The effects of the interactive use of management control systems on product innovation

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Abstract

Simons’ ‘levers of control’ framework indicates that an interactive use of management control systems (MCS) contributes to fostering successful product innovation. However, his work is ambiguous in not specifying whether the relationship between interactive controls and innovation is a mediating or a moderating relationship. This paper examines the relationships among variables embedded in Simons’ framework of levers of control, explicitly distinguishing the different types of effects involved and testing their significance. The results of the survey-based research do not support the postulate that an interactive use of MCS favours innovation. They suggest this may be the case only in low-innovating firms, while the effect is in the opposite direction in high-innovating firms. No evidence is found either in favour of an indirect effect of the interactive use of MCS on performance acting through innovation. In contrast, the proposition that the impact of innovation on performance is moderated by the style of use of MCS is supported, with results indicating that the explanatory power of a model that regresses performance on innovation is significantly enhanced by the inclusion of this moderating effect.

Introduction

In recent years there has been an increased interest in examining the relationships between product innovation and the use of formal management control systems (MCS). 1 Understanding how an organization can use its formal control systems to support product innovation has emerged as an important research question

1 The term Management Control Systems (MCS) refers to the set of procedures and processes that managers and other organizational participants use in order to help ensure the achievement of their goals and the goals of their organizations (Otley & Berry, 1994), and it encompasses formal control systems as well as informal personal and social controls (Chiapello, 1996; Otley, 1980; Ouchi, 1977). Formal MCS consist of purposefully designed, information based and explicit sets of structures, routines, procedures and processes (Maciarello & Kirby, 1994) that help managers ensure that their organization’s strategies and plans are carried out or, if conditions warrant, that they are modified (Merchant, 1998; Simons, 1995a).
A significant body of literature has explored the relationships between formal MCS and product innovation within subunits, taking R&D departments, product development teams and product development projects as the level of analysis (Abernethy & Brownell, 1997; Brown & Eisenhardt, 1995; Davila, 2000), but limited emphasis has been placed on the relationship between the use of formal MCS at top management levels and product innovation examined from an organizational perspective.

Not only are there relatively few empirical studies in both the innovation and MCS literatures that address this relationship at the organizational level, but also the limited prior research appears to provide inconclusive and even contradictory findings. The innovation management literature tends to minimize or ignore the potential role of formal MCS as a factor that may influence successful product innovation (Dougherty & Hardy, 1996; Gerwin & Kolodny, 1992; Leonard-Barton, 1995; Tidd, Bessant, & Pavitt, 1997; Verona, 1999), thus suggesting that the use of formal MCS by top managers is not relevant for successful product innovation. More strikingly, a second line of research present in both the innovation and the management control literature affirms that a widespread use of formal MCS is in fact incompatible with innovation, including product innovation (Abernethy & Stoelwinder, 1991; Amabile, 1998; Miles & Snow, 1978; Ouchi, 1977). A third stream of studies has found formal MCS to coexist with product innovation (Ezzamel, 1990; Khandwalla, 1973; Miller & Friesen, 1982). In the context of a “control package” (Otley, 1980, 1999) that combines multiple management control elements, while informal MCS and other managerial systems and processes are expected to encourage innovation, formal MCS are expected to block innovation excesses and to help ensure that ideas are translated into effective product innovation and enhanced performance (Bart, 1991; Chenhall & Morris, 1995; Clark & Fujimoto, 1991; Dent, 1990; Kaplan & Norton, 1996; Wheelwright & Clark, 1992). Finally, a fourth group of studies affirms that inasmuch as formal MCS may provide a prioritary agenda and a stimulating forum for the generation and implementation of creative ideas including product development ideas, the most innovative firms are intensive users of formal MCS and an intensive use of MCS may lead to increased innovativeness (Simons, 1990, 1991, 1995a). Overall, both the innovation and the MCS extant research provide inconsistent findings regarding the relationship between formal MCS and product innovation.

Some authors have pointed to the different styles of use of formal MCS (Simons, 1990, 1991, 1995a) or the different roles of MCS (Chapman, 1997, 1998) as explanations for these apparently inconsistent studies. This paper focuses on the interactive style of use of formal management control systems as defined by Simons (1990, 1991, 1995a). On emphasizing the relevance of attributes related to use rather than design and on pointing out the distinct implications of different styles of use of formal MCS, Simons’ levers of control framework provides insights that help understand the mentioned apparent inconsistencies. More precisely, Simons’ framework contributes to explaining the contradictory findings regarding the direction and significance of the effects of formal MCS on successful innovation as reported in prior literature. In Simons’ terms, those studies that find that formal MCS (i.e. feedback and measurement systems) hinder innovation are partial to the extent that they focus exclusively on thermostat-like, diagnostic uses of formal MCS, and ignore the implications of interactive uses of MCS. On the contrary, those studies that have found that formal MCS act as facilitators of successful innovation are those that are more comprehensive to the extent that they capture the presence of interactive uses of MCS as well as the dynamic tension between diagnostic and interactive uses of formal MCS.

However, while Simons’ framework (1990, 1991, 1995a, 2000) suggests that an interactive control system contributes to successful innovation, this framework is ambiguous and does not clearly discriminate between whether an interactive control system makes companies more innovative or whether it makes innovative companies
more successful in terms of improved performance. The purpose of this paper is to explicitly discriminate between the different effects of the interactive use of MCS on product innovation and performance, as well as to assess their significance. As defined in this study, product innovation encompasses the implementation stage (Damanpour, 1991; Wolfe, 1994) and refers to the development and launching of products which are in some respect unique or distinctive from existing products (Higgins, 1996; OECD, 1997; Sánchez & Chaminade, 1998). Consequently, this study aims to clarify the causal model and the explanatory links implied in Simons’ framework as they apply to product innovation, explicitly testing whether an interactive control system makes companies more inclined to develop and launch new products or whether it contributes to successfully enhance the impact of the introduction of new products on performance.

The following section develops the theoretical arguments that lead to the setting forth of several testable propositions which refer to distinct expected effects of the interactive use of MCS. The Research Methodology and Design section presents the research method, including data collection procedures, operationalization of measurement instruments, and model specification. Results are then presented and discussed and interpreted in next two sections. A final section concludes, summarizing the findings, evaluating some of the limitations of the study and introducing some directions for future research.

**Theoretical development and hypotheses formulation**

Simons’ levers of control framework (1990, 1991, 1995a, 2000) focuses on the tensions between the organizational need for innovation and the organizational need for the achievement of pre-established objectives, and points out the consequent tensions among components of formal MCS that need to be managed in order to successfully deal with these organizational needs. Depending on their design attributes, Simons classifies formal MCS in three categories: beliefs systems, boundary systems (both used to frame the strategic domain) and feedback and measurement systems (used to elaborate and implement strategy). Furthermore, Simons emphasizes the relevance of the style of use of control systems, distinguishing two styles of use of feedback and measurement control systems: diagnostic control systems (used on an exception basis to monitor and reward achievement of specified goals through the review of critical performance variables or key success factors) and interactive control systems (used to expand opportunity-seeking and learning). Beliefs and boundary systems are formal systems that explicitly delineate the acceptable domain of activity for organizational participants, in terms of positive ideals and prescriptive limits. Within this acceptable domain of activity, feedback and measurement systems help both to implement intended strategy (i.e. diagnostic use) and to adapt to competitive environments (i.e. interactive use) (Simons, 1990, 1991, 1995a, 2000).

In particular, interactive control systems are measurement systems that are used to focus attention on the constantly changing information that top-level managers consider to be of strategic importance. In contrast to diagnostic controls, what characterizes interactive controls is senior managers’ strong level of involvement. Top managers pay frequent and regular attention to interactive control systems, and get personally involved in them. Furthermore, this pattern of attention signals the need for all organizational members to pay frequent and regular attention to the issues addressed by the interactive control systems. Through interactive control systems, top managers send messages to the whole organization in order to focus attention on strategic uncertainties. Consequently, interactive control systems place pressure on operating managers at all levels of the organization, and motivate information gathering, face-to-face dialogue and debate. As participants throughout the organization respond to the perceived opportunities and threats, organizational learning is stimulated, new ideas flow and strategies emerge. In this way, interactive control systems guide and provide input to innovation and to the formation of emergent strategies. In expanding and orientating opportunity-seeking and learning,
interactive control systems contribute to fostering the development of innovation initiatives that are successfully transformed into enhanced performance.

Overall, Simons’ framework emphasizes the relevance of the interactive use of MCS in fostering successful innovation, including successful product innovation. However, it does not provide a clear picture of the relationships among the variables involved. In particular, the framework does not provide a well-defined differentiation between two types of potential effects which are conceptually distinct and should be analytically distinguished. On the one hand, the interactive use of MCS may foster product innovation (which in turn may eventually increase performance); on the other hand, the interactive use of MCS may enhance the impact of any level of product innovation upon performance. Simons does not make an explicit distinction between these two effects, referring to them rather indistinctly in his argumentation.

In order to examine the implications of the two different effects embedded in Simons’ framework, this paper sets forth two models in which different types of relationships between product innovation, interactive use of MCS and performance are made explicit. As illustrated below, these two models discriminate Simons’ rather indistinct references to effects which are in fact inherently distinct and organize them in two model forms which are equally supportable from theory. A first model (formalized in H1) aims to test the significance of direct and indirect effects of the interactive use of MCS respectively on product innovation and performance. A second model (formalized in H2) aims to test the presence of moderating effects by which the interactive use of MCS influences the impact of product innovation on performance.

