MCS Configurations and Efficiency in Mechanical Engineering Firms: An empirical evidence based on stochastic frontier analysis ☆

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Abstract

Although recent years have witnessed a growing interest in studying broader management control system configurations, it has been difficult to assess the outcomes of various control choices. Using firm overall financial performance as an indicator of control configuration effectiveness is questionable as there are many other factors in addition to MCS configuration that has an impact of firm financials. Assessing quality of MCS against control problems those systems are to deal with is equally difficult in large empirical studies. This study contributes to this discussion by showing how stochastic frontier method can be applied to empirically assess the performance effects of archetypal control configurations. The research focus on a single industry, mechanical engineering, in one country, where we collect data from a cross-sectional sample of 242 medium sized firms. We identify control configurations in use, assess their efficiency and address the interplay of formal and informal controls After controlling for heterogeneity of firms as well as number of contextual factors, firms in the decentralized control mode appear more efficient than firms relying on centralized control. Based on our empirical analysis we develop a theory of efficient management control configurations for medium sized mechanical engineering firms. Implications of findings for both research and practice are discussed.

Keywords: Management Control, Control Package, Configuration theory, Efficiency, Stochastic Frontier Analysis

1. Introduction

Recent years have witnessed a growing interest in studying broader management control system configurations. As we do not have a solid theory base to develop hypothesis regarding what type of control configurations are likely to exist in different circumstances, this emerging research has been mainly explorative in nature, aiming to identify configurations of controls used in practice (Bedford and Malmi, 2015; Bedford et al., 2016; Kruis et al., 2016). What is difficult to address is the outcomes or effectiveness of these observed configurations. Already in medium sized firms there are number of controls in use, addressing various control problems. Hence, in large sample studies relying on conventional statistical methods, it is difficult to judge how optimal a certain configuration is by assessing its control outcomes. Similarly, using firm level financial indicators as a proxy for MCS quality is questionable as profitability of a firm is a factor of so many other things than control system design (Grabner and Moers, 2013). However, if the aim is to develop theories of effective control configurations, we need ways to assess the relative effectiveness of observed configurations. The aim of this paper is to develop a theory of effective control configurations to medium sized mechanical engineering firms. We focus our efforts on one specific industry, and medium sized firms in that industry, as we assume different types of firms with different contextual and organizational characteristics are likely to use somewhat different control configurations. First, we identified two main control archetypes in use, hybrid and interpersonal. In this study we assess whether different emphasis on results, centralizationand socio-ideological controls within these archetypes are associated with firm efficiency. In other words, we assess if one or more types of controls alone, or together, within these broader control archetypes, is associated with firm efficiency. We also assess whether one of these control archetypes could be regarded as more effective in driving firm efficiency. To assess firm efficiency we apply stochastic frontier analysis (SFA). The use of frontier analysis is quite popular in

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economics, management science, and engineering (Banker et al., 1987), but relatively seldom used in management accounting (Deville et al., 2014; Malmi, 2016). Frontier analysis assesses performance against best practice among studied organizations and allows the assessment of relative productivity of each unit. It has been suggested that Stochastic Frontier measures are crucial indicators of non-financial performance (Callen et al., 2005; Deville et al., 2014). Devinney et al., 2010, pg. 922 argue "Performance measures based on the frontier produce controllable indicators"[1] Our results suggest that firms employing hybrid control archetype achieve greater firm efficiency when they emphasize both results and socio-ideological controls, but suffer lower firm efficiency when emphasis is both on results and centralization controls. Firms employing interpersonal control archetype achieve greater firm efficiency simply by relying on centralization controls. Changes in emphasis on results or socio-ideological controls do not affect firm effectiveness among firms applying this archetype. Overall, firms relying on hybrid archetype are more efficient compared to firms relying on interpersonal control archetype. Our paper makes the following two contributions to the literature. First, we develop propositions, or theory, of effective control configurations for medium sized mechanical engineering firms. Second, we demonstrate how SFA can be applied to assess firm effectiveness in studies addressing multidimensional and complex control configurations. The remaining paper is organized as follows. Section two provides a brief literature review. Section three describes research methods. Results are presented in section four, followed by discussion and conclusion in section five.

2. Literature review and research question

2.1. Management control configurations

It is generally recognized that in contemporary organizations a number of MCS exists and those various systems may form a one large system, or operate as a package of more or less interrelated systems (Malmi and Brown, 2008). Abernethy and Brownell (1997) claimed that without interplay between different control mechanisms, our understanding of MCS will remain "piecemeal". So far as, researches limited their attentions to individual effects of one type of control without dealing the interaction effects among them. These studies misleading results and could bring weak prescriptions about how control affect the performance (Davila et al., 2009a; Helsen et al., 2017; Malmi and Brown, 2008; Sandelin, 2008). Few empirical studies address the way how multiple controls combine within specific contextual variables (Bedford and Malmi, 2015; Bedford et al., 2016; Cravens et al., 2004; Goebel and Weißenberger, 2017; Jaworski et al., 1993; Kruis et al., 2016).

Jaworski et al. (1993) based on Jaworski (1988)' framework, demonstrated by a survey of 379 marketing' firms, the existence of four combinations of controls (formal and informal): traditional bureaucratic, with a primary emphasis on formal control; clan systems, with a primary emphasis on informal control; low control systems and high control systems. They also explored contextual variables able to predict them. The results indicated that task complex predict the configurations in use.

Cravens et al. (2004) following Jaworski et al. (1993)' approach, explored how sales organizations combine in setting control configurations and their impact in term of individual salesperson consequences (job satisfaction, role ambiguity and conflict, salesperson performance). Their findings display four control configurations: high (high formal, high informal), bureaucratic (high formal, low informal), clan (high informal, low informal), and low (low formal and informal). Findings suggest that in high control, salespeople perform better, are more satisfied, and reveal lower role stress, than others control combinations.

Bedford and Malmi (2015) employed the cluster analysis techniques suggest five different control configurations:
i) simple control, characterized by informal centralized control, some use of diagnostic control, limited involvement of subordinates and interpersonal, direct supervision, as well as high emphasis on personnel selection; ii) results control, marked by a great emphasis on diagnostic control and performance-based compensation; iii) action control, based on centralized authority, direct mentoring and restricted autonomy of subordinates; iv) devolved control, where the reliance is on socialization processes and social control with a low emphasis on standards and performance targets; v) hybrid control, characterized by a pattern of multiple control types. A bureaucratic structure based on intensive application of accounting tools co-habits with delegation of the authority, lateral integrative devices and socio-ideological

[1] Deville et al., 2014, pg. 31 "controllability principle argues that performance should be evaluated on the basis of factors that are within the control of the decision maker (endogenous) that capture the empirical multidimensional nature of performance without any reliance on arbitrary aggregation"

controls. Contextual factors indicate that: simple control is mainly observed in small size, non-listed firms characterized by both an imperfect understanding of transformation processes and a low outcome measurability. Results control is associated with more predictable and stable environments; otherwise, action control firms are found to face in more unpredictable, turbulent, and hostile context. Devolved control can be referred to large organizations that facing unpredictable and turbulent environment with an emphasis on innovation; hybrid control is consistent with high values of administrative technology, also size, age, innovation and customer focus show to be the most important contextual factors in this configuration.

Kruis et al. (2016) based on levers of control framework (Simons, 1994, 1995) provided evidence about four control configurations: i) strategic vigilance, firms in this cluster made high emphasis on all levers, compare to the other clusters (beliefs, boundaries, diagnostic, interactive), and control appears to be tight and intensive; ii) strategic exploitation, the firms score high on boundaries, with centralized power and limited involvement of subordinates; iii) strategic responsiveness, whose members emphasize belief and interactive controls, but less intensively compare strategic vigilance's cluster; iv) strategic stability, characterized by relatively loose controls with relatively low emphasis on each of the four control levers (compared to other configurations). Within the cluster the focus is on diagnostic controls tied to a strategy as a plan. The desire to innovate is weak.

Looking at the contextual factors, the authors argued that: in strategic vigilance, goal clarity and measurability are the main variables that predicted cluster membership; firms comprised in the strategic exploitation cluster could be predicted mainly by high uncertainty and centralization power; strategic stability is related to firms with a low outcome measurability, so as the initiating structure style of leadership. Also, contextual variables that mark strategic stability, are low-initiating structure style of leadership and low levels of uncertainty.

The Authors also seek to investigate the link between patterns of balance and performance. Performance is conceptualized as the capacity to search for new strategic capabilities. They find the highest level of performance within the strategic vigilance cluster where organizations tend to be ambidextrous, being able to manage short term demand and to adapt to the changing environment.

Bedford et al. (2016) investigated the link between control configurations and effectiveness in defender and prospector firms. The performances refers to firms' effectiveness in terms of: goal alignment; adaptability; and integration. The results highlighted how multiple MC [management-control] packages are equally effective. The authors claimed that strategy represent a boundary for the control combinations alternatives and also the compliance of different MC practices affect the effectiveness of different control choices . Defenders are more effective, combining mechanistic structural controls with a diagnostic use of accounting. For defenders, mechanistic structural controls and measure diversity seem to be substitutes. Prospectors increase performances through organic structural controls with an interactive use of accounting. The differences in the studied management controls and the selected contingent variables make these contributions difficult to compare. Moreover, the performance is achieved in different way, it is a further factor that affect the results' comparability of the study above.

Previous research on SMEs has focused mainly on individual effects of singles type of control without dealing their interaction as holistic point of view. (Aureli, 2014; Benjaoran, 2009; Carlson et al., 2006; Duréndez et al., 2011; Garcia Perez De Lema and Durendez, 2010; Reheul and Jorissen, 2014; Wijewardena et al., 2004). An important line of research studies focus their attention on entrepreneurial strategies to the design of management control systems (Davila and Foster, 2007a; Davila et al., 2009a; Davila, 2005; Granlund and Taipaleenmäki, 2005; Merchant, 1998; Wijbenga et al., 2007)

Only one study, addressed the performance effect of MCS interplay in SMEs. Voss and Brettel (2014) explore the way a set of human resource management practices such as selection and training, job complexity design and resource provision - tagged as personnel controls (Merchant and Van der Stede, 2003) - influence the effectiveness of formal and informal management controls.

