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An exploratory study on the emergence of management control systems: formalizing human resources in small growing firms

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Abstract

The adoption of management control systems (MCS) is a key element in managing the tension that growth imposes on young growing firms. Despite its importance to a large number of organizations, only recently has the empirical literature devoted attention to the evolution of these systems over the lifecycle of firms [Moores and Yuen, Account. Organizat. Soc. 26 (2001) 351]. This paper builds upon existing management control theory, mostly focused on established organizations, and existing predictions based on extended field observations to explore how these systems are adopted within growing firms. To advance theory, the paper also draws from the entrepreneurship and life cycle literatures. It identifies several variables as drivers of the emergence of management control systems including the size of the organization, its age, the replacement of the founder as CEO, and the existence of outside investors. The empirical evidence, from a database on the adoption of human resource management systems, is consistent with these variables being associated with the adoption of MCS. The paper also provides initial results on how the emergence of various types of management control systems depends on which systems the organization has already adopted.

Introduction

Existing research taking an organizational view of management control systems (MCS) focuses mostly on the population of medium and large firms where formal systems have long been established and play a major role in structuring the organization and implementing strategy (Langfield-Smith, 1997; Luft & Shields, 2003). Moreover, the typical research design approaches the study of MCS from a cross-sectional perspective rather than taking a longitudinal view. [1] Over time, this literature has developed a rich set of variables to explain the cross-sectional variation among different types of MCS as well as among

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[1] Papers that have taken a longitudinal design include Jones (1985) and Kober, Ng, and Paul (2000) who use field research to study the redesign of management control systems in processes of organizational change. Also a different line of research has examined causality in management control systems through experiment-based research designs (Fisher, Maines, Peffer, & Sprinkle, 2002; Webb, 2002).

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the characteristics of these systems (Hartmann, 2000; Shields & Shields, 1998). The theoretical underpinning, rooted in contingency (Chapman, 1997; Chenhall, 2003) and agency theories (Baiman, 1982) has emphasized a static, cross-sectional view of organizations.

However, an important transition point in the life of organizations that is receiving increasing attention is the emergence of MCS (Sandino, 2004). Lack of professional management tools such as MCS has been argued to restrain growth and even to cause the failure of firms (Greiner, 1972, 1998). MCS are important to organizational growth (Flamholtz & Randle, 2000); they liberate top managers' attention from processes that can be controlled by exception and provide them with information when their informal network is overloaded. Thus, understanding how this transition happens is an important research and managerial question. This transition point, when companies move from an informal management approach to the need for formal management tools, is most visible in the population of small growing firms. [2] Growing companies are faced quickly with the tensions associated with informal processes and the challenge of successfully mastering the transition into formal control systems. At this point, the dynamic process of transitioning from an informal management to the development of MCS becomes critical to the success of these organizations. So far, our understanding of how these systems emerge in growing firms is captured through experience-based models (Flamholtz & Randle, 2000; Greiner, 1972, 1998; Simons, 2000). Based on life cycle models (Kazanjian & Drazin, 1989; Miller & Friesen, 1984) of the firm, recent research (Moores & Yuen, 2001) empirically identifies the growth phase in the life cycle of an organization as the phase when MCS become important to management.

The objective of this paper is to extend current theory and examine empirically variables that are predicted to be associated with the emergence of MCS. [3] This exploratory study focuses on those systems associated with human resource management in high-technology firms. Managing human resources is likely to be one of the most challenging tasks that small growing firms face and where MCS may have an earlier role. While not exhaustive of all management control systems in an organization (therefore, the results cannot be generalized to any MCS), systems that are used to manage organizational culture, evaluate and reward employees, and code organizational processes capture a significant and important part of MCS in small growing firms. Moreover, focusing on a subset of MCS allows triangulating the data among different respondents knowledgeable of these systems, in particular CEOs and people knowledgeable about human resource practices. This triangulation has the objective of increasing the reliability of the data at the expense of reducing the scope of MCS that could have been examined, given the knowledge of the managers interviewed. Because firms typically face similar challenges in managing human resources, focusing on these systems allows cross-sectional comparability. While focusing on a subset of MCS limits extrapolation of the results beyond theoretical generalizability (Yin, 1989), previous work has taken this approach given of the benefits associated with it (Abernethy & Lillis, 1995; Gerdin, forthcoming).

Because the study relies on the experience of respondents regarding the adoption of MCS, the sample criteria include achieving a certain size over a relatively short period of time. Moreover, given the field nature of the research project a geographical criterion was also imposed. Most of the firms that meet these three criteria are in the high-technology industry, an industry that because of the dynamism associated with it has been an important research field (Burgelman, 2002), and

[2] The phenomenon, which is driven by small organizations outgrowing informal management processes, may also be observed within departments of medium and large firms.

[3] An important line of research studies the relevance of entrepreneurial strategies (also prospector strategies) to the design of management control systems (Simons, 1987). This type of research is typically cross-sectional and focuses on entrepreneurial strategies as part of a typology of business strategies not necessarily associated with small, young firms. These studies do not examine the emergence of MCS, which is the focus of this paper.

the sample was gathered within this industry to control for potential omitted variables at the expense of limited generalizability of results (Yin, 1989).

The rest of the paper is organized as follows. The second section develops the theory behind this exploratory study. Predictions are grounded on existing knowledge in the management control systems and entrepreneurship literatures and variables that existing models of the emergence of MCS have identified (Flamholtz & Randle, 2000; Greiner, 1972, 1998; Simons, 2000). The third section presents the research design. The study is based on a rich database (Baron, Burton, & Hannan, 1996, 1999) that includes survey as well as interview information on the human resource practices of a large sample of young, high-technology firms. The fourth section presents the results. The results indicate that both size and age affect the emergence of MCS for human resource management. However, the impact of age decreases with firm size. The evidence is also consistent with the presence of venture capital and the replacement of the founder by a new CEO affecting the emergence of these systems. Further evidence indicates that the replacement of the founder is mostly significant for smaller firms. Finally, the paper provides evidence on how existing control systems affect the adoption of new ones, and which particular systems are adopted earlier. The fifth section suggests future research and concludes.

Theoretical framework

Various lines of research provide guidance to inform explanations of the emergence of management control systems including: experience-based models (Flamholtz & Randle, 2000; Greiner, 1972, 1998; Simons, 2000), the entrepreneurship literature (Bhide, 1999; Covin & Slevin, 1997), and contingency research in MCS (Bruns & Waterhouse, 1975; Chenhall, 2003; Govindarajan, 1988; Otley, 1980). The current study combines the concepts and relationships outlined in these lines of research in order to understand the emergence of MCS, and empirically explores variables that are predicted to affect this phenomenon. [4] In bringing these different literatures together, the paper explicitly develops new theoretical arguments that are needed to explore a research question in a field in its early phases, where evidence is still emerging (Sandino, 2004).

The empirical study explores the association between certain variables and the emergence of MCS—a "selection" approach within the contingency theory framework (Drazin & Van de Ven, 1985)—in an effort to explain why these systems are adopted. It does not address how this association affects the performance of the organization—an interaction or "fit" approach. The research design is based on a longitudinal database of companies transitioning from the birth to the growth stage (Miller & Friesen, 1984), where the phenomenon is more likely to be of relevance. Recent research supports this focus and indicates that the emergence of MCS is most important for organizations moving through their growth stage (Moores & Yuen, 2001), when coordination and control problems cannot be solved through informal interaction (as happens during the birth stage). These authors conclude: "Growth firms ... pay particular attention to increasing the formality of their management accounting systems" (p. 351).

Conceptualization of management control systems for human resource management

This study defines management control systems as "the formal, information-based routines and procedures managers use to maintain or alter patterns in organizational activities" (Simons,

[4] The variables identified in this section are structural variables in that they reflect changes in the firm environment. Another set of variables that have been suggested to drive the emergence of MCS is event variables. For example, Simons states that MCS may be adopted as reaction to "breakdowns in control ... Errors, bad decisions, missed opportunities" (p. 309). Organizational redesign may also be due to performance crisis (Tushman, Newman, & Romanelli, 1986). The focus of the study is the structural variables described; however, the role of these events as drivers of MCS adoption is an open research question. See also the discussion in the conclusions' section for a further elaboration on alternative variables.

1994, p. 5). Theory offers several alternatives to further classify these systems (Anthony, 1988; Simons, 1994). For the purpose of this research, the typology initially proposed by Thompson (1967) and Ouchi (1979) and significantly refined by Merchant (1985, 1998) is used. This typology provides several advantages for this study. First, it is not limited to large organizations and its richness can be exploited within small growing organizations. Second, it can be applied to a subset of control systems and, in particular, to systems for human resource management. [5] Finally, the definitions of the various control processes in this typology are specific enough to map practices into it. [6]

The typology identifies three different control mechanisms [7] labeled, according to the most recent formulation by Merchant (1998), as: *personnel control*—mechanisms that influence organizational actors by aligning their personal objectives with those of the organization; *action control*—mechanisms that influence organizational actors by prescribing the actions they should take; and *results control*—mechanisms that influence organizational actors by measuring the result of their actions.