**Proposition H1 (direct and indirect effects)**

Product innovation processes, in particular in mature medium-sized and large firms, are not random, unstructured processes but rather purposeful and structured ones (Dougherty & Hardy, 1996; Gerwin & Kolodny, 1992; Tidd et al., 1997; Verona, 1999). According to Simons (1991, 1995a, 2000), the interactive use of MCS is an element that may introduce purpose and structure and eventually promote innovation. Top managers use interactive control systems “to stimulate experimentation” (Simons, 2000, p. 218) and “to stimulate opportunity-seeking and encourage the emergence of new initiatives” (Simons, 1995a, p. 93). Since they “encourage new ideas and experiments at all levels” (Simons, 1995a, p. 92), “interactive control systems help to satisfy innate desires to create and innovate” (Simons, 1995a, p. 155). These implications of an interactive use of MCS justify the fact that “the most innovative companies (use their MCS) more intensively than their less innovative counterparts” (Simons, 1995a, p. ix).

Product innovation is likely to be fostered through the interactive use of a MCS for several reasons. First, since interactive control systems are a forum for permanent debate and a recurring agenda that involves close working relationships and frequent communication, interactive control systems may point out or provide clues on where to look for new innovation ideas, thus becoming a helpful guidance tool (Simons, 1995a) in new product development. Second, the interactive control system may also stimulate the drive to search for new initiatives, breaking out organizational complacency and triggering peoples’ action thresholds to look for new ideas and opportunities for new product development (Van de Ven, 1986). Third, the interactive use of MCS should create or reinforce an atmosphere which emphasizes that product innovation does not violate prevailing norms. Interactive control systems give an opportunity for top managers to indicate to all members of the organization that product innovation initiatives are legitimate, meaningful and are welcome to the organizational agenda (Dougherty & Hardy, 1996).

Thus, the interactive use of formal MCS should stimulate and boost product innovation across the organization. The relationship between the interactive use of MCS and product innovation is then expected to be positive and is represented by arrow a in Fig. 1. According to Simons (1991, 1995a), managers choose usually no more than one specific MCS (e.g. budgets, balanced scorecards, project management systems,…) to be used interactively at any point in time. Consequently, the interactive
use of formal MCS is understood here as the interactive use of the one specific control system (whichever it is in any particular situation) that has been selected to be used interactively by senior management. This is formalized in the following hypothesis:

\[ H1a: \] the more interactive use of formal MCS by top managers, the higher the product innovation.

The management literature has long considered innovation to be one of the major determinants of long-term organizational performance in contemporary environments (Clark & Fujimoto, 1991; Drucker, 1994; Kanter, 2001; Schumpeter, 1934; Walsh et al., 1992). In particular, product innovation is considered to be one important way that organizations can effectively adapt to changes in markets, technology and competition as well as effectively take preemptive action to influence the environment (Damanpour, 1991; Dougherty & Hardy, 1996; Verona, 1999). Most empirical studies have correspondingly shown a positive relationship between product innovation and performance (arrow \( b \) in Fig. 1). This empirical literature provides evidence of the contribution made by product innovation towards performance improvement measured in terms of growth, superior value creation for the customer, returns, profitability, and stock valuations (i.e. Capon, Farley, Lehmann, & Hulbert, 1992; Cockburn & Griliches, 1988; Geroski, 1994; de Moerloose, 2000).

If the interactive use of MCS can be linked to product innovation and product innovation is linked to organizational performance, then the use of MCS can be expected to have implications for performance through the induced increase in product innovation. Thus, an indirect effect on organizational performance of the interactive use of MCS acting through product innovation may be proposed. There should be a relationship between interactive use of MCS and organizational performance which was explained in part by an indirect effect whereby interactive use of MCS increases product innovation, which in turn increases performance. This can be formally expressed as:

\[ H1b: \] there is a positive indirect relationship between the interactive use of MCS and performance acting through product innovation.

While \( H1b \) suggests the presence of indirect effects, the theoretical development herein presented does not lead to the formulation of hypotheses regarding a potential direct relationship between interactive use of MCS and organizational performance.\(^2\) Even though neither prior evidence nor the theoretical development do provide arguments for a potential direct effect, the conceptual framework contemplates the possibility that the interactive use of MCS might directly influence performance.

\(^2\) From goal theory (Locke, Shaw, Saari, & Latham, 1981), arguments in favour of a direct effect of interactive controls on performance at the individual level might be derived. According to goal theory, individual motivation and individual performance are improved if an individual knows clearly and is challenged by what needs to be done (Szilagyi & Wallace, 1990) and it may be argued from Simons’ framework that the characteristics of interactive controls do contribute to this clarification and challenge (Simons, 1995a, p. 97). However, research on MCS based on goal theory concentrates on the individual level of analysis (Murray, 1990; Weisenfeld & Killough, 1992), while the level of analysis of this study is the organization.
organizational performance regardless of the level of product innovation (link represented by path c in Fig. 1). If so, this direct effect is expected to be relatively small once controlling for innovation and a large proportion of the potential relationship between use of MCS and performance is expected to come indirectly through innovation rather than through a direct effect.

Proposition H2 (moderating effects)

A different mechanism that Simons (1991, 1995a) seems to suggest is that the interactive use of MCS influences the impact of product innovation on organizational performance. According to Simons (1995a, p. 102), “by choosing to use a control system interactively, top managers signal their preferences for search” and, in particular, top managers’ aim in using interactive controls is “to focus attention (of the members of the organization) on strategic uncertainties” (Simons, 1995a, p. 100). Following Simons’ framework, it can be expected that, by orientating the contents of the product innovation initiatives, interactive control systems “harness the creativity that often leads to new products” (Simons, 1995b, p. 86), contribute to the adequacy of the innovation initiatives that are pursued and help ensure the success of innovation initiatives so that they have beneficial consequences on performance. In Simons’ terms, “effective managers” are those who “use traditional MCS (..) in special ways (i.e. interactively) to focus attention on strategic issues” (Simons, 1992, p. 45). Consequently, it can be expected that the extent to which MCS are used interactively will influence positively the extent to which innovation initiatives are effectively translated into improved organizational performance.

This is consistent with the contingency research tradition that affirms that the impact of strategy on performance is influenced by attributes of structural arrangements such as MCS, as well as with previous studies in the innovation literature which point out that, for an innovation process to be successful and transformed into enhanced performance, there must be a supportive context and a supportive internal environment (Gerwin & Kolodny, 1992; Tidd et al., 1997; Wheelwright & Clark, 1992; Zirger & Maidique, 1990). MCS are a constituent of the internal environment and therefore supportive management control can be expected to be relevant in the pursuit of high-performing innovation initiatives.

It is plausible that the influence of the interactive use of MCS on the effect of product innovation on performance is achieved through different mechanisms. First, it provides focus and therefore indicates where to concentrate innovative efforts so that they are consistent with organization-wide strategic orientation (Van de Ven, 1986). In Simons’ terms, interactive control systems are used by top managers “to communicate where to look” (Simons, 1995a, p. 93). This is ordinarily done within the strategic domain defined by beliefs and boundary systems, even though focusing attention and learning on strategic uncertainties (Simons, 1995a, p. 100) may occasionally lead to reframing the strategic domain.

Second, in providing an agenda and a forum for the regular face-to-face dialogue and debate needed, interactive control systems help “to collectively make sense of changing circumstances” (Simons, 1995a, p. 218). The interactive use of MCS is then likely to affect the impact of product innovation on performance by acting as an internal integrative capability (Verona, 1999) that addresses the parts-whole problem which emerges from the proliferation of ideas, people and transactions involved in the product innovation effort (Van de Ven, 1986).

Finally, the pattern of permanent, regular attention on interactive control systems makes these particularly well-suited to the constantly changing conditions of innovative contexts. Interactive control systems may be expected to provide a lever to permanently fine-tune analyses and actions, contributing to making the right changes and altering product innovation initiatives as competitive markets change. The members of the organization use the interactive control system to “inform them of changing patterns and (to) allow them to respond with new action plans” (Simons, 1995a, p. 98). “As new data is released”, the members of the organization work “to gather as much data as they can” from the interactive control system “to suggest action plans that respond to changing circumstances” (Simons, 2000, p. 217) and consequently an inter-
active control system “triggers revised action plans” (Simons, 1995a, p. 109). The relationship between the level of product innovation and organizational performance can be then expected to be enhanced when focus, integration and fine-tuning are obtained through the interactive use of MCS. For a certain level of product innovation, product innovation is likely to bear a more positive relationship with performance when MCS are used more interactively. Furthermore, the enhancement of the relationship between product innovation and performance because of the presence of an interactive use of MCS should be particularly strong when product innovation is high, since avoiding the risks of product innovation initiatives that are inconsistent with the firm’s strategy, integrating micro-logics in a sensible macro framework, and being able to fine-tune and redirect actions should be particularly crucial in contexts where innovative ideas, initiatives and transactions proliferate (Chenhall & Morris, 1995; Van de Ven, 1986). When an organization is undergoing little or no product innovation, this potential enhancement is likely to be limited or insignificant since the need for focus, integration and fine-tuning can be expected to be less compelling (even though in firms with conservative strategies that entail little innovation, it may still be critical to rely on focus, integration and fine-tuning to maintain limited but well-oriented innovation). These arguments are consistent with propositions stating that interactive control systems are particularly needed in contexts where it is crucial that innovation is effective (Simons, 1995b) such as under build, product differentiation, prospector and entrepreneurial strategies (Langfield-Smith, 1997).

Overall, the theoretical development suggests that the nature of the relationship between product innovation and performance varies, depending on the interactive use of MCS. Thus, the relationship between product innovation and performance would be moderated by the extent to which MCS are used interactively. The moderating effect of interactive use of MCS on the relationship between product innovation and performance is represented by arrow d in the moderation model illustrated in Fig. 2.