The various contributions are very difficult to be compared due to three main limitations: different management controls framework, different contextual factors, and also, different performances measures that they employed. No ones of studies' control addressed the links between performances and MC-configurations. Preview research focus on which MCS interplay drive firms' performance, without addressing control archetypal in use. This is the needed of future research.

2.2. *Efficiency measures*

In management accounting research the most commonly used organizational performances it's based on perceptual measurement of respondents (usually refers to effectiveness goal-approach) (Merchant and Van der Stede, 2007). However, measures by objective-data was widely applied (mainly by through financial indicators) (Bisbe and Otley, 2004; Grabner and Moers, 2013; Langfield-Smith, 1997; Otley and Berry, 1980). To date, there is no clear agreement on what performances are the most appropriate in accounting studies. Using different measures to asses the same concepts, the risk is to obtain research with findings difficult to compare. Several authors summarized the main issues relating to these indicators.

Financial performances involves a great range of factors other than MCS design or use, so a wide level of random noise and endogeneity bias can be predict (Grabner and Moers, 2013). Moreover, financial performance has been considered to be a contingent variable (Bisbe and Otley, 2004). Lastly, "financial performance, usually not take into account statistical characteristics of performance and ignored the extent to which these characteristics affect their findings " (Devinney et al., 2010, p. 923).

Perceptual measurement refers to subjective assessment of performances by respondents (Merchant and Van der Stede, 2007; Venkatraman and Ramanujam, 1986). The goal of this approach is to build a single variable, as a linear combination of different covariates based on self-assessment of survey' respondent. The main limitations of these performance measurements is that evaluations by themselves or their organizations, steadily overestimates the performance level in the organization (This depend mainly by "common source bias", that exists when "systematic error variance shared among variables measured with and introduced as a function of the same method and/or source" (Merchant and Van der Stede, 2007, p. 469); (Richardson et al., 2009, p. 763)

Devinney et al. (2010, p. 4) claims that "the exact measure is represented without a strong theoretical relationship to the phenomenon of interest".

Another objective-data measurement is technical efficiency, seldom applied in accounting literature in the past. The efficiency measurement defines performances as business outcomes. Based to microeconomics theories on production functions it refers to relations between resources involved (input) to achieve outputs. Technical efficiency is an important issue in Economics field, but now, its relevance is rising in accounting literature too (Banker et al., 1987; Banker and Johnston, 2007; Banker et al., 1989; Banker and Johnston, 1993; Bromwich, 2006; Callen et al., 2005; Deville et al., 2014; Devinney et al., 2010).

Bromwich, 2006, pg. 139, observed that, the objective of micro-economic approach is to seek the optimal organisation of production, consumption and exchange. This objective is central to management accounting when it seeks to maximise profits and networth.

Deville et al. (2014) claims that efficiency score approach by frontier analysis brings several important advantages. First of all, it provides a performance measurement system that is a perfect match for the contingency theory. Both vertical and horizontal coherences are key features of this approach. The vertical coherence allows efficiency to take account of the hierarchical structure of an organisation, while the horizontal coherence is a relative indicator which only takes into account homogenous and comparable companies that use a bench-marking approach. The second advantage stays in the principle of controllability since efficiency score captures the empirical multidimensional nature of performance avoiding arbitrary aggregations.

Callen et al. (2005, p. 275) argue that "productivity is a key corporate objective, and by the potential importance of productivity measurement for monitoring operations and for identifying opportunities to improve operations in the automotive parts manufacturing industry".

In line with the above, frontier analysis through Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis. (SFA) are methods widely used in Economics fields. The examples in Economics literature are very extensive. Several journals widely deal on efficiency measurement (e.g., Journal of Productivity Analysis, Journal of Econometrics, European Journal of Operational Research, Empirical Economics) (Kumbhakar et al., 2015).

In Management Accounting this method is not common, but such research do exist.

Mensah and Li (1993) measure firms' inefficiencies by DEA and SFA in order to study the link between performances and long – short term objectives of budgeting. Callen et al. (2005) studied the performance effect of Just In Time (JIT) adoption by Stochastic Frontier Analysis (SFA) with a Cobb Douglas production function and Battese and Coelli (1988) specifications, in a sample of 61 manufacturing firms in Canada. Ho et al. (2011) shown how Management Control Systems affects efficiency and quality performances by applied SFA in a sample of non-profit

organisation in Taiwan. Chen (2007) used SFA with Battese and Coelli (1995) specification and Cobb-Douglas production function to estimate hotel cost-efficiency in 55 international tourist hotels. They finding demonstrated that hotel operations and management plays a relevant role to determine a hotel's profitability. Malmi (2016, p. 36) reviewed several accounting studies in MAR and JMAR using Data Envelopment Analysis (DEA) approach, as measure of technical efficiency, including: Banker et al. (1998); Deville (2009); Deville et al. (2014); Gietzmann (1992); Halkos and Salamouris (2004); Turner (1990).

However, no ones preview works use frontier analysis to study the performance effect of control configurations.

Actually, DEA compared to SFA suffers some limitations (Carson et al., 1999; Cook and Joe, 2005; Greene, 2008). "Main disadvantage is that it is a non-parametric method, absent a more detailed specification, consistency of the estimates cannot be verified, nor, as such, can consistency of the inefficiency estimates" Greene, 2008, pg. 109 and the process is sensitive to outliers (as these are extreme). SFA is not without limitations too. The main issue is that being a parametric model it needs to assume a priori that production function has specific functional form (Bogetoft and Otto, 2011).
Taking into account the methodological advantages that SFA method provides (Greene, 2008), our study considers it as the best possible way to estimate technical efficiency.

More formally the research questions addressed in this paper are:
RQ1: What are the interplay between Management Control Systems and efficiency (within effect)?
RQ2: What is the performance effect of archetypal control configurations (between effect)?

3. Research method

3.1. Construct measurement

Table 1: Variable definitions

Variable	Description
Planning control	
strategic planning	Mode to implement strategic planning process. Refers ends and means in range from formal, deliberate quantified and detailed to informal, broad, not quantified and emergent (Bedford and Malmi, 2015; Brews and Hunt, 1999; Mintzberg, 1994)
Measurement	
Diagnostic control	use of budget and financial or non financial measures of performance for: Monitoring activity through deviations from preset standards of performance (Dyson and Foster, 1980; Green and Welsh, 1988; Malmi and Brown, 2008; Simons, 1995; Widener, 2004)
Interactive control	use of budget and financial or non financial measures of performance for:Regular involvement in subordinate activities by management to encourage debate, creative behaviours and address strategic uncertainties (Bedford and Malmi, 2015; Bisbe et al., 2007; Janke et al., 2014). SMEs: (Dyson and Foster, 1982, 1980; King et al., 2010; Shrader et al., 1989)
Compensation	
Performance based compensation	level of use of Performance-contingent rewards and incentives (de Grip* and Sieben, 2005; Hayton, 2003)
Structure	
Centralization	authority centralized – decentralized (Bedford and Malmi, 2015; Bruns and Waterhouse, 1975; Hayton, 2003)
Socio–ideological	
Input control	selection and training procedures (Bedford and Malmi, 2015; Snell, 1992)
Belief Systems	Statements communicating the basic values and premises for action of the firm (Bedford and Malmi, 2015; Simons, 1995)
Social control	share norm and expectation and extent the commitment to firm objective and value are adaptation (Bedford and Malmi, 2015; Kober et al., 2007; Simons, 1995)

MC measurement based the contribution of Bedford and Malmi (2015) (see AppendixB) employing the same items but excluding some of them for multicollinearity bias affecting estimates of OLS models (communication, hiearchy,

integrative Liaison Devices and boundary system).
The choice of eliminating variables which attain the administrative control system (with the exception of the centralization) is in line with the main previous literature on medium-sized enterprises (Davila et al., 2009b; Davila, 2005; Green and Welsh, 1988; Jaworski, 1988; Merchant and Van der Stede, 2003; Snell, 1992; Voss and Brettel, 2014). This is resonable since these organizations are generally characterized by a) strong and concentrated ownerships often of family type which refuses to delegate power to professional and independent managers (Corbetta and Montemerlo, 1999; Daily and Dollinger, 1992; Feltham et al., 2005); b) owner-managers control styles settled on personal interactions with subordinates (Davila, 2005; Sandino, 2007); c) organizations settled on informal strategic and operative processes (Corbetta and Montemerlo, 1999); d) weak or absent informative systems to support the operative routines (Davila, 2005).
The control categories in the empirical analysis includes both formal and informal forms of control (detailed in Table 1). Strategic planning, measurement systems (diagnostic control and interactive control are more important), and compensation, as formals systems of control (Speklé, 2001), instead social-ideological mechanics and centralization can be either formal or informal (Davila, 2005; Kirsch, 1996a; Merchant and Van der Stede, 2003; Ouchi, 1979a)

Strategic planning will revolve around the development of long-term goals (ends) and patterns of action (means). The variable of interest refers to the specificity of both ends and means (strategic planning range). Ends and means rank from formal, deliberate quantified and detailed to informal, broad, not quantified and emergent (Brews and Hunt, 1999; Merchant and Van der Stede, 2003; Mintzberg, 1994; Ouchi, 1979b).
Measurement involves diagnostic and interactive control (Simons, 1995). Diagnostic controls are performances measurement utilized to measure the outputs of a process, set a standard, and measure deviations (Galbraith, 1973; Simons, 1995). Interactive control, are performance measurement used to personnel involvement in decision making through dialogue that encourages information sharing throughout the organization. (Simons, 1995, p.232).
Compensation refer to evaluation-reward process by financial rewards. (Flamholtz et al., 1985; Otley, 1999). We assessed both the extent to which firms rely on performance-based compensation and whether the method of determining individual compensation is objective or subjective in nature (Fisher, 1995; Flamholtz, 1983).

Centralization concerns the specification of roles and patterns of authority and communication within an organization. We addressed the extent of the centralization of decision making.