Drivers of the emergence of MCS—size

Size has been found to explain cross-sectional variation among the design of MCS (Merchant, 1981), the survival of young firms (Hannan & Freeman, 1989) and is the basis for organization life cycle models (Kazanjian & Drazin, 1989). Within the experience-based models of emergence of MCS, size is proposed as a driver in all cases [8] (Flamholtz & Randle, 2000; Greiner, 1972, 1998; Simons, 2000, p. 310). In the early stages of a company, control and coordination happens through frequent and informal interactions. As the company grows, its attention shifts to developing systems that anchor informal interactions around a set of formalized systems. The relevance of size is linked to the increasing costs of governance associated with an informal approach to management. Informal management requires direct contact among employees; but as the number of people increases, the number of possible interactions among organizational members increases much faster. [9] If these interactions drive coordination and control costs, then the efficiency of an informal management rapidly decreases with size (Bhide, 1999, Chap. 10). Because communication and control happen through direct contact, organizational members need to allocate an increasing amount of time to maintaining an increasing number of interactions. This time is divested from potentially more value-added activities. To regain efficiency in managing the organization, coordination and control mechanisms are formalized with the objective of coding and documenting organizational learning (Ditillo, forthcoming; Levitt & March, 1988) and reducing the demand that routine activities impose on the management team's time. Size may also reflect increasing complexity not only through the interaction among participants and the need for differentiation and integration (Lawrence & Lorsch, 1967), but also through the complexity associated with new markets and new products (Mintzberg, 1979). These arguments suggest a positive association between size and the adoption of MCS.

[5] Previous research using this typology has successfully used it to analyze the control process within specific functions rather than at the company level (Rockness & Shields, 1988).

[6] Sandino (2004) proposes a different typology of management control systems in young firms based on whether their objective is to inform about revenues, costs, or risks.

[7] The word "mechanism" is used to reflect the fact that this typology is not restricted to formal control systems and can also include informal mechanisms. To make this distinction, "mechanism" includes both formal and informal procedures, while "systems" refer to formal mechanisms only.

[8] The arguments in these models are based on cause–effect relationships, however the empirical tests in the current study are tests of association and not causality and the results should be interpreted with this caveat in mind. The paper refers to the variables that these models predict as affecting the emergence of MCS as "drivers." The use of this term is related to the evolutionary perspective and the causal association that these models adopt. It should not be interpreted as suggesting that the results of the paper prove causality.

[9] For N employees the number of potential one-to-one interactions is $N(N-1)/2$.

The previous arguments are valid for MCS interpreted as homogenous systems. However, Merchant's framework allows more detailed arguments regarding differential impact of size upon management systems. To the extent that these arguments are empirically confirmed, the assumption of homogenous systems that underlies the testing of MCS as a whole becomes less valid and the empirical results at this level less informative.

In small firms, personnel control are implemented informally. Frequent interactions allow new employees to absorb the culture of the organization, acquire the knowledge required to execute their job, and communicate their ideas to management. As the organization grows, the forces that undermine informal management outlined in the previous paragraphs lead to the formalization of personnel control. Formal personnel control insures that new employees receive proper introduction to the company's culture (rather than relying on processes that happen through informal interactions) and current employees are periodically reminded of organizational objectives. These systems are most salient in human resource management systems that are important levers to manage organizational culture. Thus, size is expected to be associated with personnel control systems.

Size also drives the need to codify organizational processes through action control systems; in particular, processes within the human resource function benefit from formalization because they clarify expectations, facilitate coordination, and simplify control through organizational rules and employee roles. However, action control systems have also been associated with internal controls (Merchant, 1998) that have argued to be the only formal controls required from the start of a firm (Simons, 1994). If this is the case, then action control systems are in place from the founding of the firm and therefore their adoption unrelated to size.

Finally, size is also expected to affect the formalization of results control. Smaller firms rely on the judgment of the founder to distribute rewards (both social and economic); moreover, the motivation of initial employees may be close to that of the founder; however, as the organization grows, the founder is less likely to be able to have enough information to evaluate every employee, new employees may put more weight on tangible rewards and systems are formalized to provide these rewards. Thus, size is expected to be associated with the formalization of results control.

Drivers of the emergence of MCS—age

The second variable that has been argued to drive the emergence of MCS is age (Greiner, 1972, 1998). Age has been found to be associated with the likelihood of survival, where older firms are more likely to survive than their younger counterparts (liability of newness) (Hannan & Freeman, 1989). Age acts through the learning that accrues from experience in a way similar to the mechanisms that govern the learning curve. Even if the company is not growing, learning about management can be translated into improved MCS. Learning requires experience, experimentation, and interaction with other firms that can only be acquired over time as processes are executed again and again until a dominant design is chosen. Management control systems then emerge to formalize this learning by codifying routines and liberating management attention from repetitive tasks. The process is similar to enactment, selection, and retention processes (Weick, 1979), where organizations experiment with different alternatives (variation), select one, and develop mechanisms to retain the alternative chosen. If MCS facilitate the process of management, age will be related to their emergence. [10]

Routines, as part of action control systems, have traditionally been interpreted as repositories of organizational learning (Howard-Grenville, 2002; Nelson & Winter, 1982) and the arguments in the previous paragraph apply to action control. Initially, organizational members experiment with different ways of executing processes until a satisfactory solution is found, which is then codified.

[10] Age may not have a linear relationship with the emergence of MCS (Luft & Shields, 2003). While age may initially be associated with learning, as firms become older they may also become set in their operating ways and unable to change. I appreciate one of the reviewers for pointing out this potential non-linearity.

This argument suggests that age is associated with action control.

Codification may also play a role in personnel and results controls. Over time management may experiment with different approaches to align the motivation of employees and manage the culture and with different ways of rewarding results. This experimentation, following the learning arguments developed in the previous paragraphs, then leads to the formalization of these systems. However and in contrast to the relevance of this learning-codification argument to action control, personnel and result controls do not necessarily formalize learning as routines do. Rather they may be interpreted as systems that are adopted to solve a pressing challenge, such as loosing employees because the culture was not well communicated to them or because they did not get the appropriate economic incentives. If the emergence of these systems is unrelated to learning and are adopted because of reasons other than age, then we do not expect age to be associated with them.

The previous two variables (age and size) may interact to increase the probability of emergence of MCS. In particular, the learning that accrues with age may not be relevant to smaller companies where informal communication and control may be more effective than formal MCS. For these smaller firms, the costs of formalization outweigh their benefits. Even if the experience that these firms have accumulated would facilitate the emergence of MCS, their size does not require this step. Thus, the arguments developed in the previous paragraphs may depend on the size of the organization.

Drivers of the emergence of MCS—new CEO

In addition to size and age, the replacement of the founder has been identified as a critical event in moving from an informal organization to an organization that formalizes its processes (Greiner, 1972, 1998). The argument is based on the psychological characteristics of entrepreneurs being unsuited to manage a more formalized organization. Greiner (1998) indicates that "[the founders] are probably temperamentally unsuited to be managers" (p. 61). The need to replace founders with professional managers is echoed in Flamholtz and Randle (2000) as well as in the entrepreneurship literature (Chandler & Jansen, 1992; Willard, Krueger, & Feeser, 1992). This literature suggests that personal characteristics of most entrepreneurs are well suited for the uncertain environment of a young startup; but these same characteristics are ill-suited to the management of a more structured and larger organization (Mintzberg, 1973). [11]

The limitations of the founder to move from an entrepreneurial to a managerial role (Mintzberg, 1973) are likely to be more relevant for personnel control. Because entrepreneurs have a vision of where they want to lead to company and the original team shares this vision, they are more likely to disregard the need to manage the motivation of new employees under the assumption that everybody joins the company for its vision. Their leadership, charisma or the promise of the business model takes care of the culture of the organization and therefore personnel control systems are not needed. Only when a new CEO joins the company, the need for these systems is realized and they are put in place.

In contrast, the need for action control emerges because of the need to formalize learning or organize business processes and therefore is more likely to be unrelated to the management style of the entrepreneur. Unless entrepreneurs are unable to establish processes or allow their development, action control systems are adopted because of business needs and therefore unrelated to the turnover in the CEO position.

The effect of CEO turnover on results control depends on the balance of the arguments that have been developed for personnel and action controls. On the one hand, results control systems are associated with motivation and as such the entrepreneur may not give them appropriate weight because of the arguments developed for personnel control. On the other hand, the needs associated with a growing business lead to result control much in the same way as action control does; for

[11] The argument does not suggest that all founders are replaced or that the only reason for replacement is inadequate personal characteristics to take the company to the next stage. However, the literature suggests that the argument will hold on average.

instance, new employees not sharing the vision will demand clear accountability goals.

Much in the same way as size may interact with age, the effect of CEO turnover may be more important to management control systems in smaller companies. Larger firms may already have adopted the MCS that they need and the change in CEO position is unrelated to the ability of this person to grow the company. In contrast, smaller firms lack MCS and the replacement of the CEO may be more relevant to the emergence of MCS. Moreover, this argument may not only hold for personnel control but also for action control. In particular, smaller firms that replace the CEO may do so because the person is unable to organize the company and enable the development of processes required to grow the firm. In other words, replacement of the CEO in smaller firms may reflect the lack of ability of the CEO to establish action control.