The following research hypothesis is proposed to test the prediction of this moderating effect:

\[ H2: \text{the more interactive the use of formal MCS by top managers, the greater the effect of product innovation on performance.} \]

Research methodology and design

Sample selection and data collection

Data were gathered by a survey research method that involved the administration of a written questionnaire to a sample of CEOs of medium-sized, mature manufacturing Spanish firms. The unit of analysis of this study is the individual firm. The use of the firm as the unit of analysis is well established in the literature about the relationships between product innovation and other organizational characteristics (e.g. Capon et al., 1992; Li & Atuahene-Gima, 2001; Miller, Dröge, & Toulouse, 1988; Miller & Friesen, 1982). The term “firm” includes both independent companies with no subsidiaries and strategic business units of multi-business corporations as long as they are legal entities. A series of t-tests on the study variables revealed that the distribution of responses over the two groups (i.e. independent vs. corporate-owned) did not present significant differences. Furthermore, the inclusion of the type of ownership as a control variable in regression analysis supported the non-significance of the type of ownership regarding the investigated relationships. This evidence backed up the pooling of data for analysis.
purposes of this research, medium-sized firms were defined as those with an annual turnover of between €18 and 180 million and between 200 and 2000 employees. Mature firms were defined as those founded at least ten years before the survey was administered. Firms whose CNAE-93 (Clasificación Nacional de Actividades Económicas) code belongs to Section D (Manufacturing Industries) were considered manufacturing firms. In order to control for undesired effects related to relationships with headquarters, subsidiaries of multi-national companies (MNCs) with headquarters outside Spain were excluded since most often these MNCs do not locate research centers and innovation activities in Spain (Barceló, 1993; Hermosilla, 2001). The sample was also selected on a geographical basis, focusing on firms whose headquarters are in Catalonia (northeastern Spain, with the Barcelona metropolitan area as its manufacturing hub). Exploitation of the Dun and Bradstreet/CIDEM, 2000 database (referred to 1998 data) resulted in 120 firms fulfilling the screening criteria.

A survey instrument was used to collect the data for the study. Questionnaire instruments documented in the extant academic literature as well as theoretical input from MCS and innovation research were used as the basis for an initial draft. Circulation of drafts among six scholars with expertise in the areas of management control, business policy and statistics as well as pilot runs with three CEOs of medium-sized companies led to the introduction of some conceptual modifications, reorderings and rewordings in the questionnaire. Overall, the revision process emphasized the need to shorten and abridge the questionnaire as much as possible given the position of the target respondents (see Appendix B). Questionnaires were distributed and returned by mail. A five step implementation strategy was devised following the lines suggested by Dillman (2000), including a series of telephone calls to check data accuracy, pre-notice letters, cover letters with attached questionnaire, follow-up letters with replacement questionnaire (3 weeks later) and a final series of phone calls to solicit non-returned questionnaires (3 weeks after the follow-up letters). Out of the 120 distributed questionnaires, 58 were returned, all of which were complete. Thus, the process yielded a 48.33% response rate. This compares well with the response rate of similar studies. However, for the sake of consistency in the time framework of the study, 4 cases where the executives reported not to have been in their current position for at least three years (n = 18) were excluded for purposes of statistical tests. Only those cases where respondents reported to have held their position during at least the last three years were used. The resulting useable sample for purposes of statistically testing the specified models was n = 40. 5 Neither the two-samples t-tests nor the visual inspection of parallel box-plots indicated significant differences between immediate replies and late replies after follow-ups, supporting the absence of any obvious non-response bias. Support in favour of the absence of common method variance caused by single-source bias was obtained using a Harman’s one-factor test which yielded four factors with eigenvalues greater than one, with the first factor explaining 22.04% of the variance, indicating that no single factor was dominant.

**Definition and measurement of constructs**

**Interactive use of MCS (or style of use of MCS)**

While multiple formal control mechanisms are likely to be present simultaneously in a complex organization’s overall control package (Otley, 1980, 1999), it was necessary for practical purposes to focus the analysis on a limited number of control mechanisms which are relevant to our research goals. In order to describe and measure the interactive use of MCS, this study pays special atten-

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4 The variables performance and innovation were operationalized in the questionnaire as performance and innovation during the last three years.

5 The firms in the resulting useable sample represent a variety of industries, including chemical and pharmaceutical (9 firms), textile (5 firms), food and beverages (4 firms), manufacturing of mechanical equipment (4 firms), metal manufacturing (4 firms), manufacturing of electrical equipment (3 firms), automobile supplies and parts (2 firms) and miscellaneous (9 firms). Average sales are 57.5 million € (minimum 18.63, median 49.35, maximum 165.28 million €) and the average number of employees is 386 (minimum 204, median 347, maximum 800). Four of the firms were listed in the stock market.
tion to three specific control mechanisms which, according to the management control literature, are widely used in practice (Amat, 1991; Chenhall & Langfield-Smith, 1998) and have been theoretically linked to innovation and performance (Chapman, 1997; Davila, 2000; Kaplan & Norton, 1996, 2000; Langfield-Smith, 1997; Simons, 1995a). The three selected control mechanisms are (i) budget systems, (ii) balanced scorecards or *tableaux-de-bord* 6 and (iii) project management systems (see Appendix C for statistics on the presence of the specific MCS).

Interactive control systems are formal control systems that managers use to become personally and regularly involved in the decision activities of subordinates and that become the basis for continual exchange between top managers and lower level of management as well as between organizational members. They provide the opportunity for top management to debate and challenge underlying assumptions and action plans, to guide organizational attention and to facilitate organizational learning and formation of strategies (Simons, 1995a, 2000). Evidence of the potential for interactive uses of the three selected control mechanisms has been reported in the literature (i.e. Abernethy & Brownell, 1999 and Simons, 1991, 1995a on budgets; Kaplan & Norton, 1996, 2000 and Tuomela, 2001 on balanced scorecards; Davila, 2000 and Simons, 1995a on project management systems).

Interactive use of MCS was measured by a multi-scale instrument based on the instruments suggested by Abernethy and Brownell (1999) and Davila (2000). For each of the three selected specific control systems, respondents were asked about the extent to which the information generated by a certain control system deserves attention as a means of regularly questioning and challenging ongoing action plans (as opposed to its use for merely monitoring achievement of pre-established goals); the degree to which information from the control system is discussed face-to-face merely on an exception basis; the extent to which it demands frequent and regular attention from the top manager; and the extent to which it demands frequent and regular attention from operating managers at all levels of the organization. If a certain specific control system was present in a firm, its top manager was asked to rate the items related to the interactive use of that system on 1–7 Likert scales. In those cases where a certain MCS was absent in a firm, the absence of a certain specific control system was conceptualised as an extreme instance of absence of an interactive use of that particular system and the items related to the interactive use of that MCS were consequently scored zero.

Factor analysis indicated that, in each of the three selected systems, three items loaded on one factor that could be interpreted as interactivity of use of a certain MCS (see Appendix B). A fourth single item that loaded on a second factor was excluded from analysis since ex-post analysis raised some concerns about the unambiguity of the anchor statements. Factor analysis using the three retained items supported unidimensionality for each of the three selected control systems. Three summated scales (one per specific control system) were created by adding the scores of the three retained items related to each of the control systems. The theoretical range of each summated scale was 0–21. Since there was one underlying factor to the items included in each scale, and since the variances of the items included in each scale were similar, the internal consistency of each of the three scales was assessed using Cronbach’s alpha. The three alphas were in the range 0.77–0.79, suggesting that the reliability of the constructs was very acceptable. The constructs resulting from the summated scales were labeled *Interactive Use of Budgets* (USEBUD), *Interactive Use of Balanced Scorecards* (USEBSC) and *Interactive Use of Project Management Systems* (USEPMS).

Simons’ framework posits that in order to achieve successful innovation, top managers use some formal control systems interactively—usually only one—while at the same time some other formal control systems are used diagnostically.

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6 As defined in the questionnaire, balanced scorecards or *tableaux-de-bords* do not need follow the exact procedure suggested by Kaplan and Norton (1996, 2000). For our purposes, summarized, multi-perspective sets of both financial and non-financial indicators that aim to capture the extent to which strategic objectives are being achieved, qualify as balanced scorecards or *tableaux-de-bord*. 
Firms can introduce interactivity in the balance between levers of control through the interactive use of alternative specific control systems. Thus, rather than simply describing the degree of interactive use of a specific control system in an interactive mode, it was considered of interest to describe the degree to which interactivity is present in an overall control situation, regardless of the specific control system in which the interactive use is embodied. For this purpose, the variable Interactive Use of Management Control Systems (USEMCS) was defined in order to represent the extent to which some control system (whichever it is) is used in an interactive style, determining the presence of interactivity in the overall control situation. Since the study focuses on three specific control systems, the presence of interactivity in the overall control situation can be detected as long as it comes from one of these three control systems. While we acknowledge that interactivity might be introduced through other specific control systems not picked up in this study, an option was taken to delimitate the potential sources of interactivity under examination for purposes of tractability.

The variable USEMCS was operationalized as the degree of interactivity presented by the specific control system that presents the maximum interactivity score in any given firm. The specific control system that presents the maximum interactivity score in any given firm varies across the sampled firms (budgets in 23 cases, balanced scorecards in 23 cases, project management systems in 10 cases. Further information on the comparison between the different interactive use constructs is provided in Appendix C). Having defined USEMCS as the maximum among USEBUD, USEBSC and USEPMS, a high interactivity score in any of the three mechanisms (be it USEBUD, USEBSC or USEPMS) implies high scores in USEMCS. Very low scores in USEMCS imply none of the three control mechanisms is used interactively. The theoretical range of USEMCS is 0–21 (see Table 1 for descriptives). Normality of the construct was supported by a Shapiro–Wilk’s test.