Socio-ideological controls can be either formal or informal. Managers use formal selection and training practices to try to ensure employees share common values and direction, and possess the skills and abilities needed to perform their tasks properly. These are also referred to as "personnel" or "input" controls (Snell, 1992, pg. 297). It's well known their effect on effectiveness of both informal and formal control in SMEs (Collier, 2005; Cravens et al., 2004; Davila, 2005; Jaworski, 1988; Kirsch, 1996b; Ouchi, 1979a).

Informal control are measured by cultural controls. Set of values, beliefs and social norms affect on behavior. Some authors have call these informal controls cultural, clan, or social controls. Social controls exert influence through normative and social pressures in organizations. They can either created without any managerial intentions or can be developed by managers to shape and manipulate employees' behaviors (Lange, 2008; Schein, 2010). Previous research demonstrated the importance of informal control forms in SMEs (Davila et al., 2009a; Davila, 2005; Voss and Brettel, 2014). We therefore assessed the extent to which shared norms guide behavior.

Variables included in the empirical analysis are detailed in Table 1 Each variables have been measured by multiple items using Likert-type from one to seven. Variables take the sum of the underlying item scores, and after are scaled and normalized in range 0 to 1 to minimize the effect of different measurement scales.

Each variables have been measured by multiple items using Likert-type from one to seven. Variables take the sum of the underlying item scores, and after are scaled and normalized in range 0 to 1 to minimize the effect of different measurement scales. AppendixC presents the measurements for each items. (Hair et al., 1998) method to interpret and validate the items. Unidimensionality is evaluated through factor loadings. Internal consistency is assessed by calculating Cronbach alphas. Factor loadings indicate that items load strongly on single factors (> 0.35) with satisfactory alphas (between 0.67 and 0.90). Confirmatory factor analysis (CFA) with maximum likelihood estimation in R is used throughout our study to explore "factor structure". We consistently find that the multifactor models fit the data well.

Because the primary motivations was to reduce construct complexity (due to large number of items that affect model estimations) and increasing the estimation model parsimony, a partial aggregation approach (Bagozzi and Edwards, 1998) was taken to represent multi-dimensional constructs. This means that each indicators was treated as

sums of all items within a component. For example, for the strategic planning dimension, one composite item was calculated as the sum (after normalized 0-1) of four original items.

Management control systems measurement come from Exploratory Factor Analysis (EFA). We used the factor scores to describe the emphasis on MCS variables. Principal component with Varimax rotation across the 8 management control items (see Table 1) was applied to examine the underlying dimensions and extracted factors with eigenvalues greater than 1. As reported in Table 2 ratings measured three MCS orientations (F): f1 representing result control, f2 Socio-ideological control and f3 centralization.

Result control is characterized mainly by use of formal decision-making, that involve extensive use of strategic planning, measurement systems (diagnostic control and interactive control are more important), and compensation (Speklé, 2001).

Socio-ideological controls capture the effects of formal and informal processes among employees, including input controls and cultural controls. Centralization refers specification of roles and patterns of authority and communication within an organization. High value of centralizations involve, concentrated decision-making power, limited involvement of subordinates and direct supervision.

All items load on their respective reflective constructs with factor loadings above 0.50 (Hulland, 1999)

Performances refers to technical efficiency, we estimated it by Stochastic Frontier Analysis (SFA). To conduct SFA we measured outputs these firms produced and inputs they used for these outputs. Output is measured by amount of value added (va) at the end of the year; labor input (L) is measured as the total number of employees at the end of the year; capital stock (K) in a given year is proxied by the nominal value of tangible fixed assets. All monetary measures have been deflated by the proper industry level index.

Additional factors come from a preview study on efficiency and managerial practices in SMEs (Bloom et al., 2008; Cucculelli et al., 2014) which identifies size, governance, ownership, partnership and education. An important additional variable in SMEs is family business that reflect firms controlled or owned by a family, which has high influences in firm's performance (Alattar et al., 2009; Bloom et al., 2008; Cucculelli et al., 2014; De Lema and Duréndez, 2007; Neubauer et al., 2013).

Table 2: Factor Analysis table

factor loadings for value ratings

Variable	f1	f2	f3	h2	u2	com
strategic planning	**0.77**			0.71	0.29	1.38
diagnostic control	**0.91**			0.87	0.13	1.12
interactive control	**0.83**			0.84	0.16	1.41
performance based compensation	**0.67**			0.62	0.38	1.72
centralization			**0.99**	0.99	0.01	1.01
input control		**0.76**		0.74	0.26	1.52
social control		**0.85**		0.82	0.18	1.25
belief systems		**0.83**		0.77	0.23	1.24
SS loadings	2.89	2.46	1.02			
Proportion Var	0.36	0.31	0.13			
Cumulative Var	0.36	0.67	0.8			
Cum. factor Var	0.45	0.84	1			

f1 = result control; f2 = Socio-Ideological control; f3 = centralization control
Three factors were extracted by means of principal analysis and rotated according to varimax.
Factor loadings < 0.40 are not shown.

3.2. Data collection

The firm level data on management controls was collected by a survey to Italian machine engineering industry. The population is composed of 1.221 medium sized enterprises (ME) with numbers of employees ranging from 50 to 250

and a turnover 10-50 million euros annually (or total assets from 10 to 43 millions of euros (European Commission, 2005).

A single industry was selected in order to minimise environmental heterogeneity (Dess and Davis, 1984). The machine engineering industry are known to be highly innovative and probably reflect high general growth rates. This strategy find support in many studies for several reasons: i) 'companies classified as manufacturing are more likely to develop MCS sooner. The nature of the manufacturing process (more R and D oriented) may itself lead to more rapid formalization compared to the other industries" (Chenhall, 2003; Davila, 2005, p. 235); to eliminate possible organizational differences due to value chain stage (Cravens et al., 2004, p. 244); iii) An additional explanation is that machine engineering industry are typically small or medium-sized companies characterized by entrepreneur-owners, who typically make great emphasis on MCS use (Granlund and Taipaleenmäki, 2005, p. 29); iv) Also, several empirical studies deal MCS in entrepreneurial context, that could bring a good results' comparability (Davila and Foster, 2007a; Davila et al., 2009a; Davila, 2005; Granlund and Taipaleenmäki, 2005; Merchant, 1998; Wijbenga et al., 2007).

The response rate was 30% (370), 128 with partial data, which have been eliminated. The final sample was 242 firms. Manova with Wilks' test was employed to check non-response bias comparing non-respondents to respondents across several financial accounts (Anderson et al., 1958). Results shown non statistically significant differences for total assets, sales, number of employees.

Survey protocol was performed over three months in 2015. Sample respondents are chief executive officers, general managers and operational managers, whose details were available in the AIDA database. Questionnaires were distributed and returned by e-mail, following Dillman's guidelines (Dillman, 2000).

Questionnaire was pre-tested through informal on-line meetings with 10 managers from different firms. Participants were informed of the anonymity of their responses and a synthesis of the findings was promised to them to ensure a high response rate. Initial phone calls were made to the whole population to verify that the respondents had appropriate knowledge and to stimulate their interest.

A four-step procedure was carried out (Dillman, 2000). First, a pre-notice letter was sent informing them about the research; second, surveys including a cover letter were sent out by email within one week; third reminder postcards were sent two weeks after initial mailing and finally a telephone call was made to non-respondents after two weeks of sending reminder postcards.

The assessment of efficiency is based on archival data. Balance sheet information is from Bureau Van Dijk's AIDA dataset (2011- 2014) and sectoral deflators for outputs and inputs used in SFA come from the Italian National Institute of Statistics (ISTAT).

3.3. Empirical Strategy

We first identified configurations in use in MEs by cluster analysis. These and environmental variables able to predict cluster membership are reported in AppendixB (provides a summary of that analysis). The results shows two stabile configurations, called hybrid controls and interpersonal controls. In order to assess the link between Management Control Systems and efficiency (RQ1) and explore which control configuration ensure greater efficiency in the ME industry (RQ2), three step analysis was conducted [2]. First, efficiency scores for all firms have been estimated applying Stochastic Frontier Analysis (SFA). In the second step, OLS regression models have been employed in both control configurations in order to study the relation between efficiency scores and Management Control Systems variables. Third, we used a Efficiency effect frontier (EEF) model (Battese and Coelli, 1995), to asses the performance effects of archetypal control configurations.

3.3.1. First step: Efficiency scores

Suggested by Aigner et al. (1977); Meeusen and van Den Broeck (1977) the stochastic frontier analysis (SFA) is widely used to estimate firm level efficiency scores. Stochastic frontier model can be written, in log-linear form, as: Stochastic frontier model can be written, in log-linear form, as:

$$y_{i,t} = \alpha + \beta x_{i,t} + \varepsilon_{i,t} \tag{1}$$

[2] All estimations and calculations are based on R Core Team (2017) and StataCorp (2015)

$$where : \varepsilon = v - \mu \tag{2}$$

Equations 1 and 2 combine to give:

$$y_{i,t} = \alpha + \beta x_{i,t} + v_{i,t} - \mu_i \tag{3}$$

where y represents output, x is a vector of input, the component v captures statistical noise and is assumed to follow a normal distribution centred to zero; μ is a non-negative term that reflects technical inefficiency. Technical efficiencies (TE) are usually defined as the ratio between the observed output (y) and the (individual) stochastic frontier output (y*) (Coelli et al., 2005, p. 244).
TE reflects the ability of a firm to produce the maximum level of output from a given set of inputs. When a firm is inefficient, it produces less than what is expected from the inputs used by the firm at the given technology. The objective is estimate the firms-specific TE indexes. The parameters of the model are estimated by the maximum likelihood (ML) method using the following distributional assumptions:

$$\mu_i \sim N^+(0, \sigma^2) \; or \; N^+(\mu, \sigma^2), \tag{4}$$

$$v_{it} \sim N(0, \sigma_v^2) \tag{5}$$

The estimation is usually performed via maximum likelihood (ML) methods to obtain consistent and efficient estimates of vector β and variance parameters σ_v^2 and σ_μ^2. Estimates of $\varepsilon_{i,t}$ it are directly recoverable as $\widehat{\epsilon}_{i,t} = y_{i,t} - \widehat{\alpha} - \widehat{\beta'} x_{i,t}$ and the estimator developed by Battese and Coelli (1988) can then be used to obtain estimates of the efficiency scores:

$$\hat{\mu}_{i,t} = E(exp(-\mu)_{i,t}|\varepsilon_{i,t}) = \left[\frac{1 - \Phi(\frac{\sigma_* - \mu_*}{\sigma_*})}{1 - \phi(\frac{-\mu_*}{\sigma_*})}\right] exp\left[-\mu_* + \frac{1}{2}\sigma_*^2\right] \tag{6}$$

where, $\sigma_* = \frac{\sigma_u \sigma_v}{\sqrt{\sigma_v^2 + \sigma_\mu^2}}$; $\mu_* = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_\mu^2}$; and $\phi(\cdot)$ and $\Phi(\cdot)$, denote respectively, the density function and the cumulative function of the standard normal distribution.
$TE_i = 1$ shows that the i-th firm obtains the maximum feasible output, while $TE_i < 1$ provides a measure of the shortfall of the observed output from maximum feasible output. A higher efficiency scored implies that the firm make better use of the resources at a given level of output.
The specification contained in Eq.(3) (Battese and Coelli, 1992) are based on assumptions that μ and v are homoskedastic. The panel data model of Battese and Coelli (1992) is somewhat restrictive because it only allows inefficiency to change over time exponentially. Furthermore, these models mix firm effects with inefficiency (Kumbhakar et al., 2014).
Greene (2005a,b) proposed two models, "true" fixed-effects (TFE) and "true" random effects (TRE), which treats firm-specific time-invariant heterogeneity and time-varying inefficiency separately[3]. The TRE model can be expressed as follows:

[3]Our decision to not include the TFE is motivated from some problems discussed by Belotti et al. (2013). The model TFE suffers the accidental parameter problem that emerges when the panel is at less then 10 years and also involved a computational difficulty due to large dimension of the parameter spaces involved. This leads in an inconsistent estimation of specific companies intercept that in turn influences the term inefficiency. Our dataset contains companies whose appearance varies from 1-4 years. Belotti et al. (2013) argue that these problems can be addressed by TRE model.

$$y_{i,t} = \alpha + \omega_i + \beta X_{i,t} + v_{i,t} - \mu_{i,t} \tag{7}$$

where ω_i is the random term which is specific to each firm and assumed to be uncorrelated with inputs, and the other variables and parameters are defined in Eq.(3)
However, if firm-specific effects are correlated with the vector of inputs, the TRE model may be subject to the heterogeneity bias. [4]
A useful solution for correcting the TRE model, accounting for this correlation, is to adopt the adjustment proposed by Mundlak (1978)[5], modelling the correlation of unobserved heterogeneity with regressors in an additional equations, as follows: (Abdulai and Tietje, 2007)[6]

$$\omega = \delta \bar{x}_i + \bar{z}_i \tag{8}$$

where:
$\bar{x}_i = \frac{1}{T_i} \sum_1^{T_i} x_{i,t}$, δ is the vector of parameters to be estimater, and it is assumed that $\bar{z}_i \sim N(0, \sigma_z^2)$.
Combine (7) and (8) as:

$$y_{i,t} = \alpha + \beta x_{i,t} + \delta \bar{x}_i + \bar{z}_i + v_{i,t} - \mu_{i,t} \tag{9}$$

The model used for estimate technical efficiency taking into account unobserved heterogeneity problem is "true" random effect with Mundlak's adjustment model (TREMU) . Also we compered TREMU model (section 4 provides more information on the model used to estimate efficiency scores) with different production frontier models. These include a pooled model (pool), the "true" random effect model (TRE), and Battese and Coelli (1992) model.
Our analysis employs translog production function. It can be specified as:

$$\begin{aligned} y_{it} =& \alpha + \sum_L \beta_L \cdot x_{Lit} + \frac{1}{2} \sum_L \sum_K \beta_{LK} \cdot (x_{Lit} x_{Kit}) \\ &+ \sum_n \delta_n \cdot \bar{x}_{Li} + \frac{1}{2} \sum_L \sum_K \delta_{LK} \cdot (\bar{x}_{Li} \bar{x}_{Ki}) \\ &+ v_{it} - \mu_{it} + \tau_t \end{aligned} \tag{10}$$

where:
y_{it} represents output (value added), x is a vector of input (L, K are number employees and fixed capital). We also control for time factors by including (t - 1) year dummies τ_t

3.3.2. Second step: MCS and efficiency

The OLS model use effectiveness scores as dependent variable, while MCS variables as independent variables. We run Exploratory factor analysis (EFA) to examine the underlying dimensions across the MCS variables (principal component with Varimax rotation. See Table 2) and extracted factors with eigenvalues greater than 1. We used the factor scores to describe the emphasis on MCS variables. As reported in Table 2 ratings measured three MCS orientations (F)[7]: f1 representing result control, f2 Socio-Ideological control and f3 behavioral controls.
Result control is characterized mainly by use of formal decision-making, that involve extensive use of strategic planning, measurement systems (diagnostic control and interactive control are more important), and compensation

[4]The term "heterogeneity bias" is used by Chamberlain (1982) to refer to the bias induced by the correlation between individual effects and explanatory variables in a general RE model.

[5]The application of Mundlak's adjustment in frontier models has been proposed by Farsi et al. (2005)

[6]In the case of a SFM, in which the composed error term is asymmetrically distributed, the heterogeneity bias may still exist, but only minimally, as the correlation between firms' effects and the explanatory variables is now taken into account in the model (Abdulai and Tietje, 2007, p.7).

[7]The process of interpreting the factors take into account the item(s) that have the highest loadings in the factor (Hair et al., 1998)

Table 3:
Descriptive statistics of efficiency conscruct
panel data: years 2011-2014

Statistic	Variable	Unit	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
va	Y	Thousands euro	960	7,265	5,193	−1,315	3,842	9,202	42,256
employee	L	Number	960	100	54.379	3.000	61.000	129.149	320.000
Capital stock	K	Thousands euro	960	4,039	4,469	−1,922	920.390	5,429.769	25,109
family business	FAMB	Dummy	960	0.467	0.499	0	0	1	1
manager degree	MANDE	Ratio	960	0.504	0.377	0.000	0.167	0.885	1.000
partnership	PARTN	Dummy	960	0.467	0.437	0.000	0.000	1.000	1.000

(Speklé, 2001).
Socio-ideological controls capture the effects of informal processes among employees, including input controls and cultural controls. Several authors (Davila, 2005; Kirsch, 1996a; Ouchi, 1979a) stand for the main informal control mechanisms by personnel controls and cultural controls (the construct are detailed in section 3.1).
Behavioral controls refers to high centralisation of powers, limited involvement of subordinates and direct supervision. Centralization reflect this mechanism (Bruns and Waterhouse, 1975; Speklé, 2001).
All items load on their respective reflective constructs with factor loadings above 0.50 (Hulland, 1999).
For the cluster C_i the OLS panel model can be written as:

$$\mu^{TREMU} = \alpha_0 + \omega_i + \theta(F) + \delta(Z) + \varphi(F)(F) + \varepsilon \tag{11}$$

Where: ω_i is a random term, α_0 intercept, (F_i) are a factor variables (f1, f2, f3) that representing Management Controls, (Z) are additional factors, and (F)(F) are interaction terms.

3.3.3. Third step: The performance effects of archetypal control configurations

To explore which control configurations ensure greater efficiency in machine engineering industry (RQ2), we used a model suggested by Stevenson (1980) and later extended by Battese and Coelli (1995) (see Table 8), including additional explanatory variables (C_i = MCS configurations) as observed heterogeneity.
Observable heterogeneity refers to measured variables. There are different models to treat observable heterogeneity[8] in stochastic frontier analysis. Usually additional variables Z are used to shift the production or cost function or shift the inefficiency distribution μ_i (Firm-specific heterogeneity). As explained above, it does not seem too reasonable to have different production functions for each configurations. However, it seems reasonable to assume that firms in a certain configuration have an average different efficiency than firms in others configurations. For the above reasons, we used the model of Battese and Coelli (1995) that takes into account this issues. Inefficiency term μ follows a positive truncated normal distribution with zero mean and variance σ^2, constant scale parameter and a location parameter μ that depends on additional explanatory variables Z.
The stochastic frontier production function to be estimated is:

$$y_i = \beta x_i + v_i - u_i \tag{12}$$

where[9]:
y_i represents output, x_i is a vector of input, v_i captures statistical noise.
$v_i \sim N[0, \sigma_v^2],\ \mu_i = |U_i|$

$$U_i \sim N^+(\mu_i, \sigma_i^2); with\ U_i = \mu_0 + \theta z_i \tag{13}$$

[8]For a complete review of heterogeneity in SFM see Greene (2005b, p.154)
[9]Input and output variables are as defined in the previous section

The random variable μ_0 follow a truncated normal distribution, and θ is an additional parameter (vector) to be estimated. Only if this parameter is significant, then the additional Z variable have effect on efficiency.

4. Results

After assessment of the adequacy of frontier model and some robustness checks, this section reports technical efficiences, using true random effect with Mundlak's adjustment (TREMU) as measure of technical efficiency. We then assess the link between Management Control configurations and efficiency, addressing first the interplay of formal and informal controls (RQ1), and then performance effects of archetypal control configurations (RQ2).

Table 4:
Descriptive data of MCS

Statistic	N	Mean	St. Dev.	Min	Max
Long-term Planning					
strategic.planning	242	0.6	0.2	0.0	1.0
Measurement					
diagnostic control	242	0.6	0.3	0.0	1.0
interactive control	242	0.5	0.2	0.0	1.0
Compensation					
performance based compensation	242	0.5	0.3	0.0	1.0
Structure					
centralization	242	0.5	0.3	0.0	1.0
Socio-Ideological					
input control	242	0.6	0.2	0.0	1.0
social control	242	0.5	0.2	0.0	1.0
belief systems	242	0.5	0.3	0.0	1.0

4.1. First step: stochastic frontier models

The estimation of the SFM is presented in Table 5 (see construct measurement in Table 3)
The λ parameter is 5.32, which means that inefficiency resides in the data, compared to average production function without inefficiency ($u_{it} = 0 \; for \; all \; i, t$).
After defining translog specification, we conducted robustness checks comparing different SFM. AppendixA summarizes the results of the pooled stochastic frontier (PSF); TRE and TREMU.
LR test is carried out on the various models in order to check the best one. Tests provide support for TREMU model. LR test and descriptive statistics on the estimated efficiency scores obtained via the Battese and Coelli (1988) estimator for the TREMU model are presented in Table 6.
First, we controlled for the adequacy of production function, comparing the translog (T-L) specification against the more parsimonious Cobb-Douglas (C-D) form: data supports T-L specification. LR test confirm Stochastic Frontier model is better than OLS (OLS vs Pooled Stochastic Frontier (PSF)). We then checked if panel structure is better then cross section forms by tested the significance of the vector of firms dummies α_i (PSF vs LSDV). LR test shows the significance of α_i and this means that panel structure provide better informations (model capture firms specific heterogeneity). In the end we tested the adequacy of TREMU model compared to TRE (TRE vs TREMU).

