). Since ICS focus organisational attention on strategic uncertainties (Simons 1995), ICS can be expected to help senior managers in high EO firms in mitigating this risk, reining in these excesses and curbing superfluous generated concepts arising from unfocused creative efforts. An interactive use of the formal measurement reports submitted by project managers gives senior managers the opportunity to engage in discussions, challenge the validity of assumptions and action plans, and question whether there is a sound case for continuing or discontinuing the concepts that were generated in the creativity phase. ICS also help project managers gain awareness and internalize the expectations and the criteria senior managers are likely to use when examining on-going projects (Jorgensen and Messner 2009). Hence, the use of ICS is likely to lead on occasions to the delay, non-implementation or abandonment of some unfocused, poorly-directed or superfluous initiatives. Overall, we expect entrepreneurial firms that strongly rely on ICS to find it easier to weed out innovative excesses than those that do not rely on ICS. In contrast, conservative firms are unlikely to count on ICS to activate filtering. Even if ICS provide processes involving dialogue and debate, these are primarily focused on strategic uncertainties. The strategic uncertainties faced by conservative firms are related to organisational complacency and loss of creative will-power, not to the need to curb the conversion of superfluous generated concepts into ill-oriented actual product launches (Miller and Friesen 1982, Covin and Slevin 1989, Bisbe and Otley 2004; Rauch *et al.* 2009). Therefore, in a low EO context, ICS should not have a direct effect on filtering. We formalize this as:

H3b: The emphasis firms place on interactive control systems is positively associated with filtering activities in product innovation processes in entrepreneurial firms but not in conservative firms.

As cybernetic tools for ensuring compliance and predictable goal achievement, DCS create constraints and aim to eliminate deviation from pre-established plans and pre-set standards of performance (Simons 1995, Henri 2006). DCS might be expected to help control innovation progress towards launch by testing at given milestones or intervals whether and how ideas fit KPI targets related to market and technology, resource constraints and overall plans (Jorgensen and Messner 2009). However, DCS by themselves are unlikely to provide sufficient input for decisions that directly involve stopping or delaying resource commitment to take creative ideas to completion (Amabile *et al.* 1996). DCS are mechanistic in tracking and supporting the achievement of predictable goals (Simons 1995, Henri 2006). They tend to generate automatic responses when variances are detected. By contrast, filtering activities in innovation processes are hard to programme, and prone to uncertainty, variability and exceptions that call for rich discussion and debate rather than strict adherence to plans (Abernethy and Brownell 1997). Therefore, DCS on their own are likely to fail to produce the learning that is needed to address the complexities and uncertainties of the activities related to filtering. We expect filtering activities in innovation processes to be more related to feed-forward exercises in which alertness to the future is enhanced and future scenarios are assessed than to an examination of variances for feed-back purposes. Hence, we expect that, left to their own devices, DCS have limited applicability for effective and meaningful filtering of generated concepts. If so, DCS should not have a significant direct effect of DCS. We then expect that

H3c: The emphasis firms place on diagnostic control systems is not associated with filtering activities in product innovation processes.

RESEARCH METHOD

Sample selection and data collection

Empirical data was collected through a survey administered to a sample of senior managers in medium and large Spanish firms (minimum turnover of €10 million and 50 employees). We limited our database to manufacturing firms located in Catalonia, from which we excluded subsidiaries of multi-national companies with headquarters outside Spain. The SABI (Iberian Balance Sheet Analysis System) database yielded 554 active firms that met the screening criteria and that were the object of survey.[7]

The survey used existing instruments where possible and was pre-tested among four academics and four top executives for clarity and face validity. Questionnaires were distributed and returned by ordinary post. Following Dillman's guidelines (2006), several procedures were employed to increase the response rate and the likelihood of senior managers actually receiving and personally replying to the questionnaire. After a preliminary informative letter, a four-step implementation procedure was applied. The procedure was composed of a first round of packages that included a cover letter, a questionnaire, and a postage-paid envelope; a submission of reminder postcards; a series of follow-up phone calls to non-respondents, and finally, a second round of packages. After these rounds, 126 questionnaires were returned, representing a response rate of 22.7%. The final sample was made up of 118 usable questionnaires.[8]

T-tests supported the absence of differences between early and late respondents, thus suggesting absence of non-response bias (see Table 1). Several remedies were employed to alleviate the potential undesirable effects of common method bias (Podsakoff *et al.,* 2003). The questionnaire was designed in such a way that the potential dependence among variables was not evident, and different scale formats and scale anchors were employed (Dillman 2006). In addition, three *post hoc* techniques were conducted to test common method variance. First, a Harman's one-factor test on the 38 survey items resulted in nine factors with eigenvalues > 1 (first factor explaining up to 33% of the total variance). Second, we partialled out a general factor score, identifying a proxy for common method variance that was subsequently included in our structural models as a control variable (Podsakoff *et al.*, 2003). Results obtained for the hypothesised relationships under this model were similar to those of our base model. Finally, we included a factor method construct based on all self-assessed items and compared the average variances explained by the method-based factor and the average variances explained by the substantive constructs (Liang *et al.*, 2007). The ratio of the average of variances explained by the substantive constructs (0.733) to the average of variances explained by the method-based factor (0.016) was 47:1, with no significant method factor loadings detected for all but one item at $p < .01$. The results of the three *post-hoc* techniques suggest that common method variance due to single source biases is not a serious threat in this study. Table 2 reports the profile of the respondents in the usable sample and the firms' industry classification.

INSERT TABLE 1 AND TABLE 2 HERE

Measurement of constructs

Table 3 presents an abbreviated version of the questionnaire as well as the descriptive statistics of the questionnaire items. The three forms of control were initially modelled as second-order constructs with first-order formative dimensions that were measured in turn by several reflective manifest items (MacKenzie *et al.*, 2005, Diamantopoulos *et al.,* 2008). Based on Marginson (2002, 2009), we conceptualised VS as including both formal and informal components. We considered beliefs systems, boundary systems (Simons, 1995), and social surveillance control systems (Widener *et al.*, 2008) as three constitutive facets of VS. To operationalise the two first dimensions, we used three items for measuring beliefs systems and three items for boundary systems that were previously developed by Widener (2007). For the operationalisation of social surveillance controls, we considered the extent to which the work environment encourages the transmission of values through sense of belonging (for which we adopted an item from Jaworski *et al*., 1993) and through acquaintance with the activities of co-workers (for which we adopted an item from Welbourne and Ferrante 2008). Regarding ICS, we followed Bisbe *et al.* (2007) to identify four constitutive dimensions: (1) an intensive use by top management and by operating managers; (2) a pervasiveness of face-to-face challenges and debates; (3) a focus on strategic uncertainties; and (4) a non-invasive and facilitating involvement. Indicators for dimensions (1) and (2) were based on items developed by Henri (2006) and Widener (2007). To measure dimensions (3) and (4), four additional items were developed on the basis of the conceptualisation described in Bisbe *et al.* (2007). Finally, DCS were conceptualised to have two constitutive dimensions: tracking of the achievement of pre-established goals; and its use on an exception basis (Simons 1995). The first DCS dimension was measured using items formerly proposed by Henri (2006), Naranjo-Gil and Hartmann (2007) and Widener (2007). This was supplemented with two self-developed items that aimed to capture whether MACS were used on an exception basis by top managers.