Product innovation
Product innovation is understood in this paper from an output perspective (Barceló, 1993; OECD, 1997; Sánchez & Chaminade, 1998) and it encompasses the implementation stage (Damanpour, 1991; Wolfe, 1994). It is defined as the development and launching of products which are

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<th>Theoretical range</th>
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<td>11.62</td>
<td>5.74</td>
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<td>18.00</td>
<td>8.05</td>
<td>6.78</td>
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<td>4. Interactive use of management control systems (USEMCS)</td>
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<td>20.00</td>
<td>14.05</td>
<td>3.70</td>
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<td>1.00–10.00</td>
<td>5.08</td>
<td>9.65</td>
<td>7.24</td>
<td>1.00</td>
<td>7.37</td>
</tr>
<tr>
<td>6. Innovation (INNOV)</td>
<td>3.00–21.00</td>
<td>6.00</td>
<td>21.00</td>
<td>14.67</td>
<td>4.31</td>
<td>14.50</td>
</tr>
</tbody>
</table>

n = 40.

What produces high levels of USEMCS is the fact that one of the specific MCS is used in a very interactive style. A control situation in which one of the systems scores high in interactive use while the other systems score extremely low represents a situation in which high interactivity is present in the overall control system. In contrast, a control situation in which each of the systems scores fairly low in interactive use represents a situation in which low interactivity is present in the overall control system. While the first overall control situation is highly interactive and the second is not, one can easily figure out combination of scores that led to the same sum of interactivity scores and average scores across the two situations (or even higher sums and averages in the second situation). For this reason, neither the sum of scores of USEBUD, USEBSC and USEPMS nor the average score were considered adequate to operationalize USEMCS.
in some respect unique or distinctive from existing products (Higgins, 1996; OECD, 1997; Schumpeter, 1934). The firm level is taken as the minimum level of institutional novelty for defining the scope of product innovation (Bart, 1991; Kamm, 1987; OECD, 1997; Souder, 1987). The measure of product innovation is drawn from instruments used by Capon et al. (1992), Scott and Tiessen (1999) and Thomson and Abernethy (1998). The adapted instrument consists of four items measured through 7-point Likert scales, namely the rate of introduction of new products, the rate of modification of existing products, the tendency of firms to pioneer, and the part of the product portfolio corresponding to recently launched products. Anchors of the Likert scales referred to innovative/non-innovative behaviours during the last three years in relative terms, in comparison with the industry average.

A decision was made in favour of the eventual deletion of the item rate of modification of new products, given its too low communality (less than 0.50). Factor analysis results indicated that the three remaining items loaded on a single factor (percentage of common variance explained = 75.44%) which supported the unidimensionality of the measurement instrument (Appendix B). A summated scale was created by adding the scores of the three items that loaded on the factor. The theoretical range of the summated scale was 3–21, and the scale was reversed so that high scores represented high levels of innovation. Since there was an underlying factor to the three items and since their variances were similar, the internal consistency of the items included in the scale was assessed using Cronbach-alpha as a reliability coefficient. The resulting 0.83 alpha, above the 0.70 recommended level of acceptability, indicated a high internal consistency of the innovation summated scale. See Table 1 for descriptives of the construct. The Shapiro–Wilk’s test supported normality of the Innovation construct.

**Performance**

In accordance with previous research (i.e. Chenhall & Langfield-Smith, 1998; Gupta & Govindarajan, 1984; Kaplan & Norton, 1996; Otley, 1999; Venkatraman & Ramanujam, 1986), organizational performance was understood here as the degree of goal attainment along several dimensions, both financial and non-financial. In order to measure performance, we adapted Govindarajan’s well-established multi-dimensional instrument (Abernethy & Guthrie, 1994; Chenhall & Langfield-Smith, 1998; Chong & Chong, 1997; Govindarajan, 1984; Govindarajan & Gupta, 1985; Govindarajan, 1988; Gupta & Govindarajan, 1984). Following Govindarajan, we use a subjective (i.e. self-rated, based on primary data) and relative (i.e. as compared to a reference) set of performance indicators that are aggregated into a single composite by means of self-reported weights. Govindarajan’s instrument was adjusted to adapt it to the characteristics of the target sample, which includes both independent firms and firms belonging to multi-business corporations. Top managers were asked to rate the actual performance of their companies on that dimension compared with their assessment of the actual average performance in the industry, as well as the importance they attach on a given dimension. Govindarajan’s instrument was further adjusted in order to adapt it to the specific research goals of this paper. Since innovation is considered in this study as an antecedent of performance rather than a constituent of it, innovation subdimensions were excluded from the performance construct. The adaptation of the Govindarajan instrument herein proposed captures financial and customer perspectives (Kaplan & Norton, 2000). The selected indicators include eight selected subdimensions (four related to a financial perspective: sales growth rate, revenue growth rate, ROI, profit/sales ratio; four related to a customer’s perspective: customer satisfaction, customer retention, customer acquisition and increase in market share).

Top managers were asked to indicate on 11-point Likert scales, ranging from ‘well below average’ to ‘well above average’, their assessment of the firm’s performance in comparison with the industry average along the eight selected subdimensions. Top managers were also asked to rate the importance attached to each of these items on an eleven-point Likert scale. A composite index was obtained by weighting the performance score of each of the items by its relative importance score.
Descriptive statistics of the construct performance are reported in Table 1. The Shapiro–Wilk/C213/s test supported normality of the performance construct. In order to obtain a cross-validation of the composite performance measure, respondents were asked to provide an overall global rating of performance. The single global performance rating correlated at 0.773 (p < 0.01) with the composite index used for testing the analytical models.

**Analytical models**

In order to test $H1a$, $H1b$ and $H2$, two analytical models were proposed: a mediation model (corresponding to Fig. 1) and a moderation model (Fig. 2). In using innovation as an intervening variable, the mediated model allows for testing $H1a$ and $H1b$ through the use of correlation and path analysis techniques. In capturing the interaction between innovation and style of use of MCS, the moderated model allows for testing $H2$ through Moderated Regression Analysis. 8

**Mediation model**

**Correlation analysis**

The expected fit between interactive use of MCS and innovation as expressed by $H1a$ and as represented in the mediation model (Fig. 1) was tested by analyzing the zero-order correlation coefficient between the aggregated construct that represents the interactive use of some of the three MCS (USEMCS) and innovation. Should $H1a$ be supported, the correlation coefficient between interactive use of MCS (USEMCS) and innovation would present a significant positive value. Additionally, correlations between each of the three selected individual control systems (e.g. budgets, balanced scorecards, project management systems) and innovation were also analyzed to test whether variations of $H1a$ would hold for each individual MCS.

**Path analysis**

To test the hypothesis of indirect effects of interactive use of MCS (USEMCS) on performance acting through innovation as expressed by $H1b$, a path analysis technique was used. 9 Path analysis allows for the modeling of multiple interrelated dependence relationships between endogenous and exogenous constructs, decomposing correlations into direct, indirect and spurious effects. The path model may be expressed in equation form as follows:

\[
\text{INNOV} = \gamma_{11(i)} \text{USEMCS}_{(i)} + \zeta_1 \\
\text{PERFORM} = \gamma_{21(i)} \text{USEMCS}_{(i)} + \beta_{21} \text{INNOV} + \zeta_2
\]

where

\[
\text{USEMCS}_{(i)} = \text{interactive use of MCS or style of use of MCS by top management (high scores represent interactive use, low scores represent no interactive use)}
\]

\[
i = \text{the aggregated MCS construct (} i = 1 \| \text{USEMCS}_1 = \text{USEMCS}) \text{ or each of the three selected control systems (} i = 2, 3, 4 \| \text{USEMCS}_2 = \text{USEBUD}; \text{ USEMCS}_3 = \text{USEBSC and USEMCS}_4 = \text{USEPMS}).
\]

\[
\text{INNOV} = \text{product innovation} \\
\text{PERFORM} = \text{firm’s performance} \\
\gamma_{nm} = \text{relationships of exogenous to endogenous constructs}
\]

---

8 It is often stated in the management literature (Abernethy & Brownell, 1999; Govindarajan, 1988) that analytical models should control for potential effects of firms’ size in order to avoid omitted variable bias. The replication of the analytical models including turnover and number of employees as proxies for size revealed no differences in the significance of the relationships postulated by the hypotheses as compared with the significances obtained in the models excluding size. Analogous conclusions were obtained when including ownership status (i.e. independent vs. corporate-owned) as a dummy control variable. The apparent non-relevance of size and ownership status support the non-inclusion of these variables in the models for the sake of parsimony.