4.2. Second step: The impact of MCS on firm's technical efficiency

In order to investigate the relationship between firms' efficiency and MCS (RQ1), we start estimating Eq.(11), in which MCS and Z variables determines the technical efficiency by means of OLS. We run two OLS models, one for hybrid control cluster, and the other ones for interpersonal control cluster.
Interpretations of the results are based on cluster's features reported reported AppendixB. Models A and B refers

Table 5:
TREMU SFM

Dependent variable: lnY		
Variable	Coefficient	β / SE
ln L	β_l	-0.9352
		(0.8039)
ln K	β_k	0.8174***
		(0.2457)
(.5) $(lnL)^2$	β_{ll}	0.3979***
		(0.2245)
(.5) $(lnK)^2$	β_{kk}	-0.0858***
		(0.0333)
(ln K)(ln L)	β_{kl}	-0.0277*
		(0.0513)
Constant	α	4.0028***
		(0.5806)
Error parameters		
	σ_u	0.5835***
	σ_v	0.1095***
	λ	5.3243***
Year dummies	τ	Yes
Firms random terms	ω	Yes
Within-group means	δ	Yes
Log-likelihood		-511.8906
Observation		949

Complete table available from authors upon request
τ and δ estimates omitted to save space
Significance levels: * 10%, ** 5%, *** 1%

Table 6: Generalized LR tests on parameters of the SFA model and efficiency scores

Null hypothesis	Restricted vs. unrestricted	Conditions	χ^2 statistics	*Prob* > *chi*2 (5%)
Cobb-Douglas restriction	(C-D vs. Translog)	$\beta_{np} = 0$ and $\delta_{np} = 0$ for n,p = K, L	29.58	0.0000 ***
No inefficiency	(OLS vs. M1)	$\sigma_u = 0$	45.44	$4.193\ e-11$ ***
No firm dummies	(M1 vs. LSDV)	$\alpha_i = 0$	1100.8	$2.2e-16$ ***
No Mundlak term effects	(M3 vs. M4)	$\delta_i = 0$	29.58	0.0000 ***

Efficiency scores	Mean	SD	Min	Max.
μ^{TREMU}	0.6771	0.1896	0.0000487	0.9928

Table 7:
Interplay of Management Controls and their impact on Efficiency

Dependent variable: μ^{TREMU}		Hybrid control			Interpersonal control		
		A1	A2	A3	B1	B2	B3
		(OLS-RE)	(OLS-RE)	(OLS-RE)	(OLS-RE)	(OLS-RE)	(OLS-RE)
variable	Coefficient						
f1	θ_1	0.017	0.019	−0.004	−0.013	−0.011	−0.019
		(0.015)	(0.015)	(0.018)	(0.022)	(0.023)	(0.041)
f2	θ_2	0.025	0.019	−0.002	0.016	0.027	0.041
		(0.017)	(0.018)	(0.019)	(0.027)	(0.028)	(0.041)
f3	θ_3	−0.005	−0.002	0.014	0.022	0.028*	−0.007
		(0.016)	(0.016)	(0.020)	(0.016)	(0.016)	(0.033)
MANDE	δ_1		0.033	0.006		0.551	0.381
			(0.090)	(0.085)		(0.435)	(0.468)
(PARTN = 1)	δ_2		0.067*	0.070*		0.038	0.043
			(0.038)	(0.038)		(0.040)	(0.040)
(PARTN = 2)	δ_2		0.043	0.046		−0.024	−0.017
			(0.034)	(0.034)		(0.065)	(0.066)
(FAMB = 1)	δ_3		−0.056**	−0.062**		0.014	0.010
			(0.028)	(0.027)		(0.048)	(0.046)
ln L	δ_4		0.013	0.011		−0.033	−0.027
			(0.027)	(0.028)		(0.035)	(0.035)
$f1 : f2$	φ_1			0.035**			−0.005
				(0.016)			(0.032)
$f1 : f3$	φ_2			−0.033*			−0.002
				(0.017)			(0.015)
$f2 : f3$	φ_3			−0.003			−0.033
				(0.016)			(0.024)
Constant	α	0.650***	0.591***	0.621***	0.633***	0.756***	0.748***
		(0.018)	(0.112)	(0.118)	(0.042)	(0.157)	(0.167)
Random Effect trasformation	ω	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	τ	Yes	Yes	Yes	Yes	Yes	Yes
Observations		655	655	655	294	294	294

f1 = result control; f2 = socio-ideological control; f3 = centralizationcontrol
family business= 0–no family business; 1–family business
Partnership= 0–no partnership; 1–national partnership; 2–international partnership
MANDE: was transformed in range (0-1)
Note :
*p<0.1; **p<0.05; ***p<0.01

respectively hybrid and interpersonal configurations. Specifications 1 examine only MCS variables, specifications 2 it also includes the additional variables (Z) in the model, while specifications 3 includes all variables (MCS, Z) with the addition of interaction terms.
We take into account unobserved heterogeneity (time-invariant firm characteristics) which may be correlated with the level of efficiency, using the random-effects transformation of Eq.(11). Estimates are shown in Table 7.
In hybrid control cluster (specification A3) the interaction between result control (f1) and socio-ideological control (f2) have direct and positive effect on efficiency; in particular, when firms combine f1 and f2, the efficiency scores increase by 3.5%.
The firm's in this configuration have to face more intense level of complexity and environmental unpredictability and this involves a more clear and formal strategy. The data also suggests that the interaction between centralizationcontrol (f3) and result control (f1) decrease firm efficiency by -3.3% .
Moving from no-partnership to national-partnership, firm's efficiency increase by 7% and also, family business have a negative impact of -6.2 % (in other terms, no-family firms have a higher efficiency by 6.2%).
In interpersonal configuration (specification B2) the main MCS that drive firm's efficiency is centralization control. By only increasing the use of centralization control firms can enhance their technical efficiency by 2.8%. No other MCS mechanism and control factors seems to be significant reducing/increasing firm's efficiency (specification B2 and B3). The hierarchical authority of managers does not ensure compliance with others controls systems.
Contextual factors that mark out interpesonal group are smaller size company, lower complexity, lower environmental unpredictability and lower task and outcome programmability.

4.3. The performance effects of archetypal control configurations

Table 8 show the results of Battese and Coelli (1995)' model. (θ) coefficient is significantly positive (at 5% significance level), which means that control archetypal have effect on efficiency. Firms in interpersonal configuration (C2 clusters) have a higher inefficiency term μ_i, i.e. are significantly more inefficient. The size of the coefficient (θ) cannot be reasonably interpreted, only by marginal effects of the factors Z on the efficiency estimates we can measure the impact of management controls configurations (C_i) on the inefficiency scores (Liu and Myers, 2009).
Where marginals effect $\frac{\partial[E(\mu_i|x_i,z_i)]}{\partial_{z_i,k}}$ can be interpreted as the partial effect of $Z_{i,k}$ on the variance of inefficiency term μ_i.

Table 9 show that firms that belongs to interpersonal configurations are -2.14 % less efficient than firms in hybrid configuration (C1). In other words, the optimal configuration choice in machine engineering industry seem to be represented by the hybrid configuration (Table 10 provide more informations about efficiency score between two clusters).

Table 8:
Efficiency effect frontier

Dependent variable: lnY		
Variable	Coefficient	β / SE
ln L	β_l	0.2361 (0.258482)
ln K	β_k	0.5674*** (0.0931)
(.5) $(lnL)^2$	β_{ll}	0.3009*** (0.0854)
(.5) $(lnK)^2$	β_{kk}	-0.0858*** (0.0333)
$(lnK)(lnL)$	β_{kl}	-0.0901*** (0.025954)
Constant	α	4.1883*** (0.4050)
Error parameters		
	σ_u	0.2173***
	σ_v	0.1083***
	λ	1.4165***
Variables in function μ_i		
$Z = 0$	θ	0.1630** (0.0718)
Firms random terms	ω	Yes
Log-likelihood		-554.2412
Observation		949

Complete table available from authors upon request
τ and δ estimates omitted to save space
Z is a dummy variable where: 0 = Hybrid cluster; 1 = Interpessonal cluster
Significance levels: * 10%, ** 5%, *** 1%

Table 9:
Marginal effects on efficiency

Statistic	N	Mean	St. Dev.	Min	Max
C	948	−0.021	0.006	−0.028	−0.002

Table 10:
Efficiency scores by configurations
Descriptive statistics

C1									
	n	mean	median	min	max	range	skew	kurtosis	se
μ^{BC}	655	0.61	0.60	0.06	0.98	0.92	-0.02	-0.19	0.01
μ^{TRE}	655	0.70	0.70	0.03	0.99	0.95	-0.42	-0.31	0.01
μ^{TREMU}	655	0.69	0.69	0.03	0.99	0.96	-0.37	-0.29	0.01
C2									
	n	mean	median	min	max	range	skew	kurtosis	se
μ^{BC}	294	0.57	0.55	0.21	0.94	0.73	0.22	-0.05	0.01
μ^{TRE}	294	0.64	0.65	0.00	0.99	0.99	-0.27	-0.18	0.01
μ^{TREMU}	294	0.64	0.64	0.00	0.99	0.99	-0.26	0.01	0.01