Organisational creativity was operationalised as a reflective construct drawn from the instrument developed by Lee and Choi (2003) that measures in relation to the last three years: (a) frequency in the generation of new product concepts; (b) ability to generate novel and useful ideas related to new products; (c) time devoted to the ideation of the new concepts generated; (d) the importance given to new product concepts. Our measure of the reflective construct CKI draws upon seven items developed by Pavlou and El Sawy (2006) and Sherman *et al*. (2000), which assess the management of interdependencies in on-going projects, the ability of the organisation to incorporate the thought and knowledge of various individuals into a pattern of mindful interrelations and the quality of interaction among diverse functional areas during project implementation.[9] Finally, we considered the definition of filtering (Cooper 1998, 2008, Tidd and Bessant 2009) in developing an instrument that asked respondents to state the extent to which their companies: (a) promoted frequent meetings to assess projects under implementation; (b) were able to rule out undesirable initiatives under implementation;

abandoned, delayed, or changed the scope of on-going projects through (c) technological or (d) financial appraisals.

INSERT TABLE 3 HERE

We measured EO using the adaptation by Hult *et al*. (2007) of Covin and Slevin's (1989) scale. This adapted scale assesses EO as a first-order reflective construct in terms of the firm's proclivity to take risks and its tendency to be bold and pro-active in exploring trends and marketplace opportunities. Since the pre-test of the questionnaire suggested an excessive length of the questionnaire and a perception of some degree of redundancy in the EO items, we reduced the four items in the Hult *et al*. EO scale to three by merging the item on inclination to initiate actions to which other organisations respond and the item on time orientation of those actions into one new single item that captured the inclination to be first-to-market. The average of the ratings of these three items was used as the firm's EO score. For some of the analyses in this study, observations were split on the basis of the firms' EO scores into two sub-samples: one representing entrepreneurial firms (high EO scores); and the other one representing conservative firms (low EO scores). Taking into account the skewness of the sample (skewness = -0.63, sd. = 0.22), the mean was used as a criteria for sub-sampling. To ensure that the resulting subgroups were unambiguously entrepreneurial or conservative, firms with scores in the grey area around the mean (mean ± 0.1; n=20 observations) were not included in the sub-samples (Chenhall and Morris 1995). This procedure generated an entrepreneurial subgroup with 58 observations and a conservative subgroup with 40 observations.

Finally, we included environmental dynamism, changes in prior performance, size, and maturity as industry- and firm-specific control variables (obtained from SABI database). Environmental dynamism was defined as the rate of unexpected change or change that is hard to predict in a given environment (Dess and Beard 1984) and was operationalised as a standardised measure of the volatility of industry turnover (Simerly and Li 2000, Bisbe and Malagueño 2012) from 2007 to 2009. We also controlled for changes in the firm's prior performance as these may explain variations in managerial cognition and determine strategic actions (Nadkani and Barr 2008). We measured prior performance change by averaging changes in the values of ROS and ROA over the prior two years. Size was measured by the logarithm of sales. Maturity is a dummy variable that equals 1 if the observation represents companies founded at least 10 years before the survey was launched and 0 otherwise.

Evaluation of the measurement models

In this research we employed a Partial Least Square (PLS) method to test our hypotheses, using a bootstrap procedure with 1000 replacements. We first analysed separately the measurement model to guarantee that the construct measures are reliable and valid before assessing the relationships between the constructs (Hulland 1999, Hair *et al.,* 2006). The results of the measurement model are reported in Tables 3–6. For first-order reflective constructs, construct validity was assessed on the basis of the factor loadings (Table 3). All items loaded on their respective reflective constructs with factor loadings above 0.70 (Hulland 1999) with the exceptions of *ics41*, *eo1* and *eo2*. For each of the variables, Dillon-Goldstein ρ was above 0.73, which demonstrates acceptable construct reliability (Nunally 1978, Fornell and Larcker 1981). Given the satisfactory composite reliability of ICS2 and EO, *ics41*, *eo1* and *eo2* were maintained in the analysis.

All the loadings of the scale items on their assigned construct were larger than their cross-loading on any other construct, suggesting adequate discriminant validity (Table 4). Still, as item *cki3* presented a high cross-loading above 0.60, it was excluded from all subsequent analyses. In Table 6, comparison of the square root of AVE statistics to the correlations among the latent variables further supports adequate discriminant validity (Fornell and Larcker 1981). Our analyses reveal adequate convergent validity as none of the reflective constructs exhibit average variance extracted (AVE) lower than 0.50 (Table 6) and each of the measurement items loads with a significant t-value on its latent construct (p-value of these t-values < 0.01 in all cases) (Chin 1998, Gefen and Strauβ 2005). Overall, the results from the PLS measurement model suggest that each of the reflective constructs exhibits adequate reliability and validity.

INSERT TABLE 4 HERE

Latent variable scores that represent first-order reflective dimensions for the three MACS second-order formative constructs were initially estimated and subsequently used as indicators in a separate higher-order structural model analysis (Anderson and Gerbing 1988, Ringle *et al*. 2012). For second-order formative constructs, we examined the weights reported in Table 5 to assess validity and the degree to which the empirical realisation of the formative constructs coincided with the nominal definition of the constructs. The presence of negative weights for DCS2 in both the full sample and the conservative group suggested that the DCS2 dimension was not contributing to an empirical meaning of DCS that was congruent with its nominal meaning (Howell *et al.*, 2007, Cenfetelli and Bassellier 2009). Consequently, we opted for dropping DCS2 from the analysis, so that DCS was eventually measured only by the reflective first-order dimension DCS1. For the full sample as well as for the two sub-samples, VIF levels in the formative measurement models were below the commonly accepted cut-off value of 10 (Hair, *et al.*, 2006) (between 1.16 and 2.26 for VS and between 1.69 and 3.55 for ICS), indicating absence of multi-collinearity problems.

INSERT TABLES 5 AND 6 HERE

RESULTS

Tables 7 and 8 depict the effects of MACS on each of the three phases of innovation processes for respectively the high- and low- EO sub-samples. The equations reported in these tables contain the structural variables of interest and a set of control variables. Models 1 in Tables 7 and 8 control for interactions between MACS. Models 2 include industry- and firm-specific control variables. Models 3 additionally control for interdependencies with preceding (sub-)phases. Table 9 supplements the analysis by reporting the effects of MACS on the three (sub-)phases of the innovation process for the full sample. In addition to replicating the Models 1 to 3 for the full sample, Table 9 reports a Model 4 in which EO is included and operationalised as a continuous variable. In this Model 4, the posited influences of EO on the relationships between MACS and phases are modelled as interaction terms (i.e. EO*VS and EO*ICS are included where such influences of EO are hypothesised).[10]

INSERT TABLE 7 HERE

As reported in Tables 7 and 8, the analysis by sub-samples suggests that, as predicted by H1a, the emphasis placed on VS is positively associated with organisational creativity in entrepreneurial firms (in Model 3, $\beta = 0.372$, $t = 4.165$, $p < 0.01$), whereas no significant positive association is found for conservative firms (in Model 3, $\beta = 0.246$, $t = 1.243$, $p > 0.10$). The formal test of the equality of the coefficients between the two sub-samples shows that the difference between the two coefficients is significant ($t = 4.261$, $p < 0.01$), thus confirming support for H1a.[11] The results reported in Table 9 fail to detect an interaction effect EO*VS for the full sample ($\beta = -0.019$, $t = 0.194$, $p > 0.10$).