Drivers of the emergence of MCS—venture capital

A final variable that has been found relevant in the entrepreneurship literature to explain the level of professional management in growing firms is the presence of professional funding in the company's financial structure and, in particular, venture capital (Hellmann & Puri, 2002). [12] Existing evidence indicates that venture capitalists are not simply suppliers of financial resources, but also facilitate access to a network of knowledge and resources (Sapienza, Manigart, & Vermeir, 1996; Robie, Wright, & Chiplin, 1997). Through their investments, venture capitalists develop a significant knowledge about growing firms that they can share with the firms that they invest in, thus accelerating their development. If MCS are important to the success of a growing firm, then venture capitalists will encourage their development in a timely fashion.

The specific demands on information disclosure that venture capitalists require may also lead to faster implementation of result control. Venture capitalists have a financial interest on the firm and as such they are interested in aligning the motivation of employees with the financial success of the firm—through financial and non-financial objectives, which happens through results control.

The effect of venture capitalists on personnel and action control is uncertain. On the one hand, venture capitalists may encourage their adoption because they believe them to be important for the well functioning of the organization and its success. If this is the case, venture capitalists demand companies that they invest in to have these professional tools. On the other hand, personnel and action controls are further removed from the governance structure of the organization—in particular the board of directors where these investors seat—compared to compensation decisions and organizational goals' approval, which are associated with results control. Unless venture capitalists spend significant amount of time at the companies, they may be unable to affect how personnel and action control systems are structured.

Research design

Research data

The sample for this study contains 95 small, young, technology-oriented firms in California's Silicon Valley. The focus on small, young, high technology firms allowed the selection of a large enough homogenous sample within geographical reach and likely to be transitioning into a stage where MCS are needed. While a homogenous sample limits the threat of potential confounding

[12] Venture capital is a form of financing where venture capitalists (financing intermediaries) provide cash to the company in exchange for a portion of the equity. Given the uncertainty that characterize young companies (Venkataraman, 1997), venture capital tends to be the only professional long-term financing that these companies get before they go public (Gompers & Lerner, 1999). Therefore, the argument for this hypothesis is stated around venture capital following the focus of the entrepreneurship literature and the evidence that this type of capital is typically the only professional funding that these companies get. If alternative professional sources of funds are important, then the research design decision around using venture capital would decrease the power of the study. An alternative relevant funding event is the IPO; tests (not reported) indicate that this event is not significant in the sample examined.

effects, the results can only be extended to non-tech firms through theoretical generalization (Yin, 1989). [13] The database combines qualitative and quantitative information on how these firms formalized practices to manage human resources through the development of management control systems. These systems are not exhaustive of all systems in an organization. However, systems to evaluate and reward employees, manage organizational culture, and code certain organizational processes (within the human resource function) capture a significant and important part of MCS in small growing firms. Focusing on a subset of management control systems allowed triangulating the data among different respondents knowledgeable of the human resource management systems. This research design decision increases the reliability of the data at the expense of reducing the scope of MCS examined. Thus, the findings only apply to this subset of MCS and further generalizations should be made with the appropriate caveats.

As previously mentioned, the firms included in the sample are young firms (at most 10 years old when the project started), but with more than 10 employees (to exclude firms too small to have any formal processes). The sample includes at most 10 years of information per company even if, given the periodic updating of the database, additional information is available for some firms. [14] This cut-off gives enough observations within each single year (the minimum being 45 observations in the 10th year). The initial list of companies was gathered from three different sources of firms in the Silicon Valley: *Rich's Everyday Sales Prospecting Guide*, *Technology Resource Guide to Greater Silicon Valley*, and *Silicon Valley Business Press*. The sampling procedure excluded foreign firms; it also grouped firms according to size and then larger firms were over-sampled relative to smaller firms. This stratified sampling procedure was intended to capture larger firms where professional management tools are more likely to have been adopted. The data was gathered through interviews with different managers in each of these firms including founders, CEOs, and managers knowledgeable about the human resource practices of their firm. The interviews were semi-structured with a clear set of questions to be explored; additional archival information describing the history of the firm was gathered when available during these interviews. Before the interviews were conducted, several key informants were asked to fill out different surveys. These surveys included information on the timing of adoption of different MCS related to human resource management, [15] size of the company, and date for critical events including founding date, replacement of CEO, and venture capital funding received. The questionnaire was reviewed during the interview process to insure that all the information was appropriately captured. Interviews were used, among other purposes, to identify the strategy of the firm. The information on each company was supplemented with any additional public information available. Even if the database has various characteristics that make it unique to the purposes of this paper, it is subject to the recall and respondent biases associated with survey and interview data as well as to a potential survivorship bias, because only existing firms were sampled.

Table 1 presents the various MCS in the database that were adopted by at least 25 firms in the sample. Baron et al. (1996) provide a detailed analysis of the individual evolution of each of these systems. Merchant's typology (previously described) is used to classify the various systems captured in the questionnaire. Because

[13] The study builds upon a larger research effort initiated in 1994 known as the Stanford Project on Emerging Companies (SPEC) (Baron et al., 1996, 1999; Burton, 1996; Hellmann & Puri, 2002). The broad focus of this research project is the impact of the founders' model of organizing on the human resource practices in growing firms including managerial intensity, employment systems, gender mix, inertia and change, and turnover.

[14] The project went back to the companies on a periodic basis until 1998. The 10-year period of data for each company ends between 1994 and 1998 depending on whether the company was already 10 years old in 1994.

[15] The survey asked respondents to provide the date when a particular management control system was adopted but not whether it was subsequently dropped. Interview data indicates that the latter event was rare. Appendix A reproduces the questionnaire item capturing management control data.

Table 1
Classification of management control systems by academic scholars

	Management control system	Personnel	Action	Results	Not a control system	Number of companies that adopted the system
P1	Regular company-wide sponsored social events	11	0	1	3	83
P2	Regular company-wide meetings	9	2	1	3	83
P3	Employee orientation program	15	0	0	0	67
P4	Mission or values statement	12	3	0	0	66
P5	Standard employment application	12	3	0	0	61
P6	In-house training	12	2	0	1	55
P7	Background check on prospective employees	13	0	2	0	47
P8	Human resources information system	8	5	0	2	45
P9	Newsletter or other regular company-wide correspondence	7	3	1	4	38
P10	Employee suggestion system	7	1	1	6	30
A1	Legal agreements about intellectual property/ non-competition	1	13	0	1	84
A2	Organizational chart	2	11	0	2	81
A3	Standard performance evaluation form	0	9	6	0	79
A4	Personnel manual or handbook	4	10	0	1	72
A5	Written job descriptions	1	14	0	0	49
A6	Written affirmative action plans	2	12	0	1	41
R1	Stock options	0	0	15	0	84
R2	Written performance evaluations	0	1	14	0	81
R3	Individual bonuses	0	0	15	0	69
R4	Skilled based pay	3	0	11	1	42
R5	Non-monetary recognition awards	1	0	14	0	39
R6	Team incentives or bonuses	2	0	13	0	32
R7	Profit sharing	1	0	14	0	29
	Signing bonus	6	0	2	7	33

the actual design of each MCS may rely on a weighted combination of the three types of control that Merchant identifies, mapping the systems into the typology involves a certain degree of subjectivity. To address this concern and map these systems into the typology, the following procedure was used. [16] Fifteen professors knowledgeable about MCS—either through their research or their teaching—were contacted. Each one was asked to classify each of the 23 management control systems in the database into the type of control that best reflected the control process of the system (or into the category "not a control system"). The kappa statistic measure of inter-rater agreement was 0.51 ($p < 0.001$). Finally, each system was assigned to the type of control that received the most votes. Table 1 presents the results.

[16] Alternative procedures like statistical techniques for variable reduction were not used for several reasons. The first is related to data availability: to run these techniques a significant sample is required, however most firms did not adopt all the systems and the available sample was smaller than the number of variables. Second, the common data among systems are their adoption dates, thus grouping variables around common factors would involve using an independent variable to define the dependent one.

Independent variables

Size (*LnSize*) is measured as the natural logarithm of the number of employees working at the

end of each year. [17] Age (*Age*) is the time since the founding of the company; to homogenize the interpretation of this event, it is defined as the date in which the company was registered. Venture capital (*VC*) is a dummy variable updated yearly that takes the value of one if the company has venture capital financing and zero otherwise. Similarly, *NewCeo* is a dummy variable also updated every year that takes the value of one if a new CEO replaced the founder and zero if the founder is still CEO.

In addition to these variables, the research design controls for industry. This variable may capture some of the differences across firms in terms of their external (Gordon & Narayanan, 1984) or production environments (Brownell & Merchant, 1990). The broader literature on MCS indicates that these variables are associated with variation in the design of these systems across companies. If the arguments developed to explain variation among the MCS of larger firms are relevant to the emergence of MCS—for example, firms with more structured operations like product assembly may adopt MCS sooner because these tasks are more amenable to explicit coding compared to less structured operations like product development, then controlling for them may enhance the power of the research design. Five industries are coded using dummy variables: telecommunications, medical devices, manufacturing, semiconductors, and computer (reference industry in the empirical tests).