5. Discussion and conclusion

The aim of this paper is to develop a theory of effective control configurations to medium sized mechanical engineering firms. We first identify controls configuration in use in this industry. The results shown two main control archetypes, hybrid and interpersonal. In this study we assess the link between MC and efficiency. We first assess wether different emphasis on various controls within each cluster is related to firm efficiency. We then assess whether one of these control archetypes could be regarded as more effective in driving firm efficiency.
Using true random effect with Mundlak's adjustment (TREMU) as measure of technical efficiency, our results suggest that firms employing hybrid configuration achieve greater firm efficiency when they emphasize both results and socio-ideological controls (efficiency increase by 3.5%).
On contrary, the interaction between result controls and centralizationcontrols seem to be related to lower firm efficiency (efficiency decrease by -3.3%).
These leads to a following two propositions:

Proposition 1: Medium sized mechanical engineering firms adopting hybrid control configuration achieve higher efficiency by emphasisizing results and socio-ideological controls simultaneously

Proposition 2: Medium sized mechanical engineering firms adopting hybrid control configuration suffer lower efficiency by emphasisizing results and centralizationcontrols simultaneously

It was interesting to observe that non-family ownership have a positive impact on efficiency. This result is in line with studies of Bloom et al. (2008); Cucculelli et al. (2014), who demonstrated that family firms put less emphasis on managerial practices and are less efficient compared to non-family firms.
Firms employing interpersonal control archetype achieve greater firm efficiency by relying on centralizationcontrols. The emphasis on other controls along the centralizationcontrol does not increase firm efficiency. This results leads to a following proposition:

Proposition 3: Medium sized mechanical engineering firms adopting interpersonal control configuration achieve higher efficiency by emphasisizing centralizationcontrols

We also assessed wether control archetypes are able to explain techical efficiency in medium sized firms in ME indutry. Employing Battese and Coelli (1995) model, including MC configurations as additional explanatory variable (observed heterogeneity), data show that is significantly positive (at 5% significance level) to explain technical efficiency in machinery engineering industry. This could bring several advantages: efficiency is a objective measure and is resist to several bias that distort subjective measures (based on opinion of respondents), also SFA can be confirmed and replicated by others researchers.

Finally, we assessed which control archetype is more effective in driving firm efficiency. Data suggest that firms adopting hybrid archetype are more efficient (+2.1%) compared to firms relying on interpersonal control archetype. This leads to our fourth and final proposition:

Proposition 4: Medium sized mechanical engineering firms adopting hybrid control configuration achieve higher efficiency, on average, than firms adopting interpersonal control configuration

There are a number of limitations to this work. First, we focused on single country, and it could restrict the generalizability of results to other medium sized ME firms in other countries, as effective control configurations may also depend on cultural context in which they operate. Second, all traditional caveats of survey research relying on subjective assessment by single respondent apply also to this study. Third, as multicollinearity forced us to reduce the number of studied controls, further studies could attempt to cover also those forms of controls not addressed by this study.
Our findings suggest some possibilities for future research. First, researchers could test if our propositions hold in other countries and even in other industries. Second, similar propositions regarding effective control configurations could be generated for other industries. Third, researchers could apply SFA to study the link between MC systems and performance also in other contexts.

AppendixA. Models specifications

Table A.11:
correlation matrix among efficiency scores

Variable	μ^{BC}	μ^{TRE}	μ^{TREMU}
Pearson's correlation			
μ^{BC}	1.00		
μ^{TRE}	0.86	1.00	
μ^{TREMU}	0.82	0.95	1.00

Table A.12:
Alternative SFM

Dependent variable: lnY		M1	M2	M3	M4
Variable	Coefficient	PSF	BC	TRE	TREMU
ln L	β_l	0.0415	0.2079	-0.6934**	-0.9352
		(0.2689)	(0.2600)	(0.3066)	(0.8039)
ln K	β_k	0.6385***	0.5636***	0.8297***	0.8174***
		(0.0963)	0.0935	(0.1288)	(0.2457)
(.5) $(lnL)^2$	β_{ll}	0.4425***	0.3140***	0.4656***	0.3979***
		(0.0881)	0.0856843	(0.1089)	(0.2245)
(.5) $(lnK)^2$	β_{kk}	0.0083	-0.0126	-0.0553***	-0.0858***
		(0.0139)	0.0133816	(0.0207)	(0.0333)
(ln K)(ln L)	β_{kl}	-0.1449***	-0.0934***	-0.0769**	-0.0277*
		(0.0268)	(0.0260)	(0.0345)	(0.0513)
Constant	α	4.2600***	4.2437***	5.4488***	4.0028***
		(0.4180)	(0.4104)	(0.3056)	(0.5806)
Error parameters					
	σ_u	0.4718***	0.4821***	0.5852682***	0.5835***
	σ_v	0.3518***	0.3301***	0.1108237***	0.1095***
	λ	1.3412***	1.4604***	5.2810***	5.3243***
Year dummies	τ	No	Yes	Yes	Yes
Firms random terms	ω	No	No	Yes	Yes
Within-group means	δ	No	No	No	Yes
Log-likelihood		-584.5629	-556.4284	-526.6825	-511.8906
Observation		949	949	949	949

Complete table available from authors upon request
τ and δ estimates omitted to save space
Significance levels: * 10%, ** 5%, *** 1%

AppendixB. Management control configurations

A two-step process was performed on the 22 management control variables outlined in Table B.14 as described by (Ketchen Jr. and Shook, 1996). In the first step (using MCS variables), the method of cluster analysis was employed to investigate configurations in use, thus identifying homogeneous groups within a population (Gerdin and Greve, 2004). Clustering was performed using a hierarchical agglomerative procedure based on Ward's algorithm with squared Euclidean distance. In the second step, the optimal cluster solution was examined using a classification procedure (a classification tree) developed by Breiman et al. (1984). The results of this analysis are shown in Table B.18 and Figure B.1. The contextual variables defining the splits, the criterion for assessing the homogeneity of the clusters, and the data characterizing the clusters were all derived from the sequence data. The splits in this method were made with the aim of producing "pure" clusters (Everitt et al., 2011).The contextual features of each cluster are presented in Table B.18. The predictive power of the contextual variables is assessed using the ten-fold CV error and global-max error rules. The correctly categorized cases (the "hit rate") are listed for ten-fold CV error as a number and a percentage. The significance of the error rate was obtained using ten-fold cross-validation error (see Table B.15).

A two-cluster solution was used in the analysis, see Table B.17.
This partition was selected based on three criteria. First, we applied the "gap statistic" method (Tibshirani et al., 2001) to estimate the number of clusters (a goodness of clustering measure). Using R package[10], the results showed a predominance for a two-cluster configuration. Second, the silhouette-width index was used to assess the quality of the cluster solution. Everitt et al. (2011, p.129) suggest that an adequate cluster structure should have a value not less than 0.2. Our result of 0.25 meets this criterion. Third, we also found three - and four - cluster solutions. These alternative cluster partitions were examined but provided less characterizing details, producing clusters with no significant overlap, and they did not produce a desirable silhouette-width index (less than 0.2).
The interpretations of the two-clusters solution were based on the comparison between the statistical differences reported in Table B.17 and prior theoretical frameworks (Speklé, 2001)

AppendixB.1. C1 control configuration–Hybrid control

The 167 firms in C1 group (Fig.Figure B.2) are marked by great emphasis on formal controls (strategic planning, diagnostic, interactive, compensation), and informals ones (socio-ideological controls such as selection and training and cultural controls) (Speklé, 2001). Employees are involved in strategy and business decisions (less centralisation than cluster $C2$), within horizontal structural arrangements (high levels of Integrative Liaison Devices). Coordination is achieved through organic structural controls (high levels of communication) that involve mutual adjustment, decentralized authority, little formalization, and lateral and emergent patterns of communication (Burns and Stalker, 1961; Mintzberg, 1979)
Classification's results show that the contextual factors able to predict configuration in use (see Table B.18) are: technology ($> C2$); size, in term of number of employees ($> C2$); partnership ($> C2$); complexity ($> C2$); and unpredictability ($> C2$). Also, companies in the C1 cluster have a low value for leadership style and put more emphasis on strategy. The employees are involved in the decisions and the leader are the facilitator of meetings in which the decisions are taken (Garengo and Bititci, 2007). This control archetipe resembles mostly what Bedford and Malmi (2015) called 'hybrid control" and Kruis et al. (2016) called "strategic vigilance", so we marked this configuration as "hybrid".

[10]Our study used "cluster" R packages. For more details see Maechler et al. (2017)

Table B.13: The control constructs and contextual constructs included in the empirical analysis.