Tables 7 and 8 also indicate that, as posited by H1b, the emphasis placed on ICS is positively associated with organisational creativity in both entrepreneurial (in Model 3, $\beta = 0.253$, $t = 1.997$, $p < 0.05$) and conservative (in Model 3, $\beta = 0.297$, $t = 1.332$, $p < 0.10$) firms. Nevertheless, the difference between the two path coefficients is not statistically significant ($t = -1.241$, $p > 0.10$). Therefore, H1b is only partially supported. The absence of significant interaction effects EO*ICS for the full sample ($\beta = 0.037$, $t = 0.410$, $p > 0.10$ in Table 9) is in line with this partial support. While the results support a positive influence of ICS on creativity in each of the two sub-samples, Table 9 reports that this influence is not significant for the full sample (n=118). Yet, results regarding the influence of ICS on organisational creativity for the two sub-samples combined excuding the 'grey area' (n=98) replicate and are consistent with the results reported in Tables 7 and 8 (in Model 2, $\beta = 0.230$, $t = 1.682$, $p < 0.05$; in Model 3, $\beta = 0.232$, $t = 1.639$, $p < 0.10$; untabulated). Hence, the lack of significant relationships for the full sample seems to be due to the observations in the 'grey area', where the positive influence of ICS on organisational creativity fades away.

Finally, Tables 7 to 9 show no evidence of any statistically significant relationship between DCS and organisational creativity ($p > 0.10$ in all cases), which is consistent with the contention that DCS are not associated with organisational creativity, as predicted by H1c.

INSERT TABLE 8 HERE

In relation to the effect of control systems on CKI predicted by H2, results in Table 9 show a positive association between VS and CKI (in Model 3, $\beta = 0.363$, $t = 4.104$, $p < 0.01$), a positive association between ICS and CKI ($\beta = 0.233$, $t = 2.026$, $p < 0.05$) and a lack of statistically significant association between DCS and CKI ($\beta = -0.058$, $t = 0.493$, $p > 0.10$). Thus, H2a and H2b are supported, whereas H2c is not supported. As reported in Tables 7 and 8, an additional analysis by sub-samples suggests that significant results are robust across the three models for VS in conservative firms and for ICS in entrepreneurial firms – whereas they hold for Models 1 and 2, but lose significance in Models 3 for VS in entrepreneurial firms and for ICS in conservative firms.

INSERT TABLE 9 HERE

Further results suggest that in conservative firms, and as expected by H3a, a greater emphasis on VS is associated with higher levels of filtering (Model 3, $\beta = 0.308$, $t = 1.749$, $p < 0.05$) and that this association is not statistically significant among entrepreneurial firms ($\beta = 0.010$, $t = 0.092$, $p > 0.10$). A formal test of the equality of the coefficients between the two sub-samples indicates that the difference between the two coefficients is significant ($t = -10.409$, $p < 0.01$), thus providing further support for H3a. This finding is consistent with the significance of the interaction term EO*VS for the full sample reported in Table 9 (β = -0.142, t = 1.544, $p < 0.10$), suggesting that the higher the EO, the weaker the influence of VS on filtering.

In turn, and as posited by H3b, results in Tables 7 and 8 support that ICS are positively associated with filtering activities in entrepreneurial firms (β = 0.189, t = 1.326, $p < 0.10$), but not in conservative firms (β = 0.093, t = 0.511, $p > 0.10$). As in the previous case, a formal test of the equality of the coefficients indicates that the difference between the two coefficients is significant (t = 2.916, $p < 0.01$), thus providing further support for H3b. This finding is consistent with the significance of the interaction EO*ICS for the full sample (in Table 9, β = 0.126, t = 1.747, $p < 0.05$) suggesting that the higher the EO, the stronger the influence of ICS on filtering. Finally, Tables 7 to 9 show no evidence of any significant direct relationship between DCS and filtering, ($p > 0.10$ in all cases), which is consistent with the contention that DCS are not associated with filtering, as predicted by H3c.

DISCUSSION

The results of this study collectively suggest that management accounting and control systems have an influence on each of the different (sub-)phases of product innovation processes They further indicate that the significance and direction of the influence of some forms of control in high-EO firms differ from those in low-EO firms firms. Next, we discuss the role of EO regarding each form of control. For each form, we compare its relationships with (sub-)phases in high-EO (i.e., entrepreneurial) firms and those relationships in low-EO (i.e. conservative) firms.

According to our results, VS are positively associated with creativity in entrepreneurial firms and positively associated with filtering of previously generated concepts in conservative firms, whereas ICS are positively associated with creativity in conservative firms and with filtering in entrepreneurial firms. These findings suggest that levels of creativity and filtering in both high- and low-EO firms are specifically influenced by MACS. Hence, for example, if VS are positively associated with creativity [filtering] in high-EO [low-EO], it is not merely because high-EO [low-EO] firms are interested in creativity [filtering], but because creativity in high-EO firms [filtering in low-EO firms] is more likely to be realized when the emphasis in VS is greater.

The main effects of VS and ICS in entrepreneurial firms present elements that mirror their main effects in conservative firms (i.e. they are similar but reversed). These findings qualify prior positions that emphasise the importance of values and VS in fostering creative behaviour (Amabile 1996, Tushman and O'Reilly 1997, Davila *et al*., 2006). While a number of studies have given insights into the implications of whether VS are expressed in positive and inspirational terms (e.g. beliefs systems) or in normative negative terms (e.g. boundary systems) (Widener 2007, Mundy 2010, Adler and Chen 2011), our results support that the effects of VS on creativity differ between the high- and low-EO firms sub-samples. This finding highlights the importance of the contents of the values and attitudes being transmitted and amplified by VS in order to gain an understanding of the consequences of the emphasis placed on VS. EO shapes the contents of the values and attitudes that are transmitted and energised by VS, and hence its relevance for the implications of the emphasis on VS. The statement that VS are best suited for fostering creativity is supported if the contents of the values being conveyed are in line with risk-taking attitudes, i.e. in a context of high levels of EO. However, our results indicate that this is not the case if the organisational culture avoids risk-taking and proactivity, as in low EO firms.

Furthermore, our results inform the debate in the literature between positions that claim that it is in the nature of ICS to universally stimulate opportunity-seeking, creativity and innovation (Simons, 1995, Henri 2006, Adler and Chen 2011) and positions that suggest that the greater the top management's involvement in new product development projects through ICS, the greater the chances to actively change decisions, redirect teams and eventually weed out innovation initiatives during project implementation (Bonner et al. 2002, Bisbe and Malagueño 2009). This study suggests that both positions can be reconciled as it reveals that ICS stimulate creativity in both conservative and entrepreneurial firms while, in addition, ICS concurrently stimulate filtering in entrepreneurial firms – hence playing a dual counter-balancing role within the overall product innovation process in high-EO firms.