In addition, a dummy is included to capture the strategy of the firm. Business strategy has been identified as relevant to explain cross-sectional variation in the design of management control systems (Kober et al., 2000; Langfield-Smith, 1997). The relevance of strategy to the success of small firms has also been empirically documented (Feeser & Willard, 1990). To code this variable, the founder and the CEO were asked to describe the distinctive competence of the firm. Their descriptions were content-analyzed by two different researchers and coded into five different strategies: superior marketing (reference industry in the empirical tests), technology leadership (innovation), enhance existing technology, cost minimization, and technology-market hybrid. The strategy variables are coded as dummy variables.

[17] The logarithm is used to capture potential non-linearity associated with large values of this variable.

Results

The second section presented different arguments that may affect the emergence of MCS. This section empirically examines these arguments. Two different multivariate methods are used: regression and structural equation modeling. Given the exploratory nature of the study, a regression specification puts very little structure on the model and directly tests the impact of the variables of interest after controlling for industry and strategy. The structural equation model puts more structure on the underlying relationships and, as such, it requires a more established theory and a larger number of observations. However, the entrepreneurship literature offers enough guidance to relate certain explanatory variables into a more elaborate model and thus more informative than the regression specification. Together, both analyses provide robust evidence about the arguments developed in the second section. The regression specification better fits the exploratory nature of the study. The structural equation model, with stronger assumptions about the underlying structure of the relationships, gives a more informative analysis.

Descriptive statistics

Table 2 presents the descriptive statistics for the sample. All of the variables increase over time. Size increases over time, as expected in growing firms. Also the number of firms that received venture funding, as well as those where the founder was replaced as CEO, grows over time. Finally, the adoption of the three types of MCS also increases over time. Panel B provides the distribution of

Table 2
Descriptive statistics

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Panel A: Descriptive statistics										
MCS										
Mean	0.17	0.26	0.34	0.39	0.44	0.48	0.51	0.53	0.56	0.60
Std. dev.	0.18	0.21	0.23	0.22	0.21	0.22	0.22	0.22	0.23	0.21
Personnel control										
Mean	0.18	0.25	0.32	0.37	0.42	0.47	0.51	0.52	0.55	0.59
Std. dev.	0.23	0.26	0.28	0.26	0.25	0.26	0.26	0.27	0.28	0.26
Action control										
Mean	0.16	0.24	0.36	0.43	0.48	0.53	0.58	0.60	0.64	0.72
Std. dev.	0.21	0.24	0.28	0.28	0.27	0.27	0.28	0.26	0.27	0.24
Results control										
Mean	0.19	0.27	0.36	0.40	0.44	0.47	0.48	0.48	0.51	0.53
Std. dev.	0.19	0.24	0.24	0.24	0.24	0.24	0.23	0.24	0.24	0.24
Size										
Mean	28.77	40.56	58.48	79.30	115.61	134.37	148.30	200.63	298.85	300.19
Median	11	20	29	42	63	70	86	120	126	190
Std. dev.	65.06	87.86	130.26	175.45	238.39	215.53	220.77	258.65	585.65	445.89
Venture capital										
Mean	0.42	0.56	0.65	0.71	0.78	0.78	0.76	0.79	0.77	0.78
Founder										
Mean	0.12	0.19	0.24	0.33	0.35	0.36	0.42	0.46	0.50	0.52

Panel B: Industry and strategy			
Industry	Number of companies	Strategy	Number of companies
Semiconductors	10	Technology leadership	49
Telecommunications	21	Enhance current technology	17
Medical devices	16	Market leadership	13
Manufacturing	5	Hybrid market-technology	11
Computer	43	Cost leadership	5

Panel C: Correlation matrix

	Age	LnSize	VC	New-Ceo	MCS	Personnel control	Action control
LnSize	0.56						
VC	0.21	0.41					
NewCeo	0.25	0.28	0.46				
MCS	0.49	0.47	0.27	0.26			
Personnel control	0.41	0.43	0.22	0.23	0.93		
Action control	0.50	0.45	0.27	0.24	0.86	0.72	
Result control	0.38	0.35	0.24	0.24	0.82	0.64	0.58

Panel A: Personnel, action, and results control are the percentage of systems adopted over the maximum number of systems that can be potentially adopted. Size is the number of employees. Venture capital (dummy variable that takes value of one if the company received venture funding and zero otherwise) reflects the percentage of firms having venture capital in their equity. Founder (dummy variable that takes value of one if the founder was replaced as CEO and zero otherwise) reflects the percentage of firms having replaced their founder as CEO.
Panel C: Pearson correlations reported, except for VC and NewCeo where coefficient of contingency is reported. All correlations are significant at the 1% level.

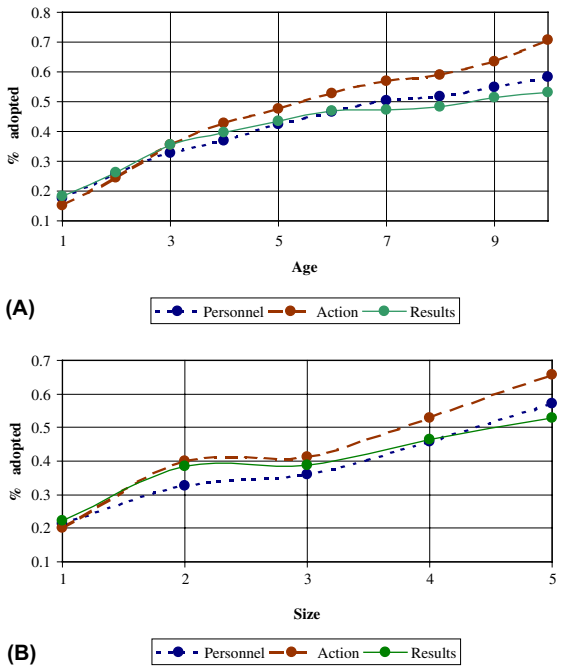

Fig. 1. Adoption of management control systems: Panel A—Management control systems and organizational age; Panel B—Management control systems and organizational size. The size portfolios are distributed to have the same number of observations and include the following sizes: <17.5, (17.5, 34), (34,75), (75, 160), >160.

companies across industries and strategies. Computer firms account for close to 50% of the sample. Given that the industry distribution, it is not surprising that close to 50% of the companies in the sample follow a technology leadership strategy. Panel C presents the correlation of the company-year observations.

Fig. 1 elaborates on the previous table and presents the growth of the three types of MCS identified in this research. Panel A plots the growth in the number of systems adopted (as percentage of the total number of systems) against the age of the company; panel B plots growth against five portfolios of company sizes. Both panels show a positive relationship and no discernible differences across types of systems. Interestingly, panel B suggests three stages in the emergence of MCS as a function of size; companies start adopting these systems for organizational sizes below 17 people, and keep on adding systems until they reach 34 people. However no new systems seem to be necessary until size reaches 75 people, when additional systems are adopted. [18] A "natural" slow-down emerges between sizes 34 and 75 indicating that above size 75 (approximately), the coordination and control needs are not fulfilled anymore with the systems developed during the early stages.

Multivariate results—regression specification

To examine the arguments presented in second section, the number of systems adopted at the end of each year per company in total and within each of Merchant's types of controls is counted. A Poisson model better captures the discrete nature of count data (dependent variable) compared to a traditional ordinary least square model (Greene, 2000). The probability of observing a certain number of management control systems adopted at a point in time is

$$\Pr(Y_i = y) = \frac{e^{-\sum_j \beta_j * x_j} * \left(\sum_j \beta_j * x_j\right)^y}{y!},$$

where $y = 0, 1, 2, 3, \ldots$ is the number of systems adopted, x_j are the explanatory variables, and β_j are the coefficients for the explanatory variables. A coefficient equal to one indicates that the independent variable has no effect upon the probability of adopting MCS. [19] A coefficient larger (smaller) than one indicates that the independent variable increases (decreases) the probability of adopting MCS. The explanatory variables include size, age, whether the founder had been replaced as CEO, and the presence of venture capital as well as the

[18] A comparison of the mean percentage of systems adopted (for each type of system) confirmed that the differences are all significant (at the 5%) except between sizes (17.5, 34) and (34,75).

[19] The tables report e^{β}, thus a coefficient of 1 is equivalent to $\beta = 0$ indicating that the incremental effect of the corresponding independent variable on the probability of adopting management control systems is zero.

control variables. All variables are updated every year. [20] Table 3 reports the results.

Size has a positive and significant impact at the overall MCS level and at the level of personnel, action, and results controls. The significance of size in action control suggests that internal controls are also adopted as the firm grows or that alternative action control systems dominate the empirical relationship. Similarly, the coefficient for age is positive and significant in every specification: older companies are more likely to have adopted a larger number of MCS after controlling for the other explanatory variables. This is consistent with the various types of systems benefiting from learning effects and against personnel and result controls being adopted as needs unrelated to time arise. The replacement of the founder by a new CEO ($NewCeo = 1$) also has a significant positive effect except for action control. This evidence indicates that while entrepreneurs allow the development of action control, they fail to put in place personnel and results controls until a new CEO brings them to the firm. Similarly, venture capital funding ($VC = 1$) is also significant for all specifications consistent with venture capitalists influencing all aspects of control systems' adoption. Industry and strategy are jointly significant. [21]

The second section also argued that the impact of age on the emergence of MCS may stronger for larger firms. To test this argument controlling for the results in Table 3, a new variable is defined as the interaction between the standardized size and age variables. This interaction term captures the effect of age at different size levels. Table 4 presents the results.