Variable	Description
Planning	
strategic planning	Mode to implement strategic planning process. Refers to ends and means ranging from formal, deliberate, quantified, and detailed to informal, broad, not quantified, and emergent (Bedford and Malmi, 2015; Brews and Hunt, 1999; Mintzberg, 1994)
Measurement	
Diagnostic control	Use of budgets and financial or non-financial measures of performance for monitoring activity through deviations from preset standards of performance (Dyson and Foster, 1980; Green and Welsh, 1988; Malmi and Brown, 2008; Simons, 1995; Widener, 2004)
Interactive control	Use of budgets and financial or non-financial measures of performance to encourage regular involvement in subordinate activities by management to encourage debate and creative behaviors and address strategic uncertainties (Bedford and Malmi, 2015; Bisbe et al., 2007; Dyson and Foster, 1982, 1980; Janke et al., 2014; King et al., 2010; Shrader et al., 1989)
Compensation	
Performance based compensation	Level of use of performance-contingent rewards and incentives (de Grip* and Sieben, 2005; Hayton, 2003)
Subjective/Objective	Incentive determination - subjective to objective (de Grip* and Sieben, 2005; Hayton, 2003)
Structure	
Centralization	Authority – centralized to decentralized (Bedford and Malmi, 2015; Bruns and Waterhouse, 1975; Hayton, 2003)
Communication	Communication patterns – mechanistic to organic (Burns and Stalker, 1961; Chenhall and Morris, 1995)
Hierarchy	number of levels (Bedford and Malmi, 2015; Scott and Tiessen, 1999)
Integrative Liaison Devices	Structural arrangements (vertical–horizontal). Practices relating to how co-operation is approached, e.g. committees, task forces, and cross-functional groups (Bedford and Malmi, 2015; Pelham and Wilson, 1995; Scott and Tiessen, 1999)
Policies and procedures	
Boundary Systems	Rules and procedures specifying the means of conducting work activities (Prajogo and McDermott, 2014)
Socio–ideological	
Input control	Selection and training procedures (Bedford and Malmi, 2015; Snell, 1992)
Belief Systems	Statements communicating the basic values and premises for action of the firm (Bedford and Malmi, 2015; Simons, 1995)
Social control	Norms, values and expectations used to drive firms' activities and enhance employees' commitment to the firm (Bedford and Malmi, 2015; Hayton, 2003; Kober et al., 2007; Simons, 1995)
Technology	
Outcome Measurability	Extent to which outcomes of subordinate activity can be validly and reliably captured in quantitative standards of performance (Eisenhardt, 1985; Ouchi, 1977)
Task Programmability	Extent to which subordinate actions required to achieve an objective are known and visible to top management (Eisenhardt, 1985; Ouchi, 1977)
Environment	
Complexity	Refers to the variety of production processes (Davila, 2005)
Unpredictability	Level of predictability of changes to: production processes and techniques; consumers and demand; new product entry; and competitors' strategies and actions (Lannelongue et al., 2014)
Hostility	Refers to market features such as prices, products, and target customers (Lannelongue et al., 2014)
Strategy	
Entrapreneurial / conservative	Emphasis on risk taking and product innovation (Bisbe and Otley, 2004; Miller and Friesen, 1982)
Additional factors	
leadership style	1 = directive; 2 = consultive; 3 = participative; 4 = oriented to the delegation (Abernethy et al., 2010; Garengo and Bititci, 2007)
Age	(Cassia et al., 2005; Davila and Foster, 2007b; Davila, 2005)
employee	Number of employees (Davila and Foster, 2007b)
partnership	0=none 1 = national; 2 = international (Hopper et al., 1999; Ilias et al., 2010)

Table B.14: Descriptive data after normalised

Statistic	N	Mean	St. Dev.	Min	Max
Long-term Planning					
strategic.planning	242	0.6	0.2	0.0	1.0
Measurement					
diagnostic control	242	0.6	0.3	0.0	1.0
interactive control	242	0.5	0.2	0.0	1.0
Compensation					
performance based compensation	242	0.5	0.3	0.0	1.0
sub.obj.based.comp	242	0.6	0.2	0.0	1.0
Structure					
centralization	242	0.5	0.3	0.0	1.0
communications	242	0.6	0.2	0.0	1.0
hierarchy	242	0.4	0.2	0.0	1.0
Policies and Procedures					
coordinations	242	0.5	0.3	0.0	1.0
boudary sistems	242	0.4	0.2	0.0	1.0
Socio-Ideological					
input control	242	0.6	0.2	0.0	1.0
social control	242	0.5	0.2	0.0	1.0
belief systems	242	0.5	0.3	0.0	1.0
Technology					
task.programmability	242	0.6	0.2	0.0	1.0
outcame programmability	242	0.5	0.2	0.0	1.0
Environment					
unpredictability	242	0.5	0.2	0.0	1.0
hostility	242	0.5	0.2	0.0	1.0
complexity	242	0.5	0.4	0.0	1.0
leadership style	242	0.7	0.3	0.0	1.0
Strategy					
entrepreneurial	242	0.6	0.3	0.0	1.0
Additional factors					
age	242	0.7	0.4	0.0	1.0
employees	242	0.4	0.2	0.0	1.0

Table B.15:
Root node error

CP	nsplit	rel	error	xerror	xstd	Train error	10-fold CV error
0.3067	0		1,000	1,000	0.0959	0.310	0.310
0.0867	1		0.693	0.773	0.0885	0.215	0.240
0.0400	3		0.520	0.760	0.0880	0.161	0.236
0.0178	4		0.480	0.653	0.0834	0.149	0.202
0.0133	**7**		**0.427**	**0.640**	**0.0827**	**0.132**	**0.198**
0.0100	10		0.387	0.827	0.0905	0.120	0.256

Table B.16:
Split selection

	firstSEmax	Tibs2001SEmax	globalSEmax	firstmax	globalmax
Num. final node	4,000,000	2,000,000	4,000,000	5,000,000	5,000,000
CP	0.017778	0.086667	0.017778	**0.013333**	0.013333

AppendixB.1.1. C2 configuration – Interpersonal Control

For Cluster 2 (C2, 75 firms, see Figure B.2), the data reveals that the basis for control and coordination is widely informal (result control, coordination, and communication are very low; $< C1$), by means of the centralised decision-making process (centralization is very high; $> C1$), and with limited autonomy and more direct supervision ($> C1$). The hierarchical authority of managers does not ensure accordance with social-ideolagical control (selection and training, belief systems and social control are very low) (Lange, 2008). A potential explanation is that decision-maker's authority facilitates absorption of values and beliefs (Davila, 2005; Sandino, 2007). According to classification analysis, the contextual factors that featured C2 clusters are smaller size, low complexity ($< C1$), low environmental unpredictability ($< C1$), low tasks and outcome programmability, and independence from business groups.
This description is very similar to structural type outlined by Bruns and Waterhouse (1975) and by Merchant (1981), for which behavioral rules and direct monitoring of subordinates are the keys mechanism of management control.
We call this configuration "interpersonal", as it does not rely much on formal controls.

Table B.17:
Results of hierarchical clustering of management control constructs

	Overall Mean	Hybrid Cluster 1	Interpersonal Cluster 2
Long-term Planning			
Strategic planning	0.57	0.64	0.42
Measurement			
Siagnostic control	0.57	0.65	0.39
Interactive control	0.50	0.59	0.31
Compensation			
Performance based compensation	0.48	0.59	0.22
Sub.obj.based comp.	0.57	0.65	0.38
Structure			
Centralization	0.49	0.45	0.57
Communications	0.59	0.68	0.38
Hierarchy	0.41	0.43	0.35
Integrative Liaison Devices	0.43	0.50	0.27
Policies and Procedures			
Boundary Systems	0.52	0.62	0.30
Socio-Ideological			
Input control	0.63	0.72	0.44
Social control	0.49	0.59	0.25
Belief systems	0.48	0.62	0.19

Table B.18:
Results of classification for environment constructs

	Overall mean	Hybrid Cluster 1	Interpersonal Cluster 2
Technology			
Task programmability[a]	0.61	0.68	0.44
Outcame programmability[a]	0.52	0.60	0.34
Envinonment			
Unpredictability	0.50	0.51	0.49
Hostility	0.49	0.50	0.47
complexity[a]	0.47	0.50	0.43
Leadership style	0.67	0.60	0.83
Strategy			
Entrepreneurial	0.65	0.68	0.58
Additional factor			
Age	0.67	0.67	0.67
Employees[a]	0.37	0.39	0.34
Partnership	0.46	0.51	0.37