The influence of EO on the associations between forms of control and (sub-)phases of innovation processes is less conclusive in the case of CKI. Our results for the full sample indicate that the emphasis firms place on both VS and ICS are positively associated with CKI. The analysis by sub-samples finds strong support for the significance of a positive association between VS and CKI in conservative firms – and of a positive association between ICS and CKI in entrepreneurial firms. Support is weaker for the significance of a positive association between VS and CKI in entrepreneurial firms and of a positive association between ICS and CKI in conservative firms.

Our results are consistent with an absence of main effects of DCS on the (sub-)phases of innovation processes, which is independent of EO. The absence of main effects of DCS on creativity and filtering is in line with our expectations. However, our results suggest a less important role for DCS in innovation than we initially expected, as we do not find evidence indicating a direct effect of DCS on CKI either. *Ex-post* we interpret the absence of this direct effect as an indication that DCS on their own are unlikely to help integrate the developing complex knowledge of multiple organisational members (Simons 1995). As DCS activate organizational attention only on an exception basis, they are unable to stimulate by themselves the cross-functional processes, free flows of information and open channels of communication that CKI around product innovation requires (Abernethy and Brownell 1999, Henri 2006). Overall, the single-loop learning stemming from DCS presents considerable limitations when applied to the informational needs of product innovation processes which tend to be plagued by complexity and uncertainty. The potential influence of DCS through dynamic tensions with other forms of control fell outside the scope of this study.

We complement the foregoing analysis of the behaviour of each of the forms of control across the EO spectrum with an additional discussion that takes the angle of the EO-based sub-samples. For each sub-sample, we next discuss the integrated package of main effects that take place across (sub-)phases. As (sub-)phases join together in overall product innovation processes, we examine how the main effects within each (sub-)phase combine throughout the process and how the sub-samples operate differently the mix of forms of control across (sub-)phases[12]. In entrepreneurial firms, organisational creativity is positively associated with both VS and ICS. VS energise and amplify messages around values that promote the pursuit of opportunities and risk-taking. ICS promote the open exchange of ideas and flow of information, build internal pressure to break down narrow search routines, stimulate opportunity-seeking and encourage the emergence of initiatives. Regarding CKI, entrepreneurial firms promote the ability of corporate sub-units to work together towards common purposes and facilitate the distribution and sharing of knowledge between interdependent parties primarily through ICS. As far as filtering is concerned, our findings are consistent with expectations that values espoused by culture in entrepreneurial firms are not keen to promote abandonment or downsizing of generated concepts. The transmission and amplification of these values through VS is therefore unlikely to further promote filtering in these high-EO firms. The findings of the study also demonstrate that filtering in entrepreneurial firms is effectively activated through ICS. The findings are consistent with the view that in these companies, ICS are used after concept generation to concentrate organisational attention, dialogues and debates on reining in the creativity initially promoted by both VS and ICS. Once concepts have been generated, the discussion and learning spawned by ICS sends messages about the need to filter unnecessary, poorly-focused or poorly-oriented new product concepts that may have been generated. In this setting, the fostering of creativity leading to concept generation through an emphasis placed on ICS appears to be compatible with the promotion of filtering after concept generation through the very same emphasis on ICS. In fact, the multiple main effects on each of the three different (sub-)phases under consideration highlight the centrality and ubiquity of ICS regarding innovation processes in high EO contexts.

This set of patterns contrasts with our findings in conservative firms on several grounds. In firms with low EO, creativity is positively associated with ICS but not with VS. Nevertheless, and in contrast to the ubiquity of ICS in the (sub-)phases of innovation processes in entrepreneurial firms, the evidence we have gathered for low EO firms suggests that in those firms the effects of

ICS are concentrated on the promotion of creativity, whereas evidence is less conclusive regarding CKI and provides strong support for ICS not being associated with filtering. We found filtering in conservative companies to be associated with VS, as VS encourage careful scrutiny of all attempts to advance creative ideas through the conversion phase.

In sum, as (sub-)phases combine to form overall innovation processes, the direct effects of control systems within each (sub)-phase are integrated to collectively influence the overall innovation process and contribute to its success. Through the combination of main effects in each phase, control systems deploy forces and tensions across phases that both spark invention and build the structure that turns inventions into marketable products.[13] Our results support that entrepreneurial and conservative companies present different patterns regarding the way the main effects of MACS integrate across the (sub-)phases of the overall processes. According to the results of this study, the specific forms of control that are involved in such integration, the distribution of their role across the sequence of the process, and their implications depend on the firms' EO.

CONCLUSIONS

Recent empirical research offers strong grounds for concluding that management accounting and control systems (MACS) may positively contribute to successful innovation efforts (Davila *et al.* 2009). Hitherto, little was known about the role MACS played in the distinct (sub-)phases of innovation processes and little large scale evidence was available about the channels through which the various forms of control used by firms affect these various (sub-)phases. This paper provides empirical evidence on whether and how specific forms of control exert different direct influences on each (sub-)phase of the innovation process. More specifically, it demonstrates that value systems and interactive control systems have significant main effects on the creativity; coordination and knowledge integration (CKI); and filtering (sub-)phases of innovation processes.

A key thrust in the paper is that caution must be taken in generalising the significance and direction of the energy generated by these specific forms of control to all firms. We argue that this significance and direction largely depend on the entrepreneurial orientation (EO) of firms, as long as EO is an organisational disposition that is reflected in the (non-universal) contents of the values being transmitted within firms and the strategic uncertainties firms face. The findings of our study indicate that the implications of these forms of control on the creativity and filtering stages vary between low- and high-EO firms. Low- and high-EO firms, while using a similar mix of controls, operate these controls differently across (sub-)phases and pursue different implications. These results cast doubts on the adequacy of claims suggesting universal effects of VS and ICS regarding innovation and at the same time highlight the relevance of EO in shaping the implications of control systems.

While the results of this study shed some light on the role of MACS as antecedents of product innovation processes, some limitations must be noted and ought to be addressed in future research. First, our model assumes unidirectional causality. The inclusion of new theoretical developments arguing in favour of potential effects of innovation processes on MACS with short causal intervals may recommend the choice of cyclical recursive or reciprocal non-recursive models. Second, this study has not examined the implications of MACS and EO at lower intra-organisational levels. Future studies could analyse organisational creativity as a function of individual creativity or group creativity, examining the contextual influences operating at each level. Third, as our study takes the firm as the unit of analysis, we cannot examine potential differences between radical and incremental innovation initiatives. Further research at the project level might examine these potential differences. Fourth, future studies might examine the idiosyncratic implications of the use of individual control systems (e.g. budget systems, strategic performance measurement systems, cost accounting systems) for the phases of innovation processes. Fifth, while our research design provides insights on the interrelationship between MACS across phases, we do not examine the interaction between forms of control that operate within each (sub-)phase. Contemplating the tensions derived from interactions within (sub-)phases would enrich the understanding of the relationships of interest. Moreover, the sample of this study was selected from medium and large manufacturing firms in a specific geographical area. Potential generalisations of the results obtained in this study to other contexts should be performed with caution. Some further limitations of our study were inherent in our chosen research methodology. We opted for a large-sample, cross-sectional study in order to test associations at a given point in time. This methodological choice may raise concerns about causality and endogeneity. Further research could use longitudinal case studies to extend and complement our findings – thereby overcoming some of these limitations and investigating in depth the dynamics of the relationships we have identified.