9 The possibility of using structural equation models (SEM) in which measurement of latent variables analysis and structural analysis were conducted simultaneously was ruled out on the basis of the large sample size required by SEM (Hoyle, 1995). This limitation applies also to moderation models, given the still on-going debate among methodologists on the pertinent formulation of non-linear functions in SEM (Jaccard & Wan, 1996; Jöreskog & Yang, 1996; Li et al., 1998; Marcoulides & Schumacker, 2003; Ping, 1995) and the limited evidence on the implications of small sample sizes in the particular case of SEM with interaction (Schumacker & Marcoulides, 1998).
\[ \beta_{en} = \text{relationships of endogenous to endogenous constructs} \]

\[ \zeta_n = \text{error terms} \]

\[ \gamma_{11(i)}, \gamma_{21(i)} \text{ and } \beta_{21} \text{ are the path coefficients which describe the relationships among constructs (i.e. } \beta_{21} \text{ represents the relationships between the two endogenous constructs performance and innovation). Path coefficients } \gamma_{11(i)} \text{ can be found by regressing innovation against interactive use of MCS, and therefore } \gamma_{11(i)} \text{ coincide with the correlation coefficients mentioned in the previous subsection. Path coefficients } \gamma_{21(i)} \text{ and } \beta_{21} \text{ can be found by regressing performance on both innovation and interactive use of MCS. Assuming residuals are uncorrelated, the path coefficients of the explanatory variables are equivalent to the standardized beta calculated from regression equations. From the combination of path coefficients and zero-order correlations, direct and indirect effects can be found. The analysis for the aggregated construct USEMCS was replicated for each of the three selected specific control systems.} \]

**Moderation model: moderated regression analysis**

Moderated multiple regression models allow the relationship between a dependent variable and an independent variable to depend on the level of another independent variable (i.e. the moderator). The moderated relationship, referred to as the interaction, is modeled by including a product term as an additional independent variable (Hartmann & Moers, 1999; Jaccard, Turrisi, & Wan, 1990; Shields & Shields, 1998). Since \( H2 \) hypothesized that the style of use of formal MCS (framed as interactivity or interactive use, \(^{10}\) from Simons’ framework) has a positive influence on the way innovation affects performance, the expected relationship can be expressed in terms of a moderated relationship. Moderated regression analysis can be used to test the significance of the interaction effects between innovation and the style of use of formal MCS as predicted by \( H2 \). The formulation of the postulated moderation model used to test the interaction hypothesis is the following:

\[
\text{PERFORM} = \beta_0 + \beta_1 \text{INNOV} + \beta_2 \text{USEMCS} + \beta_3 \text{INNOV} \times \text{USEMCS} + \varepsilon \tag{3}
\]

where

\[
\begin{align*}
\text{PERFORM} & = \text{firm’s performance} \\
\text{INNOV} & = \text{product innovation} \\
\text{USEMCS} & = \text{interactive use of MCS or style of use of MCS by top management (high scores represent interactive use, low scores represent no interactive use)} \\
i & = \text{the aggregated MCS construct (i} = 1| | \text{each of the three selected control systems (i} = 2, 3, 4| | \text{USEMCS} = \text{USEBSC and USEMCS}_4 = \text{USEPMS})} \\
\varepsilon & = \text{error term}
\end{align*}
\]

\(^{10}\) We are aware of the risk of confusion between the terms *interactivity* and *interaction*, practically homophonic. Despite the similarity of the words, they represent absolutely different concepts. *Interactivity* is a substantive term that refers to a particular quality in the style of use of MCS, while *interaction* is a statistical term that refers to a particular type of functional relationship. Even if this may potentially induce to confusion, we have respected the original terms since they are the ones widely accepted and commonly used in the respective fields.
Additional moderated regression analysis were run for each of the three specific control systems.

Results

Mediation model

Correlation analysis

Data from the sample do not support Proposition H1a stating that the interactive use of MCS is positively correlated with innovation. As indicated in the top part of Table 2, the zero-order correlation between interactive use of MCS and innovation is not significant. Analogous results were obtained for each of the specific control mechanisms (see Appendix D for the full correlation matrix).

Given the non-significance of the effects of the interactive use of MCS as tested by the correlation analysis for the full sample, it was considered of interest to run separate correlation analyses for the high innovators subsample and the low innovators subsample. Splitting at the median of innovation, two subsamples were created. Firms with innovation scores higher (lower) than the median were labeled high (low) innovators. Correlation analyses were replicated for both subsamples (see Table 2). With due caution in the interpretation of results because of the limited sample size, Fisher’s Z-tests suggested that the differences between the correlation coefficients innovation/interactive use of both subsamples were significant for each of the control constructs, providing grounds for rejecting the hypothesis that both subsamples represent populations with the same true correlation ($p < 0.10$ for the aggregated construct and budgets; $p < 0.01$ for balanced scorecards and project management systems).

For the high innovators subsample, the zero-order correlation between innovation and the aggregated construct USEMCS was significant ($p < 0.01$) and contrary to the expected direction (i.e. negative instead of the expected positive direction). The zero-order correlations between innovation and the interactive use of each of the three control mechanisms were also significant ($p < 0.025$) and contrary to the expected positive direction. For the low innovators subsample, the zero-order correlation between innovation and the aggregated construct USEMCS was non-significant. As far as the specific control mechanisms were concerned, the correlation with innovation was positive and according to the expected direction in two cases (i.e. balanced scorecards and project management systems) and negative and contrary to the expected direction in one case (i.e. budget systems). However, only the positive correlation coefficient between Product Innovation and interactive use of balanced scorecards was significant at the 0.10 level (two-tailed tests).

Path analysis

In order to assess the effects of the interactive use of MCS on performance, the coefficients ob-

---

Table 2
Correlations innovation/interactive use

<table>
<thead>
<tr>
<th></th>
<th>Subsample high innovators $(n = 20)$</th>
<th>Subsample low innovators $(n = 20)$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$r$</td>
<td>$p$</td>
</tr>
<tr>
<td>Interactive use of mgmt systems (USEMCS)</td>
<td>$-0.071$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>$(0.662)$</td>
<td></td>
</tr>
<tr>
<td>Interactive use of budgets (USEBUD)</td>
<td>$-0.221$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>$(0.170)$</td>
<td></td>
</tr>
<tr>
<td>Interactive use of balanced scorecards (USEBSC)</td>
<td>$0.182$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>$(0.260)$</td>
<td></td>
</tr>
<tr>
<td>Interactive use of project mgmt systems (USEPMS)</td>
<td>$0.018$</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>$(0.912)$</td>
<td></td>
</tr>
</tbody>
</table>

$n = 40$.

*Significant at the 0.05 level; **Significant at the 0.01 level; *Significant at the 0.10 level (two-tailed tests).
tained from the path analysis (Table 3) and the decomposition of the observed correlation between interactive use of MCS and performance (Table 4) were examined. Coinciding with correlation analysis (Table 2), the path coefficients $\gamma_{11}$ did not provide evidence of a significant direct link between interactive use of MCS and product innovation. The path coefficients $\gamma_{21}$ do not support the existence of a direct relation interactive use of MCS/performance, once controlling for product innovation. In contrast, the significance of the coefficients $\beta_{21}$ does indicate a strong effect of innovation on performance.

As reported in Table 4, the observed correlations between interactive use of control systems and performance are non-significant (marginally

<table>
<thead>
<tr>
<th>Control system</th>
<th>Path coefficient</th>
<th>Value</th>
<th>Standard error</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>USEMCS</td>
<td>$\gamma_{11}$</td>
<td>-0.071</td>
<td>0.162</td>
<td>0.441</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>$\gamma_{21}$</td>
<td>0.137</td>
<td>0.148</td>
<td>0.925</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>$\beta_{21}$</td>
<td>0.429</td>
<td>0.148</td>
<td>2.900</td>
<td>0.01**</td>
</tr>
<tr>
<td>USEBUD</td>
<td>$\gamma_{11}$</td>
<td>-0.221</td>
<td>0.158</td>
<td>-1.400</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>$\gamma_{21}$</td>
<td>0.154</td>
<td>0.151</td>
<td>1.021</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>$\beta_{21}$</td>
<td>0.453</td>
<td>0.151</td>
<td>3.004</td>
<td>0.01**</td>
</tr>
<tr>
<td>USEBSC</td>
<td>$\gamma_{11}$</td>
<td>0.182</td>
<td>0.159</td>
<td>1.144</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>$\gamma_{21}$</td>
<td>0.241</td>
<td>0.147</td>
<td>1.643</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>$\beta_{21}$</td>
<td>0.375</td>
<td>0.147</td>
<td>2.561</td>
<td>0.02**</td>
</tr>
<tr>
<td>USEPMS</td>
<td>$\gamma_{11}$</td>
<td>0.018</td>
<td>0.162</td>
<td>0.112</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td>$\gamma_{21}$</td>
<td>0.085</td>
<td>0.149</td>
<td>0.573</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>$\beta_{21}$</td>
<td>0.418</td>
<td>0.149</td>
<td>2.810</td>
<td>0.01**</td>
</tr>
</tbody>
</table>

*Significant at the 0.05 level (two-tailed tests); **Significant at the 0.01 level.

<table>
<thead>
<tr>
<th>Control system</th>
<th>Linkage</th>
<th>Direct</th>
<th>Indirect*</th>
<th>Total (observed correlation)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>USEMCS</td>
<td>INNOV/USEMCS ($Y_1/X_1$)</td>
<td>-0.071</td>
<td>-0.030</td>
<td>-0.071</td>
<td>0.66</td>
</tr>
<tr>
<td></td>
<td>PERFORM/USEMCS ($Y_2/X_1$)</td>
<td>0.137</td>
<td>-0.010</td>
<td>0.106</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>PERFORM/INNOV ($Y_2/Y_1$)</td>
<td>0.429</td>
<td>-0.010</td>
<td>0.419</td>
<td>0.01**</td>
</tr>
<tr>
<td>USEBUD</td>
<td>INNOV/USEBUD ($Y_1/X_1$)</td>
<td>-0.221</td>
<td>-0.100</td>
<td>-0.221</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>PERFORM/USEBUD ($Y_2/X_1$)</td>
<td>0.154</td>
<td>-0.034</td>
<td>0.054</td>
<td>0.74</td>
</tr>
<tr>
<td></td>
<td>PERFORM/INNOV ($Y_2/Y_1$)</td>
<td>0.453</td>
<td>-0.034</td>
<td>0.419</td>
<td>0.01**</td>
</tr>
<tr>
<td>USEBSC</td>
<td>INNOV/USEBSC ($Y_1/X_1$)</td>
<td>0.182</td>
<td>0.068</td>
<td>0.182</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>PERFORM/USEBSC ($Y_2/X_1$)</td>
<td>0.241</td>
<td>0.044</td>
<td>0.309</td>
<td>0.05*</td>
</tr>
<tr>
<td></td>
<td>PERFORM/INNOV ($Y_2/Y_1$)</td>
<td>0.375</td>
<td>0.044</td>
<td>0.419</td>
<td>0.01**</td>
</tr>
<tr>
<td>USEPMS</td>
<td>INNOV/USEPMS ($Y_1/X_1$)</td>
<td>0.018</td>
<td>0.008</td>
<td>0.018</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td>PERFORM/USEPMS ($Y_2/X_1$)</td>
<td>0.085</td>
<td>0.001</td>
<td>0.093</td>
<td>0.57</td>
</tr>
<tr>
<td></td>
<td>PERFORM/INNOV ($Y_2/Y_1$)</td>
<td>0.418</td>
<td>0.001</td>
<td>0.419</td>
<td>0.01**</td>
</tr>
</tbody>
</table>

*Significant at the 0.05 level (two-tailed tests); **Significant at the 0.01 level.