Interestingly, the coefficient on the interaction term is negative for all specifications. This result suggests that for a given size, older firms are less likely to have adopted more management control systems. To further investigate this result and potential non-linearities in the relationship, each firm-year is classified into the five portfolios defined in Fig. 1. The interaction term is replaced with four interaction terms, where a dummy variable for each of the four largest portfolios is interacted with age. The results (included in Appendix B) indicate that the negative effect of size on age weakly holds for the four largest portfolios and only when considering all MCS together. Moreover, the coefficients on the interaction terms are not significantly different from each other for the most part. Thus, it appears that the effect of size on age is not due to a particular size portfolio of firms.

The second section also developed the argument of a differential effect of the replacement of the founder as CEO across companies with different

[20] To check the robustness of the results, alternative specifications are examined. First, separate Poisson regressions for each of the 10 years are examined; the significance of the coefficients is tested using a Z-statistic that corrects for cross-sectional and serial correlation (Z is defined as $\bar{z}/(\text{stdev}(z)/\sqrt{(N-1)})$ where N is the number of regressions performed; the z-statistic is asymptotically normally distributed and Z tests the significance of its mean). Because age is kept constant in each of the regressions, this specification tests the significance of variables other than age. The conclusions from this specification were identical to the ones from Table 3. Next, the sample is partitioned based on size. Each observation is classified into one of five equal portfolios of increasing size (the five portfolios were the same ones as in Fig. 1: size <17.5, 17.5 < size < 34, 34 < size < 75, 75 < size < 160, size > 160). When a company has more than one observation in a portfolio (for example its size in different years fell within the same portfolio), observations are averaged. A separate Poisson regression is run for each size portfolio. This specification tests the significance of variables other than size (in particular, age). The results were also consistent with Table 3 except for personnel control systems, where age was not significant. To further test the significance of the results, a survival model to explain the time-to-adoption of 50% of the MCS was examined. Results were also comparable.

[21] Companies classified as manufacturing are more likely to develop MCS sooner (although this conclusion should be read with care as the sample only includes five firms in this industry). The nature of the manufacturing process may itself lead to more rapid formalization compared to the other industries in the sample that appear to be more R and D oriented. Companies following an innovation strategy and hybrid strategy take longer than the reference strategy (market leadership), probably reflecting an effort to safeguard the creativity that has typically been associated with informal management. Surprisingly, companies following a cost strategy take longer to adapt action control; given the importance of controlling costs, a fast adoption of action control to code and monitor cost reduction learning would be expected. (Again, only five companies follow a cost strategy and this conclusion should be read considering this caveat.)

Table 3
The emergence of management control systems

	LnSize	VC	NewCeo	Age	Industry				Strategy			
					Semi-cond.	Telecom.	Medical	Manuf.	Innovate	Enhance	Hybrid	Cost
MCS												
Coefficient	1.03**	1.38***	1.11**	1.10***	0.91	0.94	0.87	1.49***	0.78*	0.84	0.77***	0.86
Z-stat	1.76	3.81	2.13	9.22	−0.72	−0.55	−1.09	4.90	−2.36	−1.30	−2.73	−1.54
Personnel control												
Coefficient	1.03*	1.41***	1.11**	1.10***	1.05	0.93	0.89	1.73***	0.78	0.91	0.74*	0.83
Z-stat	1.32	2.94	1.71	7.36	0.29	−0.54	−0.70	4.49	−1.60	−0.53	−1.87	−1.25
Action control												
Coefficient	1.04**	1.47***	1.07	1.12***	0.73**	0.94	0.90	1.47***	0.78***	0.71***	0.79***	0.73***
Z-stat	2.00	4.38	1.16	8.59	−2.17	−0.60	−0.89	3.51	−2.69	−2.67	−2.69	−3.29
Results control												
Coefficient	1.03**	1.26***	1.15**	1.08***	0.85	0.96	0.80	1.27	0.81*	0.90	0.82	1.02
Z-stat	1.73	2.78	2.29	8.84	−0.94	−0.33	−1.55	1.25	−1.79	−0.76	−1.40	0.13

The table reports the Poisson regression for the pooled data controlling for potential autocorrelation of error terms for observations from the same firm. The coefficients reported are the incidence rate ratio (e^{β}). ***, **, * indicate significant at 1%, 5%, 10% respectively; one-tailed for *LnSize*, *VC*, *NewCeo*, *Age*, two-tailed otherwise. The reference strategy is market leadership and the reference industry is computer. Chow test indicates that industry and strategy variables are jointly significant ($p < 0.01$) in all regressions.

Table 4
The impact of age at different size levels on the emergence of management control systems

	MCS		Personnel control		Action control		Results control	
	Coefficient	*z*-Stat	Coefficient	*z*-Stat	Coefficient	*z*-Stat	Coefficient	*z*-Stat
LnSize	1.11***	3.59	1.12***	3.08	1.13***	4.01	1.07**	1.99
VC	1.32***	3.37	1.30***	2.47	1.38***	3.61	1.30***	2.88
NewCeo	1.17***	2.80	1.20***	2.44	1.09*	1.29	1.21***	2.89
Age	1.08***	7.20	1.08***	5.49	1.11***	8.32	1.06***	4.51
*Age * Lnsize*	0.89***	−3.59	0.90***	−2.58	0.86***	−4.17	0.91***	−2.39
Industry								
Semicond.	0.87	−1.30	1.01	0.11	0.67***	−3.31	0.89	−0.94
Telecom.	0.94	−0.84	0.87	−1.45	0.93	−0.91	1.04	0.52
Medical	0.81***	−2.65	0.86	−1.47	0.84**	−1.99	0.72***	−3.88
Manufact.	1.75***	4.55	2.11***	5.30	1.69***	3.60	1.38*	1.92
Strategy								
Innovation	0.88	−1.46	0.86	−1.33	0.88	−1.45	0.90	−1.09
Enhance	0.93	−0.66	1.02	0.12	0.82*	−1.81	0.94	−0.56
Hybrid	0.96	−0.43	0.96	−0.31	0.99	−0.14	0.93	−0.63
Cost	0.68**	−2.35	0.64**	−2.27	0.52***	−3.28	0.92	−0.46

The table reports the Poisson regression for the pooled data, controlling for potential autocorrelation of error terms for observations from the same firm. The coefficients reported are the incidence rate ratio (e^{β}). *, **, *** indicate significance at the 10%, 5% and 1% respectively; one-tailed for *LnSize*, *VC*, *NewCeo*, *Age*, and *Age * LnSize*, two-tailed otherwise. The reference strategy is market leadership and the reference industry is computer. Chow test indicates that industry and strategy variables are jointly significant ($p < 0.01$) in all regressions.

sizes. To test this argument controlling for the results in Table 3, I define a new variable as the interaction between the founder's variable and the size variable. Table 5 reports the results.

The results indicate that the effect of replacing the founder as CEO on the emergence of MCS is significantly larger for smaller firms. Interestingly, the effect holds for all three types of systems, including action control. This is in contrast with the non-significant effect of replacing the founder on action control in Table 3 and suggests that in smaller firms, the replacement of the CEO may be related to the inability of this person to put in place action control. [22]

[22] As an alternative specification, firms that replaced their founder were classified into five groups, following the five size portfolios identified in Fig. 1. Each group was defined as the size of the firm when the CEO is replaced. This variable was interacted with *NewCeo* to identify the effect of replacing the CEO for companies of different size. The results indicate that the impact of replacing the founder was more significant for the smallest group of firms.

Multivariate results—structural equation model

This sub-section examines the data imposing more structure into the model rather than assuming that the hypothesized explanatory variables are fully exogenous. Using a structural equation model, the specification examines the potential endogeneity among explanatory variables as the entrepreneurial literature outlines. Fig. 2 describes the model.