Despite these limitations, this paper contributes to the literature examining the effects of MACS on creativity and innovation in two ways. First, while earlier large-scale MACS studies have tended to portray innovation processes as a single entity or focus on a phase within them, we have broken down innovation processes into (sub-)phases and we have examined separately, and at the same time brought together, the implications of MACS for each distinct (sub-)phase. Second, the paper demonstrates the relevance of EO in shaping the influence of MACS on product innovation, highlighting that firms with different EO operate forms of control differently across innovation processes. Our study therefore calls for caution in generalizing the expected effects of control systems universally across firms. Overall, by providing deeper insights into the channels through which MACS exert their influence on innovation processes, this study fosters a better understanding of how MACS can help in the collective organisational efforts needed for successful new product innovation.

[1] The relationships between (sub-)phases of innovation processes and innovation outputs have been extensively examined and tested in previous literature (e.g. Parthasarthy and Hammond 2002, Gomes *et al.* 2003, Hirunyawipada *et al.* 2010, Baron and Tang 2011). These relationships, which are not covered in the current paper, highlight the relevance of creativity and the sub-phases of conversion ability under consideration in order for innovation efforts to be successful.

[2] 'Phases' and 'sub-phases' of innovation processes tend to be conceived and deployed sequentially (Parthasarthy and Hammond, 2002; Tidd and Bessant, 2009). However, given the often interwoven and iterative nature of innovation processes (Amabile, 1996; Cooper, 2008; Jorgensen and Messner, 2009; Revellino and Mouritsen, 2009), the (sub-)phases can also be construed as distinct modes or activities in which firms engage. Still, creativity and conversion ability conceptually represent two distinct sets of mental, motivational and social mechanisms – and are consequently considered to be meaningful categories for research (Adler and Chen, 2011, Davila *et al.*, 2009; Hennessey and Amabile, 2010; Trott, 2008).

[3] Even if idea generation is central to the creativity phase, conversion ability may involve some generation of new ideas that help formulate alternatives in turning previously generated concepts into marketable products (Revellino and Mouritsen, 2009). Similarly, the creativity phase may involve structures and processes for co-ordinating and integrating ideas and knowledge in collective action as well as screening devices for helping organisational members assess the value of possible solutions before concepts are generated – and so trigger self-restraint (Amabile, 1996; Cooper, 2008). As defined in this paper, the generation of ideas after concept generation and during project implementation is not included in the scope of the creativity phase. Analogously, the coordination and knowledge integration as well as the filtering sub-phases here relates only to conversion ability, which extends from selection and prioritisation by senior managers of previously generated concepts to launch and commercialisation (Chandy et al., 2006; Sheremata, 2000).

[4] Typologies of controls are rarely exhaustive. In our case, for example, the proposed typology does not encompass administrative controls or ways of effecting personnel controls such as selection, placement, training or job design.

[5] Ongoing debates around the conceptualisation of EO refer to whether EO should be conceptualised from a dispositional or behavioural point of view (Voss *et al*., 2005, Covin and Lumpkin 2011), what are the characteristics to include under the EO construct (Lumpkin and Dess 1996, Hult *et al*., 2007) and whether EO should be conceptualised as a latent construct or as an index (George, 2011; George and Marino, 2011).

[6] The argumentation that follows and that leads to our hypotheses assumes unidirectional causality from forms of control to innovation phases. We build on the well-established stream of prior theoretical developments and field evidence that have examined the influence of forms of control on innovation-related variables using unidirectional models (e.g. Henri, 2006; Chiesa *et al*., 2009; Adler and Chen, 2011). The implicit assumption that we borrow from these studies is that the causal interval of a potential relation [innovation-related variables → forms of control] is longer than the causal interval of the relation [forms of control → innovation-related variables] and that forms of control precede in time the effects on innovation phases (Luft and Shields, 2003: 193-195). While one cannot rule out that innovation-related variables affect forms of control, this potential causal direction has been less examined in prior literature and it is not contemplated here.

[7] We used SABI 2008. Surveys were administered between March and June 2010. All firms that were object of the survey with one single exception were unlisted in 2008 and remained so at least until end of 2010.

[8] We excluded eight firms for at least one of the following reasons: the firm had not been involved in new product development in the last three years, the respondent was not a senior manager, or the respondent had been in the company for less than one year. Fourteen of the returned questionnaires had missing items. After Little's MCAR test, imputation of missing data was computed through MLE using the expectation maximisation algorithm.

[9] The original instrument for creativity developed by Lee and Choi (2003) with five questions was reduced to four questions as the wording of two of them overlapped in the Spanish version of the questionnaire. The original CKI instrument contained eight items. However, one of the eight items was dropped from the final construct because of a high volume of missing data (only item with >10% of missing data), which was considered an indication of ambiguity or lack of clarity in its wording.

[10] For models reported in Tables 7 to 9, a two-stage approach was used to estimate the parameters of second order formative constructs in our hierarchical latent variable models. We first applied the repeated indicators approach to obtain the latent variable scores for the lower order components. These scores were saved and subsequently used in a second stage in which they served as manifest variables in the measurement model of the higher order component (Henseler and Chin, 2010).

[11] In order to test the significance of difference in corresponding path coefficients across sub-samples, we use the following *t*-statistic:

$$t = \frac{Path1 - Path2}{\left[\sqrt{(\frac{m-1}{m+n-2}) \times S.E.1^2 + (\frac{n-1}{m+n-2})) \times S.E.2^2}\right] \times [\sqrt{(\frac{1}{m}) + (\frac{1}{n})}]}$$

where *m* is sample size of the first sub-sample, *n* is the sample size of the second sub-sample, with *(m+n−2)* degrees of freedom.

[12] Through this second angle, our research design provides insights on the interrelationship between MACS *across* phases, i.e. how the main effects in one phase are integrated with the effects of other MACS in other phases. Nevertheless, the cross-sectional nature of our research does not allow us to take an in-depth longitudinal view of the interplay between MACS across phases.

[13] Further tensions are likely to be introduced through interactions between control systems *within* each (sub-)phase. (Henri, 2006; Mundy, 2011). These sources of interplay have not been investigated in this study.

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Table 1. Tests for non-response bias

Panel A: Respondents vs. non-respondents	*Means*		
	Respondents (n = 126)	Non-respondents (n = 428)	*t-statistic (p-value)*
Sales (in millions)	53.312	40.025	-1.395 (0.165)
Number of employees	185	157	-1.502 (0.134)

Panel B: Early respondents (1st round) vs. late respondents (only usable responses)	*Means*		
	Early respondents (n = 68)	Late respondents (n = 50)	*t-statistic (p-value)*
Value Systems	4.93	5.06	-0.621 (0.536)
Interactive Controls	5.23	5.01	1.480 (0.141)
Diagnostic Controls	4.17	4.18	-0.042 (0.967)
Creativity	4.92	5.14	-0.968 (0.335)
Co-ordination/Knowledge Integr.	5.04	4.92	0.570 (0.570)
Filtering	4.84	4.84	0.027 (0.978)

Means are significantly different at ** p-value < 0.01,* < 0.05.