*Direct effects of the interactive use of control systems on performance and indirect effects through innovation are represented in bold prints.
significant only for balanced scorecards): these results correspond to non-significant direct effects accompanied by extremely weak indirect effects. Indirect effects are weak since, even though the positive links innovation/performance as indicated by $b_{21}$ are significant, the path coefficients that relate interactive use of MCS and innovation are not. Therefore, the null hypothesis of non-existence of indirect effects of the use of MCS on performance cannot be rejected.

Given the non-significant effects of interactive use of MCS as tested by the path analysis, and given the results of the correlation analyses by subsamples previously reported, it was considered of interest to run separate path analyses for the high innovators subsample and the low innovators subsample. Running path analyses by subsamples did not provide further evidence of the existence of indirect effects of the use of MCS on performance (see Fig. 3 for an illustration of the results of the path analysis by subsamples regarding USEMCS). In the case of low innovators, the path coefficients $\gamma_{11}$ suggest a strong and significant negative link interactive use of MCS/innovation, but the links innovation/performance as indicated by $b_{21}$ are not significant, eventually resulting in weak indirect effects as well as weak total effects. Overall, path analyses fail to support the hypothesis of the existence of indirect effects of the interactive use of MCS on performance acting through innovation.

**Moderated regression analysis**

The results of the moderated regression analysis are contained in Table 5. Prior to fitting the equation to data, the independent variables were centered to avoid potential computational problems (Hartmann & Moers, 1999). The first of the regression models contained in Table 5 refers to the aggregated construct interactive use of management control system (USEMCS). The three following regression models refer individually to each of the three selected specific control systems.

As far as USEMCS is concerned, the results show that the interaction coefficient $\beta_3$ is both

---

Fig. 3. Path analysis by subsamples (USEMCS): † †Significant at the 0.01 level; † Significant at the 0.05 level (two-tailed tests).

---

11 Centering the independent (including moderator) variables and computing the interaction term as the product of the centered scores do not change the coefficient of the interaction term, nor its level of significance. All Variance Inflationary Factors after centering were VIF < 1.25.
positive and significant ($t = 2.59$, $p < 0.014$) supporting the rejection of the null hypothesis $H_0$ stating that there is no interaction between innovation and style of use of formal MCS and providing evidence in favour of the postulate of a significant moderating effect of the style of use of MCS. Because the results indicate that $\beta_3$ is positive and significantly different from zero, it is reasonable to conclude that the slope of the line representing the association between innovation and performance is significantly steeper in situations where MCS are used interactively relative to situations with non-interactive use of MCS.

The results of the regression provide evidence that the explanatory power of the model increases because of the inclusion of the interaction term. With the interaction term included, the model explains 32.1% of the variance in performance compared with 19.4% with only the two main effects as predictor variables (Appendix E). An additional 12.7% of variance in performance was explained by the inclusion of the interaction term. Overall, results suggest a good fit of data to the moderation model.

The foregoing moderated regression analysis was replicated for each of the individual MCS selected in this study. As far as budgets are concerned, the findings closely resemble the findings for the aggregated construct. Results displayed in Table 5 show that, when using interactive use of budgets as the moderator variable, the interaction coefficient $\beta_3$ is positive and significantly different from zero ($t = 2.217$, $p < 0.05$). The replication of the moderated regression analysis with style of use of balanced scorecards as the moderator resulted in $R^2 = 0.233$ but the coefficient of the interaction term was not significant. The increase of the explanatory power of the regression equation because of the inclusion of the interaction term was negligible. Analogous findings resulted with style of use of project management systems as an explanatory variable: the coefficient of the interaction term was not significant and the strength of the interaction effect was negligible.
Discussion

The effects of the interactive use of MCS on product innovation and the indirect effects on performance

The results of the tests of the mediation model cast doubts on the hypotheses regarding the predicted positive effects of the style of use of formal MCS on product innovation and, through product innovation, on performance. In fact, the non-significant correlations between interactivity of MCS and product innovation do not support the postulate that an interactive use of formal MCS favours product innovation and the path analysis does not support the presence of an indirect effect on performance acting through product innovation.

One plausible reason why the null hypothesis of no correlation between interactive use of formal MCS and product innovation cannot be rejected is that the relationship between interactivity of control systems and product innovation is more complex than expected according to the initial theoretical development (e.g. segmented or non-linear as opposed to initial simple linear models). While analyses in the direction of non-simple linear models should be interpreted with caution given their ex-post nature, not derived from the initial theoretical development, it is considered that these analyses provide interesting exploratory insights that may be developed in future research.

In fact, the results of the segmented linear models suggest a complex relationship. They indicate that the impact of the interactive use of formal MCS on product innovation varies depending on the level of product innovation. On the one hand, and contrary to the initially expected direction, product innovation presents a significant negative correlation with interactive use of MCS in high-innovating firms. On the other hand, product innovation appears to correlate positively (although at a marginal or non-significant level) with interactive use of some formal MCS only in the case of low-innovating firms. While unexpected in the context of the initial theoretical framework, these exploratory findings can be considered theoretically meaningful to the extent that they can be interpreted along the lines of Miller and Friesen’s (1982) work.

In their 1982 paper, Miller and Friesen point out that, in absence of mitigating mechanisms, momentum is a pervasive force in organizations. The concept of momentum suggests that past practices affect behavior. Thus, firms with a propensity to innovate have a tendency to become even more innovative, whereas those apt not to innovate tend to further limit the circumstances under which they engage in product innovation. Innovation momentum can lead to dysfunctional extremes. In high-innovating firms, there is a risk of reaching too high a level of innovation in the sense that innovation is excessive, inadequate or produces dramatically diminished returns. In low-innovating firms, there is a risk of innovation sinking to a level which leads to complete strategic stagnation (Miller & Friesen, 1982).

The results reported in the previous section are consistent with the affirmation that the interactive use of formal MCS may contribute to reducing the risk of too much innovation in high-innovating firms and, even though they are less conclusive, results are consistent with the affirmation that some MCS may contribute to reducing the risk of too little innovation in low-innovating firms. Consequently, one is inclined to think that the interactive use of MCS may help attenuate the potential dysfunctional extremes of innovation momentum. Interactive control systems may offer a framework for capitalizing learning about the implications of both conservative and entrepreneurial extremes and an agenda for proactively acting in consequence. However, the learning patterns and the contents of agendas are likely to be different for low-innovating firms and high-innovating firms.

As far as the potential indirect effects of the style of use of MCS on performance are concerned, the results of the mediation model casts doubt on the hypothesis regarding such effects acting through product innovation. The data do not support the postulate that an interactive use of control systems favours product innovation, and consequently they do not support the postulate that an interactive use of MCS favours performance through an indirect effect via product
innovation. The separate analysis for high and low innovators does not support the presence of indirect effects either. Overall, the mediation model as derived from the initial theoretical development fails to provide evidence of significant relationships between interactive use of control systems and innovation as well as between interactive use of control systems and performance. Such mediation model does not help comprehend the role of the use of formal MCS in influencing the level (i.e. quantity) of product innovation, and is not informative either about the role of the style of use of formal MCS in influencing the contents (i.e. quality, adequacy) of product innovation, eventually being unable to support meaningful links between interactive use of formal control systems and performance. However, results provide interesting insights into the relationships between interactive use of formal MCS and product innovation, hinting at a complex and differentiated role of the use of MCS in influencing the level of innovation across the spectrum of innovation.

The findings of the study do not enable one to draw conclusions on the potential role a diagnostic use of formal MCS might have regarding product innovation and performance. By concentrating on the interactive use of control systems, this study does not permit the analysis of the interplay between control mechanisms that are used interactively and control mechanisms that are used diagnostically at one and the same time. While the study is concerned about depth rather than breadth, its insights into the features of interactive formal control systems may enable future research to effectively integrate an enhanced understanding of interactive formal control systems into a broader framework that captures the tensions and balances among styles-of-use of formal MCS.

The moderating effect of the interactive use of MCS on the impact of product innovation on performance

The results from the tests of the moderation model show a significant increase in the explanatory power of the regression equation because of the inclusion of the moderation term, providing evidence in favour of the affirmation that the variation in performance as a result of variation in innovation levels can be significantly better explained when style of use of formal MCS is introduced as a moderating factor. In particular, the results of the moderated regression analysis indicate that the relationship between product innovation and performance is more positive the more interactively MCS are used. In terms of H2, it supports that the more interactive the use of formal MCS by top managers, the greater the positive effect of product innovation on performance. Moreover, an interactive use of MCS is likely to enhance the impact of product innovation on performance particularly when product innovation is very high (Fig. 4). As far as the specific control systems are concerned, these results are replicated for budgets, but fail to be significant in the case of balanced scorecards and project management systems.