The model reflects the relationships captured in Table 3 between management control systems and size (β_1), age (β_2), replacement of founder (β_3), and venture capital (β_4). It also includes the moderating effect of age on size (γ_1) (Table 4) and replacement of founder (γ_2) (Table 5). In addition, it includes the potential relationship between age and size (α_1), where older firms are expected to be larger, the potential relationship between size and obtaining venture capital (α_2)—larger firms are more likely to have venture capital (Sapienza et al., 1996), the potential effect of age on the replacement of the founder as CEO (α_3) and the argument that venture capitalists professionalize firms and,

Table 5
The impact of replacing the founder as CEO at different growth rates on the emergence of management control systems

	MCS		Personnel control		Action control		Results control	
	Coefficient	*z*-Stat	Coefficient	*z*-Stat	Coefficient	*z*-Stat	Coefficient	*z*-Stat
LnSize	1.06***	2.89	1.06**	2.21	1.08**	2.75	1.07***	2.72
Age	1.10***	9.25	1.10***	7.44	1.12***	8.60	1.08***	8.66
VC	1.34***	3.76	1.37***	2.90	1.43***	4.15	1.22***	2.62
NewCeo	1.48***	2.56	1.42**	1.91	1.46**	2.17	1.58***	3.11
NewCeo * *Lnsize*	0.93**	−2.29	0.94*	−1.60	0.93**	−2.08	0.93**	−2.65
Industry								
Semicond.	0.91	−0.68	1.06	0.30	0.74**	−2.25	0.85	−0.89
Telecom.	0.94	−0.63	0.92	−0.57	0.94	−0.64	0.94	−0.49
Medical	0.86	−1.19	0.88	−0.77	0.89	−0.97	0.78	−1.65
Manufact.	1.50***	5.05	1.73***	4.67	1.49***	3.77	1.29	1.30
Strategy								
Innovation	0.80*	−2.22	0.79	−1.53	0.79***	−2.45	0.84	−1.53
Enhance	0.87	−1.08	0.92	−0.43	0.74**	−2.38	0.95	−0.40
Hybrid	0.77***	−2.80	0.74*	−1.93	0.78***	−2.69	0.83	−1.29
Cost	0.87	−1.50	0.83	−1.30	0.74***	−3.55	1.04	0.20

The table reports the Poisson regression for the pooled data, controlling for potential autocorrelation of error terms for observations from the same firm. The coefficients reported are the incidence rate ratio (e^{β}). ***, **, * indicate significant at 1%, 5%, 10% respectively; one-tailed for *Age, VC, LnSize, NewCEO* and *NewCEO* * LnSize. The reference strategy is market leadership and the reference industry is computer. Chow test indicates that industry and strategy variables are jointly significant ($p < 0.01$) in all regressions.

accordingly, are more likely to replace the CEO (α_4) (Robie et al., 1997). This alternative model is estimated using a structural equation model with linear equations including an intercept term and using the covariance matrix. Because the empirical variables are the theoretical variables of the study, the measurement model does not include an error term, but the linear equations' model does.

This estimation procedure relies on a more restrictive set of distributional assumptions than the regression specification; moreover, the number of observations available is somewhat low to estimate the full model.[23] Thus, these tests should be interpreted with these caveats in mind. However, by placing a more elaborate model, it allows to examine the relevance of the results after controlling for potentially relevant interactions. Table 6 reports the results. In contrast to the regression specification, the coefficients here are interpreted as having a positive effect if above zero and a negative effect if below zero.

Panel A reports the results comparable to Table 3 and Panel B reports the results comparable to Table 4. Goodness of fit statistics indicates adequate fit of the models. In both Panels, the results are comparable to those reported in Tables 3 and 4 except for the significance of new CEO's coefficient on the action control model, which was absent in Table 3. Its significance questions the previous conclusion and suggests that entrepreneurs may also delay the adoption of these systems. The coefficient for VC in the personnel control specification in Panel A is insignificant, in contrast to Table 3. This result is consistent with these investors not affecting the development of this type of control. The interaction in Panel B between age and size is not significant for personnel control suggesting that the argument on the effect of age on size may not hold for these systems. Finally, goodness-of-fit statistics indicate that model in

[23] The suggested number of observations is between 100 and 200 (Kline, 1998) and at least 200 if the model includes more than 10 variables. In order to maximize the degrees of freedom, the model does not include the controls for industry and strategy.

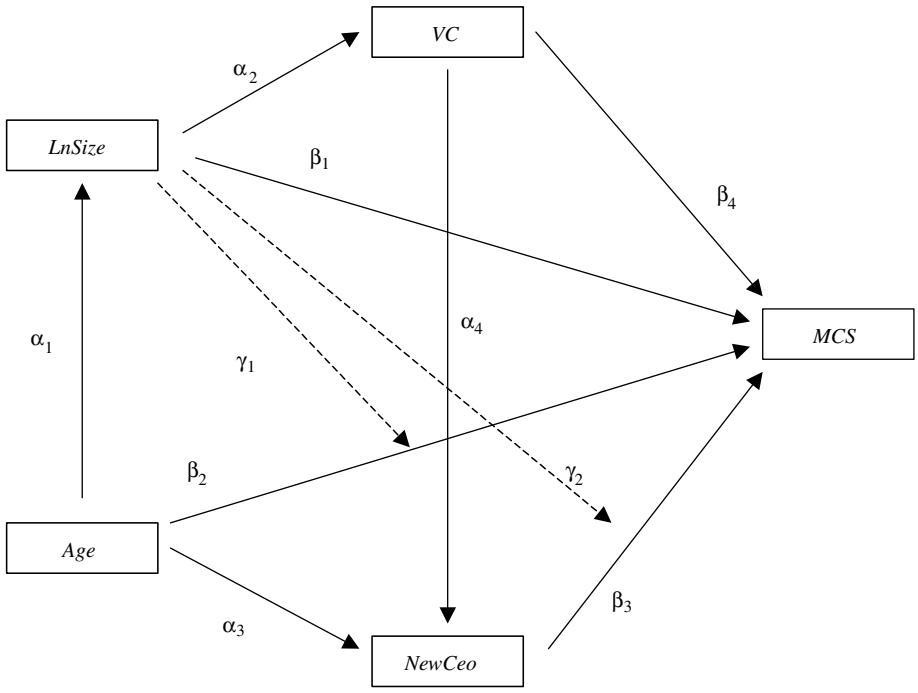

Fig. 2. Path diagram of the estimation model including potential endogenous relationships.

Panel A presents better statistical properties and that the moderating effect of size upon age may not capture this potential relationship adequately.

Including the moderating effect of size on the replacement of the founder to the models in Panels A and B was not significant; this is in contrast with results in Table 5. One potential explanation for this latter result is that the effect of age and VC upon the replacement of CEO and the correlation between age and size (α_1) and size and VC (α_2) captures this moderating effect.

Overall, the evidence is consistent with the four explanatory variables having a significant effect on the adoption on management control systems. The effect of venture capital upon personnel control and the replacement of the founder upon action control are the only variables where the conclusions are not robust across specifications.

The significance of the endogenous relationships highlights their relevance to the phenomenon. Thus, the structural equation model gives evidence relevant not only to the emergence of MCS but also to the entrepreneurial process. Moreover, the fact that the coefficients on the exploratory variables are significant after controlling for the relationship among these variables indicate that the effects are not driven by potentially omitted relationships as it might have been the case in the less developed model underlying the regression specification.

Extensions

The previous specifications do not allow for the exploration of potential interrelations among the different types of MCS that Merchant's typology identifies. Moreover, theory does not yet offer arguments to guide predictions. However, empirical examination of these relationships is relevant to understanding whether different control systems are implemented together, for example, personnel and results controls reinforce each other; whether they are substitutes for each other, for example, the adoption of personnel control makes results

Table 6
The emergence of management control systems including endogenous relationships among explanatory variables

	MCS		Personnel control		Action control		Results control	
	Coefficient	*z*-Stat	Coefficient	*z*-Stat	Coefficient	*z*-Stat	Coefficient	*z*-Stat
Panel A: Direct effects								
LnSize (β_1)	0.919***	5.58	0.479***	5.56	0.243***	4.57	0.197***	3.58
Age (β_2)	0.705***	8.86	0.280***	6.75	0.261***	10.16	0.164***	6.17
NewCEO (β_3)	1.137***	2.89	0.517**	2.51	0.227*	1.78	0.393***	2.98
VC (β_4)	0.940**	2.19	0.293	1.31	0.328**	2.40	0.319**	2.23
α_1	0.286***	18.69	0.286***	18.69	0.286***	18.69	0.286***	18.69
α_2	0.136***	12.15	0.136***	12.15	0.136***	12.15	0.136***	12.15
α_3	0.034***	5.53	0.034***	5.53	0.034***	5.53	0.034***	5.53
α_4	0.255***	7.03	0.255***	7.03	0.255***	7.03	0.255***	7.03
RMSEA	0.05		0.05		0.05		0.05	
AGFI	0.97		0.97		0.97		0.97	
Hoetler's critical *N*	779		779		779		779	
Panel B: Age-size moderating effects								
LnSize (β_1)	0.866***	5.27	0.465***	5.41	0.230***	4.33	0.172***	3.14
Age (β_2)	0.711***	8.96	0.282***	6.78	0.262***	10.23	0.167***	6.31
NewCEO (β_3)	1.197***	3.05	0.533**	2.59	0.242*	1.91	0.422***	3.22
VC (β_4)	0.872*	2.04	0.275	1.23	0.310**	2.23	0.287*	2.01
LnSize * *Age* (γ_1)	−0.423**	−2.33	−0.112	−1.18	−0.107*	−1.82	−0.204***	−3.36
α_1	0.286***	18.69	0.286***	18.69	0.286***	18.69	0.286***	18.69
α_2	0.136***	12.15	0.136***	12.15	0.136***	12.15	0.136***	12.15
α_3	0.034***	5.53	0.034***	5.53	0.034***	5.53	0.034***	5.53
α_4	0.255***	7.03	0.255***	7.03	0.255***	7.03	0.255***	7.03
RMSEA	0.08		0.08		0.08		0.08	
AGFI	0.94		0.94		0.94		0.94	
Hoetler's critical *N*	263		263		263		263	

The table presents the unstandardized path coefficients. ***, **, * indicate significant at 1%, 5%, 10% respectively.

control redundant; or whether they are independent, for example, personnel and results controls address unrelated control issues.