Table 2. Profile of the respondents

Profile of the respondents	Frequency	%
Tenure (average in years)	17	
Position		
CEO	97	82.2%
Other senior managers (CFO, COO, CCO, CHRO, etc)	21	17.8%
Firm size		
50 < employees ≤ 100	45	38.1%
100 > employees ≤ 150	26	22.0%
>150 employees	47	39.8%
Manufacturing industry classification (CNAE† Code)		
Food & beverage (10 & 11)	9	7.6%
Textile & clothing (13 & 14)	8	6.8%
Paper (17)	9	7.6%
Printing and media reproduction (18)	5	4.2%
Chemical (20)	17	14.4%
Pharmaceutical (21)	13	11.0%
Rubber, plastic & non-metallic mineral products (22 & 23)	11	9.4%
Metallurgy & metal products (24 & 25)	14	11.9%
Computer, electronics, optical & electrical equipment (26 & 27)	11	9.3%
Machinery & motor vehicles and trailers (28 & 29)	14	11.9%
Other manufacturing industries (16, 31 & 32)	7	5.9%
Total final sample (only usable responses)	118	

† Clasificación Nacional de Actividades Económicas

Table 3. Descriptive statistics for survey items and measurement model parameters for first-order constructs

	Min	Max	Mean	Median	Std. dev.	Factor Loadings	Dillon-Goldstein ρ
Organisational beliefs (VS1)							0.909
Mission communicates core values *(vs11)*	1	7	5.29	6.00	1.33	0.856	
Top managers communicate values *(vs12)*	2	7	5.17	5.00	1.20	0.897	
Workforce is aware of values *(vs13)*	2	7	5.43	6.00	1.21	0.877	
Organisational boundaries (VS2)							0.908
Communication of risks to be avoided *(vs21)*	1	7	4.59	5.00	1.75	0.912	
Definition of off-limits behaviour *(vs22)*	1	7	4.51	5.00	1.77	0.932	
Definition of inappropriate behaviour *(vs23)*	1	7	5.06	6.00	1.66	0.775	
Social surveillance (VS3)							0.817
Work environment encourages sense of belonging *(vs31)*	2	7	5.44	6.00	1.12	0.877	
Acquaintance with activities of co-workers *(vs32)*	1	7	4.41	4.71	1.35	0.783	
Intensity of use (ICS1)							0.903
Intensive use by top management *(ics11)*	1	7	5.74	6.00	1.33	0.903	
Intensive use by operating managers *(ics12)*	1	7	5.08	5.00	1.29	0.913	
Face-to-face dialog (ICS2)							0.897
Face-to-face discussion among org. participants *(ics21)*	1	7	5.06	5.00	1.56	0.907	
Continual debate *(ics22)*	2	7	5.61	6.00	1.26	0.896	
Strategic uncertainties (ICS3)							0.796
Focus on strategic uncertainties *(ics31)*	1	7	4.95	5.00	1.46	0.818	
Signal to potential environmental threats *(ics32)*	1	7	5.76	6.00	1.23	0.806	
Non-invasiveness (ICS4)							0.730
Non-invasive enabling decision making *(ics41)*	1	7	3.53	3.00	1.57	0.580	
Monitoring and respecting subordinate actions *(ics42)*	1	7	5.39	6.00	1.28	0.915	
Performance tracking (DCS1)							0.894
Focus on critical success factors *(dcs11)*	2	7	5.32	6.00	1.37	0.913	
Track progress towards goals *(dcs12)*	1	7	5.90	6.00	1.17	0.885	
Use by exception (DCS2)							0.885
Used by exception for top managers *(dcs21)*	1	6	2.32	2.00	1.47	0.928	
Not frequently used by top managers *(dcs22)*	1	7	3.17	3.00	1.94	0.853	
Organisational Creativity (CRE)							0.943
Frequent generation of new product concepts *(cre1)*	2	7	5.01	5.00	1.35	0.911	
Ability to generate novel and useful NPD ideas*(cre2)*	2	7	4.99	5.00	1.30	0.920	
Time devoted in new product concepts generated *(cre3)*	2	7	4.63	5.00	1.33	0.912	
Importance of the new product concepts generated *(cre4)*	2	7	5.43	6.00	1.36	0.845	
Co-ordination and Knowledge Integration (CKI)							0.952
Work tasks fit together *(cki1)*	2	7	4.82	5.00	1.15	0.845	
Perceived usefulness of outputs by others *(cki2)*	2	7	4.97	5.00	1.21	0.874	
Work is synchronised *(cki3)*	2	7	5.02	5.00	1.22	0.825	
Interrelated activities under fast-changing conditions *(cki4)*	2	7	4.66	5.00	1.22	0.887	
Awareness of co-workers skills and knowledge *(cki5)*	2	7	5.22	5.00	1.17	0.808	
Successful interconnection among activities *(cki6)*	2	7	4.76	5.00	1.19	0.907	
Frequent interactions between departments *(cki7)*	2	7	5.25	6.00	1.31	0.868	
Filtering (FIL)							0.866
Frequent meetings to evaluate projects *(fil1)*	2	7	5.17	5.00	1.21	0.737	
Processes to rule out undesirable initiatives *(fil2)*	1	7	4.34	4.00	1.46	0.804	
Technological appraisal of on-going projects *(fil3)*	1	7	4.88	5.00	1.44	0.858	
Budgetary appraisal of on-going projects *(fil4)*	1	7	4.98	5.00	1.43	0.738	
Entrepreneurial Orientation (EO)							
Proclivity to risky projects *(eo1)*	1	7	4.19	4.00	1.40	0.557	0.743
Tendency to gradually vs. boldly explore trends *(eo2)*	1	7	4.52	5.00	1.54	0.678	
First-to-market mindset *(eo3)*	1	7	4.51	5.00	1.64	0.851	
Environmental Dynamism (DYN)	0.00	0.14	0.06	0.04	0.04		
Change in Prior Organizational Performance (%)(PPERF)	-26.86	48.61	-0.87	-0.67	8.85		
Organisational Size (sales in millions of euros)(SIZE)	10.04	558.91	48.13	24.11	81.52		
Organisational Maturity (years after being founded)(MAT)	3	123	30.14	26.50	20.11		