Theoretical developments lead to the interpretation of the results by which an interactive use of formal MCS appears to have a moderating influence on the impact of innovation on performance, in terms of provision of direction, integration and fine-tuning. First, interactive control systems may shape the rich bottom-up process of emergence of patterns of action in high-innovating firms. It is plausible that they provide direction by signaling preferences for search, indicating those acceptable courses of action that are consistent with the overall business strategy, and providing the basis for selecting those initiatives that maximize the impact on performance. The direction provided by interactive control systems is an aspect of focus. In fact, the contribution of interactive MCS in terms of provision of focus has a dual aspect: focus as filtering (mentioned in the previous section) and the just mentioned aspect of focus as direction. Focus as filtering affects the level of product innovation, curbing it in the case of high-innovating firms. Focus as direction affects the contents of product innovation. Filtering out is made so that the firm engages in functional innovation and superfluous innovation is avoided, thus enhancing the impact of product innovation on performance.

Second, the interactive use of formal MCS may moderate the impact of innovation on performance by acting as an internal integrative capability (Verona, 1999). Interactive control systems
facilitate a forum and an agenda for organizational members to engage in the regular, face-to-face dialogue and debate that is required for dealing with the non-routine, under-identified multi-disciplinary problems entailed by new product development (Burns & Stalker, 1961; Chapman, 1998; Chenhall & Morris, 1986; Galbraith, 1973; Miles & Snow, 1978; Miller et al., 1988; Thompson, 1967; Tidd et al., 1997). The consultation, collaboration, multi-faceted generation and evaluation of alternatives and integrated problem-solving that result from an interactive use of MCS enlightens decisions on process efficiency and product effectiveness, eventually improving the impact of innovation on performance (Chenhall & Morris, 1995; Verona, 1999).

Finally, interactive control systems provide a lever to fine-tune and alter strategy as competitive markets change. As a firm becomes more innovative, the need for adjustments in strategy and strategy implementation will be more frequent and the relevance of making the right changes will increase (Chapman, 1997, 1998). A pattern of permanent, regular attention on strategic uncertainties is a defining feature of interactive control systems. Therefore these are particularly well-suited to assist in fine-tuning ideas so that they are translated into effective innovations and in altering strategy if needed because of the changing conditions of innovative contexts.

Overall, while the empirical findings tend to support Simons’ assertion that successful innovators use formal MCS interactively, the analysis makes explicit the specific mechanisms through which this takes place. In particular, the findings provide evidence against the postulates stating that innovation correlates positively with interactive use of MCS and that the most innovative companies use their control systems more interactively than do less innovative ones (Simons, 1995a). Rather, an ex-post analysis suggests that the relationship between interactive use of MCS and product innovation may vary with the level of innovation. In low-innovating firms, weak evi-

---

**Fig. 4. The moderating effect of interactive use of MCS.**

<table>
<thead>
<tr>
<th>Low product innovation</th>
<th>High product innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Interactive use of MCS</td>
<td>performance weakly enhanced</td>
</tr>
<tr>
<td>High Interactive use of MCS</td>
<td>performance strongly enhanced</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low product innovation</th>
<th>High product innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low interactive use of MCS</td>
<td>performance weakly enhanced</td>
</tr>
<tr>
<td>High interactive use of MCS</td>
<td>performance strongly enhanced</td>
</tr>
</tbody>
</table>
dence suggests that an interactive use of formal MCS may stimulate creativity and product innovation, plausibly by offering guidance, triggering initiatives and providing legitimacy. However, the interactive use of formal MCS does not appear to stimulate creativity and product innovation in high-innovating firms. In these firms, creativity, generation of ideas and launching of new initiatives are likely to be encouraged through both informal systems and formal systems other than MCS (Chenhall & Morris, 1995; Clark & Fujimoto, 1991; Roussel, Saad, & Erickson, 1991; Wheelwright & Clark, 1992) but, in the absence of mitigating mechanisms, innovation momentum tends to lead to excessive and dysfunctional generation and launching of new initiatives (Miller & Friesen, 1982). Then, an interactive use of formal MCS is likely to be functional in high-innovating firms in curbing innovation excesses. Consequently, it is not surprising that the most innovative firms within the subgroup of high-innovating firms are those that do not use MCS interactively.

However, the pieces of evidence presented suggest that the style of use of MCS is very relevant in influencing the impact of innovation on performance, both in low- and (especially) in high-innovating firms. Even though an interactive use of formal MCS may not be the channel through which autonomy and space for generation of ideas and innovation is provided in the case of high-innovating firms, autonomy and space for innovation do not preclude a great emphasis on MCS. In fact, the interactive use of formal MCS appears to have a moderating role that helps translate creativity into effective innovations and enhanced performance (Chenhall & Morris, 1995). For the autonomy and space for innovation to be successfully converted into improved performance, a proper use of MCS appears to be very relevant. And the more innovative the firm, the more relevant the proper use of MCS appears to be.

Conclusion

The purpose of this study was to clarify through which specific relationships the link between interactive use of MCS and successful innovation as posited by Simons framework of levers of control is enacted. In particular, it has been argued that Simons’ model does not provide a well-defined differentiation between distinct types of potential effects through which the interactive use of MCS may affect product innovation and performance. The study has set out to explicitly distinguish the different types of effects embedded in Simons’ model and has tested their significance. Two propositions have been developed, predicting in turn that (1) the more interactive the use of MCS by top managers, the higher the product innovation (and acting through innovation, the better the performance); and (2) the more interactive the use of MCS by top managers, the greater the effect of product innovation on performance. The results of the research have not borne out the first of these two propositions while they have provided support for the second one. Thus, results have provided evidence against the postulate that an interactive use of MCS favours product innovation. They have suggested this may be the case only in low-innovating firms, while the effect appears to be in the opposite direction in high-innovating firms. Moreover, no significant indirect effect on performance has been detected. In contrast, the proposition that the impact of product innovation on performance is moderated by the style of use of MCS has been supported, with results indicating that the explanatory power of a model that regresses performance on product innovation is significantly enhanced by the inclusion of this moderating effect.

Based on the theoretical development and empirical results, it is considered plausible that an interactive use of control systems may favour innovation in low innovating firms through the provision of guidance for search, triggering and stimulus of initiatives, and provision of legitimacy to autonomous initiatives. In contrast, an interactive use of control systems appears to reduce innovation in high-innovating firms, plausibly through the filtering out of initiatives that results from the sharing and exposure of ideas. The significant moderating effect of the interactive use of MCS on the impact of innovation on performance
may in turn result from the direction, integration and fine-tuning that interactive control systems provide.

Overall, the results of this study emphasize, in support of some prior research, the considerable importance of formal MCS in the pursuit of innovation that is successfully translated into long-term performance. More specifically, the study emphasizes the relevance of the style-of-use of formal MCS, discriminating between the different types of functional effects of an interactive use of formal control systems and providing clear evidence of the significance of these effects on both innovation and performance. The identification of significant functional effects of the interactive control systems should encourage top managers to ponder over the convenience of paying special attention to the patterns of use of formal control systems in their firms.

While the results of the study shed some light on the role of interactive MCS in fostering successful innovation, some limitations must be noted which should be addressed in future research. First, this study is confined to a limited scope of control systems. Even though this confinement was deliberate and adopted for purposes of tractability, it is acknowledged that this introduces a simplification that should be mitigated in further research. Furthermore, and based on different theories attachable to the different specific control systems under analysis, future studies could also address the potential different implications of different specific control systems being selected for interactive use. Subsequent research should also aim to capture the tensions and balances among styles of use of formal MCS (e.g. diagnostic vs. interactive) as well as among types of control systems (e.g. formal vs. informal) in order to integrate the enhanced understanding of interactive MCS into the broader framework of overall control packages and in order to examine potential complementary and substitution effects.

Second, the research domain of this study is restricted to product innovation. Extension of the inquiry to other types of innovation such as process innovation or management innovation may be addressed in future research. Future research could also usefully focus on different degrees of radicalness or degrees of institutional novelty of innovations in order to increase the understanding of the relationships between MCS and innovation. A third type of limitation of our study is related to sample size. Small sample sizes reduce the generalizability of findings and the power of statistical tests. It is noticeable, however, that despite the reduction in power, an array of significant findings have emerged from statistical tests, suggesting that the presence of true relationships among the variables of interest cannot be rejected. The sample of our study was selected from medium-sized, mature manufacturing firms. Generalizing the results to firms in other contexts should be done cautiously. The replication of this study with larger sample sizes in a variety of organizational settings (i.e. industries other than manufacturing, firms of different sizes, different national cultures, . . .) could refine the findings of this study and extend them to different contexts.

Several methodological improvements can also be suggested for future research. Further work is needed to test and refine the psychometric properties of the proposed instruments. Despite the difficulties, multi-method strategies for gathering data should be encouraged in future research in order to avoid potential common variance biases and in order to enhance the validity and reliability of the construct measures. Future studies should use refined measurement instruments in larger samples so that the stability and generalizability of the results can be improved. Moreover, enlarged sample size would open up the possibility of using structural equation models for better estimation of the models, by simultaneously dealing with measurement error issues and multiple interrelated dependence relationships.

Finally, some limitations of our study are inherent to the selected research methodology. As with all cross-sectional survey-based research designs, the nature of this study’s research design does not allow for the assessment of strict causality or positive proof of the relationships among the variables of interest. The usual caution that asso-
Association is a necessary but not sufficient condition for causality does also apply here. What can be said is that the evidence obtained is consistent with positions proposed in the theoretical discussion. Longitudinal case studies provide considerable research opportunities for investigating and confirming the proposed theoretical causal relationships as well as for enhancing the understanding of the dynamics and theoretical reasons underlying the relationships found in this study. Longitudinal case studies may be particularly fruitful in refining and testing the plausible interpretation of the contents and processual aspects of the detected effects of the interactive use of MCS on innovation and performance.