To provide some preliminary evidence on whether the three types of control systems behave as complements, supplements, or are independent of each other, the following tests explore how the density of systems already adopted affects the time it takes to implement an additional control system. For each type of management control system (personnel, action, and results) and for each company, the systems are ordered from the earliest one adopted to the latest. The time-to-adoption is the time between the adoption of two consecutive systems. For example, if a personnel control systems was implemented at the end of year three, and the following one is implemented at the end of year four, the time-to-adoption of the latter system is defined to be 1 year. [24] If the control systems that a company has already implemented behave as supplements (complements), then the time-to-adoption will be longer (shorter). For example, if action and result controls are supplements, then the time-to-adoption of a new action control is expected to be longer the more result control systems are already in place. Conversely, if they are

[24] The time-to-adoption of the first system is the time since the birth of the company (age).

complements, then the time-to-adoption is shorter. The density of existing MCS is measured using three variables (one for each type of control system): *Numper* is the number of personnel control systems already implemented, *Numact* is the number of action control systems already implemented, and *Numres* is the number of result control systems already implemented.

The time-to-adoption for each individual system is treated as an observation; standard errors are adjusted for heterogeneity. An event history analysis approach is used to examine this question. This research design is appropriate to investigate the time to an event—for example, the adoption of a management control system—and identifies which explanatory variables are relevant to this time-to-adoption. A survival model characterized by its hazard function $h(t)$ is defined as

$$h(t) = \lim_{\Delta \to 0} \Pr[(t \leqslant T < t + \Delta \,|\, T \geqslant t)/\Delta]$$

(Kiefer, 1988).

$h(t)$ can be interpreted as the conditional probability of adopting a system in the interval $(t, t + \Delta)$, given that it has not been reached at time t. [25] Several characterizations of $h(t)$ have been suggested (Lee, 1992). The simplest form is an exponential function that has constant hazard rate, and independent variables affect the slope of the hazard rate: $h(t) = \exp(\beta_i * x_i)$, where the β's are the coefficients and x's are the independent variables. In this case, it is also hypothesized that the age of the firm may affect the hazard rate and thus use a model that explicitly incorporates the effect of time: $h(t) = h_0(t)\exp(\beta_i * x_i)$. A Weibull specification is used to control for a time-varying hazard rate: $h(t) = p * t^{p-1} * \exp(\beta_i * x_i)$, where p is a parameter estimated within the model. Finally, some of the dependent variables (size, presence of venture capital, replacement of founder, and density of MCS) are time dependent, thus the estimated model is: $h(t, x_i(t)) = p * t^{p-1} * \exp(\beta_i * x_i(t))$.

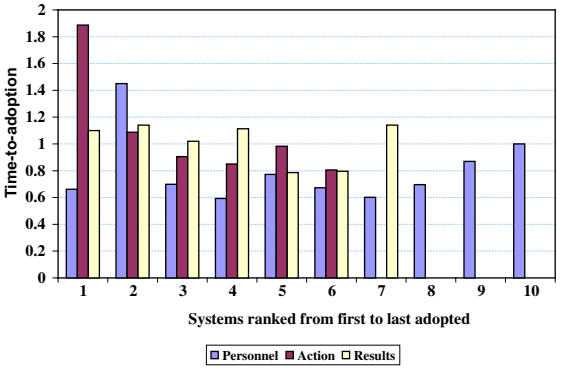

Fig. 3. Time between adoption of successive management control systems.

Fig. 3 reports the average time-to-adoption for the sequence of management control systems within each category—personnel, action, and results. The first action control takes the longest to become formalized (1.9 years compared to 0.7 for personnel and 1.1 for results). Otherwise, the pattern is not clear-cut but suggests that the time-to-adoption decreases initially and then increases.

Table 7 presents the results of the multivariate analysis. The coefficient for *Numper* for the personnel control model is less than one. This result indicates that the more personnel control systems are already implemented, the longer the time-to-adoption of a new personnel control system. In other words, personnel control systems behave as supplements of each other; the value of an additional personnel control system decreases with the number of personnel systems already adopted. Also, the number of action and results control systems has no significant impact on the adoption of personnel control systems. For the action control model, *Numper* has a coefficient larger than one. This finding suggests that the existence of personnel control decreases the time-to-adoption of action control; thus action and personnel controls complement each other. Thus, the value of action control seems to increase the more personnel control systems are present. *Numact* and *Numres* are both significant and less than one, indicating that their presence delays the time-to-adoption

[25] This interpretation is only approximate because the definition includes a Δ in the denominator.

Table 7
Time-to-adoption of sequential management systems

	Personnel control		Action control		Results control	
	Hazard ratio	*z*-Statistic	Hazard ratio	*z*-Statistic	Hazard ratio	*z*-Statistic
LnSize	1.00	−0.06	1.04	0.74	0.90	−1.47
VC	1.11	0.80	1.31**	2.02	1.40***	2.08
NewCeo	0.99	−0.04	1.12**	2.00	0.84	−1.08
Numper	0.91**	−2.05	1.12***	2.74	1.05	1.04
Numact	0.96	−0.75	0.76***	−4.21	0.92	−1.24
Numres	1.04	0.80	0.88***	−2.33	0.79***	−3.68
Industry						
Semicond.	0.92	−0.42	0.65	−1.63	0.83	−0.74
Telecom.	0.86	−0.96	1.19	1.05	0.94	−0.33
Medical	0.91	−0.50	0.95	−0.29	0.83	−1.00
Manufact.	0.80	−0.87	1.14	0.37	0.94	−0.16
Strategy						
Innovation	0.94	−0.36	0.88	−0.65	0.81	−0.97
Enhance	0.90	−0.53	0.68	−1.50	1.02	0.07
Hybrid	1.23	0.89	1.03	0.14	0.89	−0.44
Cost	0.50	1.51	0.63	−1.25	0.78	−0.63
Parameter p	0.65***	−10.77	0.76***	−6.03	0.75***	−5.30

The model estimates time-to-adoption between consecutive personnel, action, and results control systems. For the first system, the time-to-adoption is time since founding. The hazard function follows a Weibull specification: $h(t) = p * t^{p-1} * \exp(\beta_i * x_i)$. *LnSize* is the natural logarithm of size, *VC* is a dummy variable that takes value of one if the company received venture capital funds, *NewCEO* is a dummy variable that takes value of one if the founder is not CEO anymore, *Numper* is the number of personnel control systems in place at the time the new system is adopted, *Numact* is the number of action control systems in place at the time the new system is adopted, *Numres* is the number of results control systems in place at the time the new system is adopted. Significance tests are one-tailed for *LnSize*, *VC*, and *NewCeo*, two-tailed otherwise. *, **, ***, indicate significance at the 10%, 5%, and 1%.

of a new action control system. [26] The presence of venture capital, as well as the hiring of a new CEO, decreases the time-to-adoption of action control systems. This suggests that these investors, who get involved closely with the management of the firm, and new CEOs hired to move the company forward, view action control as useful to managing the organization. Finally, for the results control model, *Numres* is less than one, reinforcing the idea that the existence of systems with similar characteristics increases the time-to-adoption of systems within the same type. In this last model the coefficient for *VC* is significant and larger than one, indicating that the presence of venture capital reduces the time to adoption of results control. Finally, the effect of time (parameter *p*) also negatively affects the adoption of new systems; in other words, the longer the time since the last system was adopted, the less likely is that the company will adopt a new system.

These results indicate that the presence of management systems classified within the same type have a negative impact on the time-to-adoption. Otherwise, only action control is affected by the adoption of other types of controls; in particular the presence of personnel control reduces the time-to-adoption while results control increase it.

A final set of descriptive statistics examines which MCS are adopted earlier. For each company, each system is ranked from the first system adopted (1), second (2), and so forth. On average, results control systems have the lowest rank (mean of 6.65) and this mean is significantly smaller than

[26] A further analysis of the data (not reported) indicates that the presence of venture capital drives the significance of results control (*Numres*) in the action control model. An interaction term combining *VC* and *Numres* was included to the action control specification and was less than one and significant (*VC* remained significant and *Numres* became insignificant). This finding suggests that the presence of venture capital drives the influence of results control on the adoption of action control.

that of personnel control (mean of 7.41) and action control (mean of 7.73). [27] This finding suggests that result control tends to be adopted earlier than the other types of control. Table 8 provides the mean rank for the 23 MCS considered in this research.

The systems adopted first include: stock options, legal agreements about intellectual property/non-competition, skill-based pay and regular company-wide sponsored social events. Pair-wise comparison of means for these four systems is not significant; however, Wilcoxon pair-wise rank tests indicate a significant difference between "stock options" and "regular company-wide sponsored social events." Interestingly, these four systems include personnel, action, and results controls.