Table 4 - Cross-loadings of reflective constructs

	Full sample				
	Diagnostic Controls	Creativity	Coord and Know Integr	Filtering	Entrepreneurial Orientation
dcs11	**0.9165**	0.2321	0.3814	0.3335	0.1450
dcs12	**0.8811**	0.1739	0.2953	0.3245	0.1322
cre1	0.1847	**0.9029**	0.4649	0.3721	0.5049
cre2	0.2164	**0.9206**	0.5604	0.3838	0.4585
cre3	0.1711	**0.9151**	0.5504	0.3830	0.5367
cre4	0.2438	**0.8498**	0.5668	0.4433	0.5237
cki1	0.2712	0.4669	**0.8329**	0.5059	0.2548
cki2	0.3539	0.5040	**0.8593**	0.5272	0.3078
cki3	0.3437	0.5082	**0.9038**	0.6314	0.3618
cki4	0.2673	0.5686	**0.8847**	0.5586	0.3700
cki5	0.3090	0.4809	**0.7959**	0.5377	0.4127
cki6	0.3662	0.4870	**0.8729**	0.5504	0.3795
cki7	0.2911	0.5944	**0.8342**	0.5039	0.4731
fil1	0.2659	0.5256	0.5879	**0.7427**	0.4238
fil2	0.2450	0.3680	0.4910	**0.7941**	0.4085
fil3	0.3168	0.2780	0.5113	**0.8621**	0.2680
fil4	0.3344	0.1697	0.4085	**0.7395**	0.1236
eo1	0.0724	0.1840	0.1268	0.1499	**0.5522**
eo2	0.0773	0.3215	0.2140	0.1618	**0.6746**
eo3	0.1497	0.5543	0.4412	0.4256	**0.8540**

Table 5. Estimation of the measurement model parameters: second-order constructs

	Full Sample		High Entrepreneurial Orientation		Low Entrepreneurial Orientation	
Second-order formative constructs						
	Weights	(t-value)	Weights	(t-value)	Weights	(t-value)
Value Systems (VS)						
CCS1	0.457	(17.636)	0.454	(10.033)	0.429	(11.908)
CCS2	0.415	(17.439)	0.496	(11.271)	0.387	(15.927)
CCS3	0.283	(10.880)	0.298	(4.216)	0.293	(9.069)
Interactive Controls (ICS)						
ICS1	0.349	(11.592)	0.321	(7.839)	0.339	(6.787)
ICS2	0.353	(11.738)	0.419	(11.161)	0.308	(6.725)
ICS3	0.295	(13.273)	0.297	(7.830)	0.277	(8.000)
ICS4	0.208	(9.513)	0.201	(5.802)	0.271	(7.312)
Diagnostic Controls (DCS) †						
DCS1	0.741	(8.852)	0.946	(6.337)	0.645	(2.844)
DCS2	-0.507	(4.853)	0.382	(0.654)	-0.506	(2.396)

† DCS2 was not considered in the structural model. DCS was eventually measured by the first-order reflective construct DCS1

Table 6 – Average variance extracted and correlations

Full Sample												
	AVE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Value system	-	**(F)**										
(2) Interactive controls	-	0.419**	**(F)**									
(3) Diagnostic controls	0.81	0.354**	0.640**	**0.899**								
(4) Creativity	0.81	0.314**	0.294**	0.270**	**0.898**							
(5) Coord. and Know Integr.	0.73	0.573**	0.476**	0.406**	0.515**	**0.855**						
(6) Filtering practices	0.62	0.346**	0.493**	0.339**	0.401**	0.616**	**0.787**					
(7) Env. Dynamism	-	0.057	0.061	0.079	-0.067	0.113	-0.089	-				
(8) % Prior Performance	-	-0.008	0.065	0.051	0.045	0.038	0.061	-0.018	-			
(9) Size	-	0.082	0.132	0.189*	-0.040	-0.021	0.095	-0.161	0.111	-		
(10) Maturity	-	-0.044	0.087	-0.056	0.049	-0.032	0.038	-0.114	-0.029	0.046	-	
(11) Entrep. Orientation	0.50	0.309**	0.257**	0.133	0.401**	0.314**	0.258**	0.106	-0.062	0.039	0.088	**0.706**

High Entrepreneurial Orientation											
	AVE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Value system	-	**(F)**									
(2) Interactive controls	-	0.318*	**(F)**								
(3) Diagnostic controls	0.76	0.239	0.556**	**0.873**							
(4) Creativity	0.80	0.355**	0.406**	0.163	**0.893**						
(5) Coord. and Know Integr.	0.64	0.416**	0.519**	0.157	0.546**	**0.801**					
(6) Filtering practices	0.58	0.282*	0.456**	0.331*	0.397**	0.538**	**0.762**				
(7) Env. Dynamism	-	0.231	0.031	0.118	-0.098	0.118	-0.069	-			
(8) % Prior Performance	-	0.088	0.166	0.148	0.023	0.018	-0.033	0.091	-		
(9) Size	-	0.068	0.187	0.162	-0.223	0.058	0.124	-0.010	0.085	-	
(10) Maturity	-	-0.121	0.181	0.036	0.225	-0.029	0.001	-0.090	-0.179	0.093	-

Low Entrepreneurial Orientation											
	AVE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Value system	-	**(F)**									
(2) Interactive controls	-	0.580**	**(F)**								
(3) Diagnostic controls	0.88	0.439**	0.570**	**0.939**							
(4) Creativity	0.80	0.365*	0.376*	0.422**	**0.894**						
(5) Coord. and Know Integr.	0.74	0.584**	0.416**	0.510**	0.554**	**0.858**					
(6) Filtering practices	0.64	0.570**	0.452**	0.335*	0.382*	0.630**	**0.799**				
(7) Env. Dynamism	-	-0.124	-0.294	-0.059	-0.194	-0.003	-0.191	-			
(8) % Prior Performance	-	0.027	-0.115	0.035	0.230	0.026	-0.038	-0.336*	-		
(9) Size	-	0.134	0.400*	0.300	0.051	0.055	0.119	-0.400*	-0.059	-	
(10) Maturity	-	-0.125	-0.190	-0.298	-0.246	-0.181	-0.076	-0.174	0.076	-0.119	-

Note: *,** Significant levels 5% and 1% respectively (two-tailed). Diagonal elements (bold) are the square root of AVE (variance shared between the constructs and their indicators). Off-diagonal elements are the correlations among constructs computed in SPSS. F = formative measurement.

Table 7. High-EO sample PLS structural model results

	Model 1			Model 2			Model 3		
	CRE	CKI	FIL	CRE	CKI	FIL	CRE	CKI	FIL
VS	0.286**	0.311**	0.125	0.372***	0.270**	0.179	0.372***	0.107	0.010
	(2.302)	(2.371)	(1.131)	(3.229)	(2.024)	(1.296)	(4.165)	(0.967)	(0.092)
ICS	0.370**	0.448**	0.468**	0.248**	0.511**	0.421***	0.253**	0.397***	0.189*
	(2.023)	(2.204)	(2.377)	(1.860)	(2.393)	(2.544)	(1.997)	(2.555)	(1.326)
DCS	-0.094	-0.125	0.106	0.004	-0.174	0.079	0.003	-0.193	0.148
	(0.741)	(0.842)	(0.777)	(0.029)	(0.781)	(0.445)	(0.029)	(1.174)	(1.233)
ICS x DCS	-0.034	-0.095	-0.034						
	(0.282)	(0.747)	(0.269)						
VS x DCS	0.092	0.201	0.268						
	(0.788)	(1.182)	(1.658)						
VS x ICS	0.016	0.037	0.100						
	(0.099)	(0.184)	(0.545)						
DYN				-0.212*	0.072	-0.129	-0.208*	0.156*	-0.098
				(1.927)	(0.627)	(1.123)	(1.984)	(1.692)	(1.003)
MAT				0.243*	-0.102	-0.048	0.233**	-0.204	-0.073
				(1.743)	(0.588)	(0.307)	(2.064)	(1.544)	(0.508)
SIZ				-0.401***	-0.099	0.053	-0.396***	0.092	0.161
				(2.802)	(0.777)	(0.455)	(2.703)	(0.777)	(1.624)
PPERF				0.058	-0.074	-0.144	0.053	-0.110	-0.124
				(0.624)	(0.683)	(0.863)	(0.767)	(1.359)	(0.994)
CRE								0.470***	0.215
								(3.900)	(1.392)
CKI									0.315**
									(2.239)
R^2	0.255	0.375	0.324	0.445	0.347	0.303	0.297	0.549	0.532
Q^2	0.183	0.239	0.171	0.331	0.227	0.152	0.220	0.399	0.324

Note: Each cell reports the path coefficient (t-value). *,**,*** Significant levels 10%, 5% and 1% respectively (one-tailed for hypothesised relationships, two-tailed otherwise). Max VIF_{model1} = 3.1,Max VIF_{model2} = 1.7, and Max VIF_{model3} = 2.2.