Notwithstanding these limitations, the results of the study have provided evidence of the relevance of an interactive use of MCS in influencing product innovation and performance. The most significant contributions have been the discrimination of direct, indirect and moderating effects of the interactive use of control systems, and the identification of plausible distinct consequences of the learning derived from the interactive use of control systems in low versus high innovating firms.

Appendix A. Excerpts from the questionnaire

In comparison with the industry average, how would you qualify the performance of your company over the last three years in terms of the following indicators? (0 = well below the average; 5 = around average; 10 = well above the average): Rate of sales growth; Rate of profit growth; Return on investment; Profits/sales ratio; Customer satisfaction; Customer retention; Acquisition of new customers; Increase in market share; Overall performance.

How important are the following indicators for your company? (0 = moderately important; 5 = significantly important; 10 = absolutely crucial): Rate of sales growth; Rate of profit growth; Return on investment; Profits/sales ratio; Customer satisfaction; Customer retention; Acquisition of new customers; Increase in market share.

In comparison with the industry average,

- During the last three years we have launched, (1) many new products vs. (7) few new products.
- During the last three years we have launched (1) many modifications to already existing products vs. (7) few modifications to already existing products.
- In new products, we are (1) very often first-to-market vs. (7) very rarely first-to-market.
- The percentage of new products in our product portfolio is (1) much higher than the industry average vs. (7) is much lower than the industry average.

Is some kind of budgetary system used in your company? (Yes/no). If yes, then (ibid for balanced scorecards and project management systems)

- The main aim of budget tracking is (1) to ensure that previously established objectives are met vs. (7) to force us to continually question and revise the assumptions upon which we base our plans.
- (1) Only when there are deviations from planned performance are budget tracking reports the main subject for face-to-face discussion with my executive team vs. (7) Whether there are deviations from planned performance or not, budget tracking reports are the main subject for face-to-face discussion with my executive team.
- (1) I pay periodic or occasional attention to budgets (e.g. setting objectives, analyzing periodic tracking reports, ...) vs. (7) I pay regular and frequent attention to budgets. I use them permanently.
- (1) For many managers in my company, budgets require periodic or occasional attention, but not permanent attention vs. (7) In my company, budgets require permanent attention from all managers.

How long have you held your present management position?
### Appendix B. Factor analysis and reliability analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Items in questionnaire</th>
<th>Factor 1**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Innovation</strong> (INNOV)</td>
<td>Rate of introduction of new products (NEWPROD)</td>
<td>0.842</td>
</tr>
<tr>
<td></td>
<td>Rate of modification of products (MODPROD)</td>
<td>0.655**</td>
</tr>
<tr>
<td></td>
<td>Tendency of firms to pioneer/being first-to-market (FIRSTMKT)</td>
<td>0.833</td>
</tr>
<tr>
<td></td>
<td>% sales from recently launched products (SALESNEW)</td>
<td>0.864</td>
</tr>
<tr>
<td></td>
<td><strong>Eigenvalue</strong></td>
<td>2.58</td>
</tr>
<tr>
<td></td>
<td><strong>% of variance</strong></td>
<td>64.45%</td>
</tr>
<tr>
<td><strong>After removal of MODPROD:</strong></td>
<td>Rate of introduction of new products (NEWPROD)</td>
<td>0.856</td>
</tr>
<tr>
<td></td>
<td>Tendency of firms to pioneer/being first-to-market (FIRSTMKT)</td>
<td>0.859</td>
</tr>
<tr>
<td></td>
<td>% sales from recently launched products (SALESNEW)</td>
<td>0.891</td>
</tr>
<tr>
<td></td>
<td><strong>Eigenvalue</strong></td>
<td>2.26</td>
</tr>
<tr>
<td></td>
<td><strong>% of variance</strong></td>
<td>75.44%</td>
</tr>
<tr>
<td></td>
<td><strong>Cronbach’s α</strong></td>
<td>0.83</td>
</tr>
</tbody>
</table>

| **Interactive use of budgets** (USEBUD) | Track pre-established goals vs. challenge assumptions (BUDAIM) | 0.096 |
|                                         | Exception basis (BUDEXCEP)                                   | 0.831 |
|                                         | Permanent personal attention by the CEO (BUDFREQ)             | 0.860 |
|                                         | Permanent personal attention by managers (BUDMIDMG)            | 0.789 |
| **After removal of BUDAIM:**           | Exception basis (BUDEXCEP)                                   | 0.854 |
|                                         | Permanent personal attention by the CEO (BUDFREQ)             | 0.871 |
|                                         | Permanent personal attention by managers (BUDMIDMG)            | 0.755 |
|                                         | **Eigenvalue**                                               | 2.06      |
|                                         | **% of variance**                                            | 68.60%    |
|                                         | **Cronbach’s α**                                             | 0.77      |

Eigenvalue 2.06, Cumulative variance 51.55%, 80.87%
<table>
<thead>
<tr>
<th>Variable Items in questionnaire</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interactive use of balanced scorecards (USEBSC)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Track pre-established goals vs. challenge assumptions (BSCAIM)</td>
<td>0.303</td>
<td>0.917</td>
</tr>
<tr>
<td>Exception basis (BSCEXCEP)</td>
<td><strong>0.865</strong></td>
<td>0.209</td>
</tr>
<tr>
<td>Permanent personal attention by the CEO (BSCFREQ)</td>
<td><strong>0.845</strong></td>
<td>−0.113</td>
</tr>
<tr>
<td>Permanent personal attention by managers (BSCMIDMG)</td>
<td>0.766</td>
<td>−0.474</td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.06</td>
<td>1.21</td>
</tr>
<tr>
<td>Cumulative variance</td>
<td>51.39%</td>
<td>81.59%</td>
</tr>
<tr>
<td>After removal of BSCAIM:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exception basis (BSCEXCEP)</td>
<td></td>
<td><strong>0.832</strong></td>
</tr>
<tr>
<td>Permanent personal attention by the CEO (BSCFREQ)</td>
<td></td>
<td><strong>0.854</strong></td>
</tr>
<tr>
<td>Permanent personal attention by managers (BSCMIDMG)</td>
<td></td>
<td><strong>0.819</strong></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.09</td>
<td>% of variance</td>
</tr>
<tr>
<td>Cronbach’s α</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td><strong>Interactive use of project (USEPMS)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Track pre-established goals vs. challenge assumptions (PMSAIM)</td>
<td>0.002</td>
<td><strong>0.949</strong></td>
</tr>
<tr>
<td>Exception basis (PMSEXCEP)</td>
<td><strong>0.528</strong></td>
<td>0.708</td>
</tr>
<tr>
<td>Permanent personal attention by the CEO (PMSFREQ)</td>
<td><strong>0.892</strong></td>
<td>0.149</td>
</tr>
<tr>
<td>Permanent personal attention by managers (PMSMIDMG)</td>
<td><strong>0.921</strong></td>
<td>0.07</td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>1.92</td>
<td>1.43</td>
</tr>
<tr>
<td>Cumulative variance</td>
<td>48.07%</td>
<td>83.81%</td>
</tr>
<tr>
<td>After removal of PMSAIM:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exception basis (PMSEXCEP)</td>
<td>0.763</td>
<td></td>
</tr>
<tr>
<td>Permanent personal attention by the CEO (PMSFREQ)</td>
<td>0.879</td>
<td></td>
</tr>
<tr>
<td>Permanent personal attention by managers (PMSMIDMG)</td>
<td>0.881</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.13</td>
<td>% of variance</td>
</tr>
<tr>
<td>Cronbach’s α</td>
<td>0.78</td>
<td></td>
</tr>
</tbody>
</table>

*Factor loadings based on principal component analysis. Rotated solutions using VARIMAX.

**The low communality of MODPROD ($h^2 = 0.429$) was used as a basis for deletion.*
## Appendix C. Comparison of interactive use constructs

<table>
<thead>
<tr>
<th># of cases</th>
<th>USE$_i$ = USEMCS</th>
<th>USE$_i$ = USEMCS, USE$_j$ &gt; USE$_k$</th>
<th>USE$_i$ = USEMCS, USE$_j$ &gt; USE$_k$</th>
<th>USE$_i$ = USEMCS, USE$_j$ = USE$_k$</th>
</tr>
</thead>
<tbody>
<tr>
<td>USEBUD</td>
<td>39</td>
<td>23</td>
<td>13</td>
<td>–</td>
</tr>
<tr>
<td>USEBSC</td>
<td>34</td>
<td>23</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>USEPMS</td>
<td>25</td>
<td>10</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

$USEMCS = \max(USEBUD, USEBSC, USEPMS)$.

## Appendix D. Correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>PERFORM</th>
<th>INNOV</th>
<th>USEBUD</th>
<th>USEBSC</th>
<th>USEPMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>INNOV</td>
<td><strong>0.419</strong></td>
<td>0.007</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signif.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USEBUD</td>
<td>0.054</td>
<td>–0.221</td>
<td>0.742</td>
<td>0.170</td>
<td></td>
</tr>
<tr>
<td>Signif.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USEBSC</td>
<td>0.309</td>
<td>0.182</td>
<td><strong>0.375</strong></td>
<td>0.017</td>
<td></td>
</tr>
<tr>
<td>Signif.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USEPMS</td>
<td>0.093</td>
<td>0.018</td>
<td><strong>0.413</strong></td>
<td><strong>0.442</strong></td>
<td></td>
</tr>
<tr>
<td>Signif.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USEMCS</td>
<td>0.106</td>
<td>–0.071</td>
<td><strong>0.870</strong></td>
<td><strong>0.533</strong></td>
<td><strong>0.455</strong></td>
</tr>
<tr>
<td>Signif.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$n = 40$.

*Correlation is significant at the 0.05 level (two-tailed); **Correlation is significant at the 0.01 level (two-tailed).
References