Table 8
Ranking of management control systems' adoption

	Management control system	Mean ranking
R1	Stock options	3.72
A1	Legal agreements about intellectual property/non-competition	3.89
R4	Skilled based pay	4.00
P1	Regular company-wide sponsored social events	4.54
P2	Regular company-wide meetings	5.31
P7	Background check on prospective employees	6.52
R2	Written performance evaluations	6.99
A3	Standard performance evaluation form	7.19
P3	Employee orientation program	7.24
P5	Standard employment application	7.44
R7	Profit sharing	8.07
R3	Individual bonuses	8.09
R5	Non-monetary recognition awards	8.18
A2	Organizational chart	8.19
P4	Mission or values statement	8.26
P6	In-house training	8.38
P8	Human resources information system	9.27
A4	Personnel manual or handbook	9.38
A6	Written affirmative action plans	9.76
A5	Written job descriptions	10.20
R6	Team incentives or bonuses	10.63
P10	Employee suggestion system	10.67
P9	Newsletter or other regular company-wide correspondence	11.92

The table reports the mean rank for each MCS. A pair-wise difference in means larger than 1.30 (1.70) is significant at the 10% (5%) level.

Discussion and conclusions

Understanding the emergence of formal MCS is important to managing growing firms (Moores & Yuen, 2001). An informal approach to the coordination and control of organizational activities becomes harder (and costlier) as the organization grows and formalizing these management activities becomes vital for future growth. The paper identifies an empirical association consistent with the predictions advanced in the theoretical literature. In the early stages of the growth of an organization, size is consistently presented as a key driver of the emergence of control systems. Consistent with this prediction, the results provide evidence on the relevance of size as an explanatory variable. An interesting and unexplained pattern is the association between the percentage of MCS adopted and size. This percentage increases for firms up to a size of 34 people, then it flattens and only starts increasing again when the size of the organization reaches around 75 people.

The evidence is also consistent with age being a relevant variable in explaining the emergence of MCS. Age is argued to be relevant through its impact on the variation, selection, and retention processes where the experimentation and learning of an organization is codified over time into formal management systems.

The findings are also consistent with arguments suggesting that the replacement of the original founder by a new CEO has a positive impact on the emergence of MCS. Further analysis indicates that this effect is only significant for smaller firms. In other words, the replacement of the founder is linked to the emergence of MCS only for companies that are more likely to need these systems. Founders in these companies may not be able to manage the transition into a more structured organization and a new CEO needs to be brought in to manage the transition.

[27] The mean rank for personnel and action controls is not significantly different.

A similar effect is empirically unveiled for the presence of venture capital; this result suggests that these investors may transfer their management experience to the companies they invest in, and perceive the early adoption of management control systems as useful to the growth of the firm. Finally, industry—potentially proxying for environment or production process—and strategy are relevant to the phenomenon.

Interestingly, the pattern of behavior across personnel, action, and results control systems is very similar. All the explanatory variables affect the adoption of these systems except for the effect of the replacement of the founder on action control's adoption and venture capital upon personnel control. Such consistency suggests that similar forces affect the adoption of all management control systems. However, the research design did not allow discriminating among these different forces—for instance, the relevance of learning versus the relevance of complexity.

This study provides preliminary evidence on the emergence of management control systems, and future research can fruitfully expand these results. First, the study is limited to management control systems to manage human resources and high technology firms; it is not informative about the evolution in non-tech firms, or in other parts of the company, in particular at the top management level. A follow-up study could take a broader perspective and investigate the emergence of MCS to fulfill the planning and monitoring needs of the company or, more broadly, their role in the formulation and implementation of strategy. Planning in these companies has proven to be relevant to pace their evolution (Gersick, 1994), but both theory and empirical evidence are scant on this issue. Furthermore, the study focuses on particular systems; an alternative approach that has been previously used in the literature (Chenhall & Morris, 1986) is to abstract from particular systems and focus on the characteristics of these systems. For example, Moores and Yuen (2001) study how the mix of information, the aggregation and integration of the information, its scope and its timeliness change across life-cycle stages; but they do not address what variables drive these changes.

Second, the study documents the relevance of size as well as age and suggests why these variables are relevant; however, it fails to identify how these variables act in organizations. For example, how do growing firms identify their need to adopt MCS? Is it due to process breakdowns? Is it through managers' past experience? Do customers or partners require them? Is it prompted by the need to prepare for an event like an IPO? It is possible that more experienced entrepreneurs or entrepreneurs with large company experience are more likely to adopt MCS faster. Another alternative to develop these systems is to hire a person—such as an HR manager or a CFO—that knows about them and implements them. Furthermore, external influences, not only venture capitalists, but also partners or customers may affect the emergence of MCS. Also the particular circumstances of the organization may require earlier adoption of these systems—for instance, organizations facing cash constraints or evolving business models may rely on structured systems that facilitate the processing of information.

The study also fails to identify where the knowledge to design MCS comes from. Does it come from managers' experience? From the board of directors? Or from trial and error? These questions are important to advancing our knowledge, and the current study is silent about them. Extending the current study to non-technology firms also adds to the research agenda. Field study research could be used to answer these questions and potentially build a new theory that conceptualizes the process of MCS emergence.

Third, as companies grow, the theory indicates that organizational structure becomes a key variable to explain the emergence of new management control systems. Existing literature has looked mostly at the role of organizational structure in cross-sectional models but not from a longitudinal perspective. Finally, the study ignores performance—a traditional variable in contingency research. Including this variable can be informative in evaluating whether formalization of the coordination and control processes is

appropriate and, if so, at which stage is it most appropriate.

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Appendix A. Management control systems' questions

IV. *Documents and procedures*

Listed below are various types of human resources documents, practices and systems which an organization might have. For each item that your organization currently has, please indicate when it was created and the last time it was significantly modified. (*Check the "Not Applicable" column if your firm does not have the item.*)

Documents	Not applicable	Month/year developed	Month/year last modified
Mission or values statement			
Organization chart			
Standardized employment application			
Written job descriptions			
Personnel manual or handbook			
Written employment tests			
Written performance evaluations			
Standard performance evaluation form			
Written affirmative action plans			
Standard employment contract for exempt employees			
Employee grievance or complaint form			
Legal agreements about intellectual property/ non-competition			
Regular employee morale survey			
Newsletter or other regular company-wide correspondence			
Systems and practices	**Not applicable**	**Month/year developed**	**Month/year last modified**
Human resources information system			
Company-wide electronic mall			
Employee suggestion system			
Employee involvement programs (e.g. quality circles)			
Background checks of prospective employees			
Employee orientation program			
Job rotation program			
In-house training			
Regular company-wide meetings			
Regular company-sponsored social events			

Appendix B. Testing for the interaction between age

	MCS		Personnel control		Action control		Results control	
	Coefficient	*z*-Stat	Coefficient	*z*-Stat	Coefficient	*z*-Stat	Coefficient	*z*-Stat
LnSize	1.17***	3.41	1.19***	2.65	1.19***	3.37	1.14***	2.34
VC	1.39***	3.62	1.38***	2.64	1.48***	3.86	1.35***	3.17
NewCeo	1.17***	2.69	1.19***	2.34	1.08	1.21	1.21***	2.86
Age	1.13***	2.81	1.16**	1.97	1.14***	2.93	1.08**	1.78
*Age * size2*	0.99***	−0.25	0.95	−0.76	1.02	0.51	1.02	0.48
*Age * size3*	0.96	−0.99	0.93	−0.96	0.97	−0.71	0.99	−0.29
*Age * size4*	0.94*	−1.29	0.92	−1.06	0.96	−1.04	0.97	−0.70
*Age * size5*	0.93*	−1.41	0.91	−1.12	0.95	−1.13	0.95	−0.89
Industry								
Semicond.	0.88	−1.16	1.03	0.20	0.66***	−3.12	0.91	−0.82
Telecom.	0.94	−0.72	0.87	−1.26	0.93	−0.82	1.05	0.64
Medical	0.82***	−2.49	0.87	−1.35	0.84**	−1.97	0.73***	−3.75
Manufact.	1.78***	5.01	2.19***	6.03	1.74***	4.04	1.36*	1.84
Strategy								
Innovation	0.85	−1.74	0.84	−1.47	0.85	−1.86	0.87	−1.43
Enhance	0.91	−0.85	1.00	0.02	0.79*	−2.09	0.92	−0.76
Hybrid	0.92	−0.86	0.93	−0.58	0.93	−0.80	0.90	−0.96
Cost	0.69**	−2.28	0.65**	−2.28	0.53***	−3.58	0.95	−0.28

and size for different firm sizes

The table reports the Poisson regression for the pooled data, controlling for potential autocorrelation of error terms for observations from the same firm. The coefficients reported are the incidence rate ratio (e^{β}). *Size1* takes value of one if the company belonged to the smallest portfolio in Fig. 1 when the CEO was replaced, *size2* if the company belonged to the second portfolio, *size3* if the company belonged to the third portfolio, *size4* if the company belonged to the fourth portfolio, and *size5* if the company belonged to the largest portfolio. *, **, *** indicate significance at the 10%, 5% and 1% respectively; one-tailed for *LnSize*, *VC*, *NewCeo*, *Age*, and *interaction terms*, two-tailed otherwise. The reference strategy is market leadership and the reference industry is computer. Chow test indicates that industry and strategy variables are jointly significant ($p < 0.01$) in all regressions.

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