Table 8. Low-EO sample PLS structural model results

	Model 1			Model 2			Model 3		
	CRE	CKI	FIL	CRE	CKI	FIL	CRE	CKI	FIL
VS	0.247	0.351*	0.481***	0.245	0.414**	0.489***	0.246	0.313*	0.308**
	(1.233)	(1.547)	(2.581)	(1.189)	(1.796)	(2.712)	(1.243)	(1.535)	(1.749)
ICS	0.317*	0.353*	0.231	0.298*	0.343*	0.228	0.297*	0.191	0.093
	(1.349)	(1.642)	(1.244)	(1.317)	(1.440)	(1.262)	(1.332)	(1.025)	(0.511)
DCS	0.0154	0.219	-0.026	-0.105	-0.006	-0.020	-0.105	0.048	-0.022
	(0.057)	(0.978)	(0.158)	(0.501)	(0.034)	(0.139)	(0.546)	(0.303)	(0.141)
ICS x DCS	0.228	0.414	-0.004						
	(0.636)	(1.425)	(0.012)						
VS x DCS	-0.127	0.035	0.062						
	(0.414)	(0.136)	(0.172)						
VS x ICS	-0.088	-0.088	-0.094						
	(0.385)	(0.385)	(0.601)						
DYN				-0.075	0.070	-0.008	-0.074	0.105	-0.032
				(0.617)	(0.699)	(0.078)	(0.624)	(1.100)	(0.362)
MAT				-0.197	-0.103	0.025	-0.195*	0.000	0.062
				(1.635)	(1.169)	(0.323)	(1.697)	(0.000)	(0.879)
SIZ				-0.068	-0.130	0.025	-0.068	-0.120	0.089
				(0.766)	(1.188)	(0.329)	(0.824)	(1.247)	(0.904)
PPERF				0.262**	0.078	-0.012	0.261**	-0.061	-0.038
				(2.146)	(0.789)	(0.123)	(2.286)	(0.638)	(0.377)
CRE								0.426**	0.050
								(2.501)	(0.382)
CKI									0.404
									(1.654)
R^2	0.213	0.470	0.418	0.299	0.448	0.418	0.297	0.549	0.532
Q^2	0.167	0.311	0.245	0.226	0.282	0.226	0.220	0.399	0.324

Note: Each cell reports the path coefficient (t-value). *,**,*** Significant levels 10%, 5% and 1% respectively (one-tailed for hypothesised relationships, two-tailed otherwise). Max VIF_{model1} = 3.9, Max VIF_{model2} = 2.7, and Max VIF_{model3} = 2.9.

Table 9. Full sample PLS structural model results

	Model 1			Model 2			Model 3			Model 4		
	CRE	CKI	FIL	CRE	CKI	FIL	CRE	CKI	FIL	CRE	CKI	FIL
VS	0.357***	0.505***	0.242**	0.359***	0.510***	0.256***	0.361***	0.363***	0.001	0.167*	0.369***	-0.062
	(3.121)	(5.624)	(2.514)	(3.315)	(5.603)	(2.825)	(3.233)	(4.104)	(0.006)	(1.815)	(4.039)	(0.759)
ICS	0.143	0.276**	0.461***	0.113	0.281**	0.462***	0.113	0.233**	0.329***	-0.019	0.240**	0.300***
	(1.044)	(1.919)	(4.244)	(0.806)	(1.876)	(4.044)	(0.763)	(2.026)	(3.399)	(0.275)	(2.157)	(2.999)
DCS	0.014	-0.049	-0.055	0.031	-0.044	-0.067	0.031	-0.058	-0.055	0.141	-0.067	-0.020
	(0.106)	(0.313)	(0.454)	(0.251)	(0.314)	(0.594)	(0.239)	(0.493)	(0.524)	(1.551)	(0.851)	(0.307)
ICS x DCS	0.007	-0.017	-0.049									
	(0.055)	(0.148)	(0.388)									
VS x DCS	0.086	0.055	0.082									
	(0.485)	(0.392)	(0.472)									
VS x ICS	0.003	-0.051	-0.057									
	(0.021)	(0.426)	(0.434)									
DYN				-0.125	0.057	-0.061	-0.123	0.107*	-0.070	-0.167**	0.112*	-0.081
				(1.545)	(0.810)	(0.875)	(1.444)	(1.746)	(1.113)	(2.415)	(1.822)	(1.365)
MAT				0.028	0.074	0.001	0.023	-0.041	0.016	-0.016	-0.039	0.003
				(0.320)	(0.374)	(0.014)	(0.266)	(0.528)	(0.197)	(0.309)	(0.757)	(0.056)
SIZ				-0.188*	-0.089	0.054	-0.186*	-0.011	0.115*	-0.231**	-0.003	0.101
				(1.889)	(1.309)	(0.759)	(1.887)	(0.143)	(1.696)	(2.549)	(0.060)	(1.565)
PPERF				0.074	-0.016	0.009	0.072	-0.048	0.009	0.048	-0.047	-0.009
				(1.176)	(0.229)	(0.090)	(1.174)	(0.814)	(0.111)	(1.011)	(1.122)	(0.162)
CRE								0.414***	0.112		0.433***	0.048
								(5.075)	(1.098)		(4.610)	(0.596)
CKI									0.426***			0.450***
									(3.602)			(3.756)
EO										0.519***	-0.037	0.106
										(6.023)	(0.612)	(1.292)
EO x VS										-0.019		-0.142*
										(0.194)		(1.544)
EO x ICS										0.037		0.126**
										(0.410)		(1.747)
R^2	0.181	0.436	0.346	0.216	0.448	0.354	0.216	0.581	0.496	0.422	0.582	0.513
Q^2	0.144	0.305	0.215	0.145	0.313	0.197	0.174	0.409	0.290	0.309	0.423	0.302

Note: Each cell reports the path coefficient (t-value). *,**,*** Significant levels 10%, 5% and 1% respectively (one-tailed for hypothesised relationships, two-tailed otherwise). Max VIF_{model1} = 3.5, Max VIF_{model2} = 2.1, Max VIF_{model3} = 2.3 and Max VIF_{model4} = 2.4.