Note: [a] variables with predictive power

Figure B.1: Classification Tree

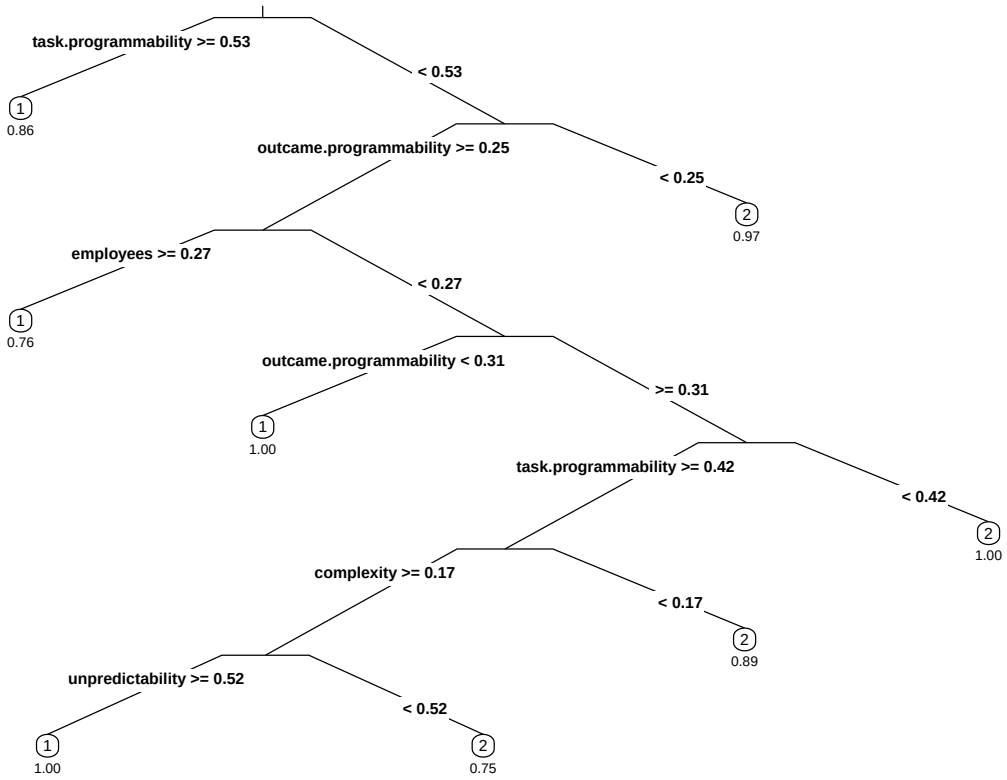


Figure B.2: Silhouette index

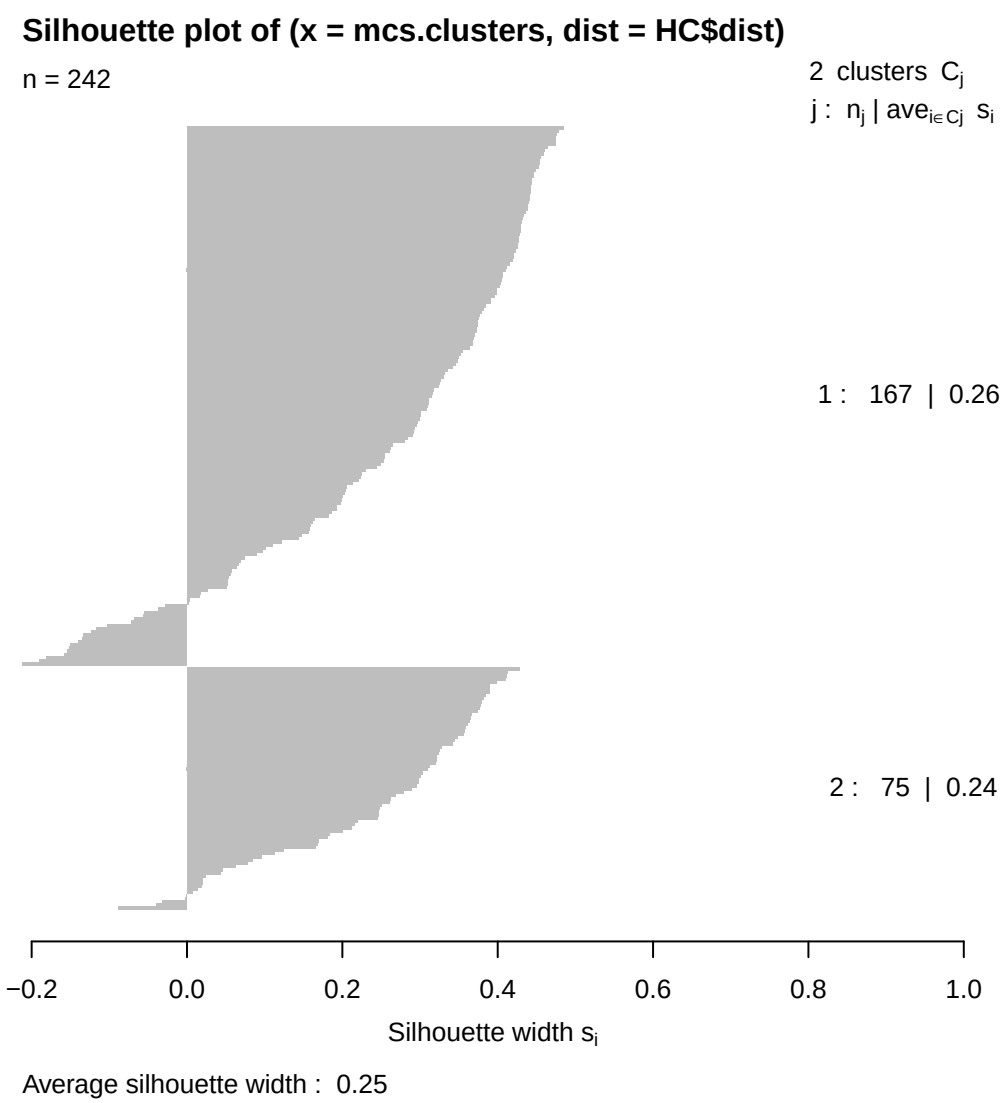
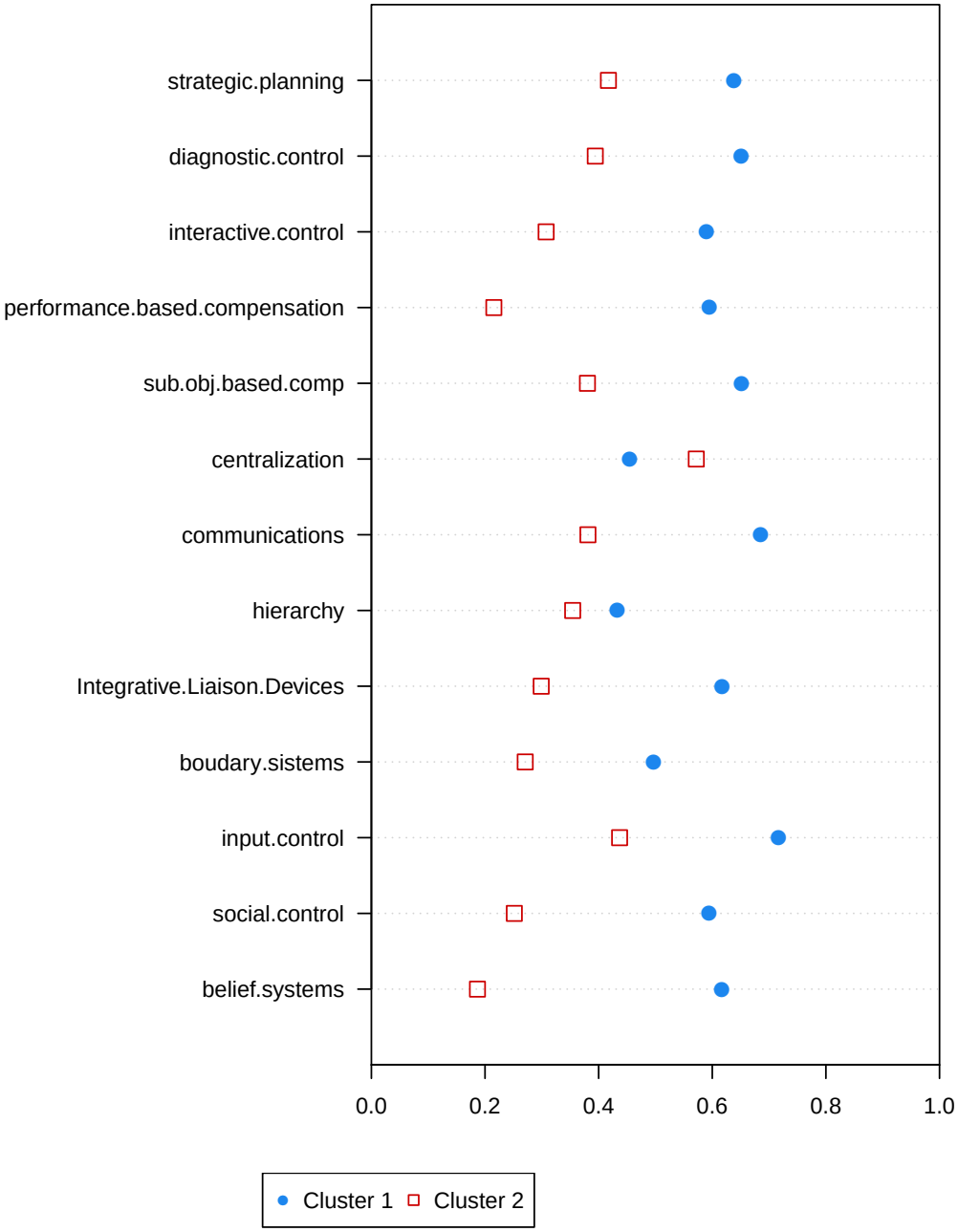


Figure B.3: Control configurations



AppendixC. Variable measurements, factor loadings and alphas

Strategic planning (Cronbach alpha 0.88)

Strategic planning refers to mode of implement long term planning. It involves the ends and means ranging from formal, deliberate, quantified, and detailed to informal, broad, not quantified, and emergent (Bedford and Malmi, 2015; Brews and Hunt, 1999; Mintzberg, 1994)

1. How would you describe the strategic goals of your enterprise (SBU)? (general, qualitative / specific, detailed, quantified) (loading 0.73)
2. How would you characterize the strategic plan of you enterprise (SBU)? (no plans / highly detailed plan by results and actions) (loading 0.86)
3. How closely is the strategic plan followed in your SBU? (1 very low extent; 7 very high extent); (loading 0.84)
4. How would you describe the process by which strategy develops in your enterprise (SBU)? (informal and intuitive / formalised and deliberated) (loading 0.802)

Diagnostic control (Cronbach alpha 0.89)

To what extent does the top management team use budgets (performance measurement systems) for the following? (1 very low extent; 7 very high extent). Description are from Green and Welsh (1988); Widener (2007). Measurements of variables are from Dyson and Foster (1980); Widener (2007)

1. measure and quantify the employees activity (loading 0.75)
2. settle and quantify objectives and standards (loading 0.95)
3. compare the expected results with the related standards behavior (loading 0.90)

Interactive control (Cronbach alpha 0.92) To what extent does the top management team use budgets (performance measurement systems) for the following? (1 very low extent; 7 very high extent). Based on the model outlined by Bisbe et al. (2007). Single measure are based on Bedford and Malmi (2015); Bisbe and Otley (2004); Dyson and Foster (1982, 1980); Henri (2006); King et al. (2010); Widener (2007)

1. Provide a recurring and frequent agenda for subordinate activities (loading 0.88)
2. Provide a recurring and frequent agenda for management activities (loading 0.82)
3. Enable continual challenge and debate of underlying data (loading 0.86)
4. Focus attention on environmental (strategic) uncertainties (loading 0.79)
5. Encourage and facilitate dialogue and information sharing within the organization (with the subordinates) (loading 0.86)

Performance based compensation

To what extent does the firm employ performance-based rewards and compensations? (de Grip* and Sieben, 2005; Hayton, 2003) (1 very low extent; 7 very high extent)

Subjective / Objective based compensation (Cronbach alpha 0.86)

To what extent does the following sentences are representative of the firm situation? (1 very low extent; 7 very high extent) de Grip* and Sieben (2005); Hayton (2003);

1. The compensation-linked objectives can be reached with reasonable efforts (loading0.73)
2. The objectives are well known in advance (loading 0.68)
3. The objectives are clearly defined and understandable (loading 0.91)

Centralization (Cronbach alpha 0.87)

To what extent does the following sentences are representative of the firm situation? (1 very low extent; 7 very high extent) (King et al., 2010; Prajogo and McDermott, 2014)

1. A person who wants to make his own decision would be quickly discouraged (loading 0.73)
2. Even small matters have to be referred to someone higher up for a final answer (loading 0.93)
3. Most decisions made here have to have supervisor's approval (loading 0.85)

Communication (Cronbach alpha 0.88)

To what extent does the following sentences are representative of the firm situation? We take organization instead of organizative unit. Reflect a continuum from mechanistic to organic; (1 mechanistic; 7 organic) (Burns and Stalker, 1961). Items are derived from Chenhall and Morris (1995); Covin et al. (2001); Leifer and Huber (1977); Prajogo and McDermott (2014)

1. In our organization, there is ample opportunity for informal talk among employees (loading 0.84)
2. In our organization, employees from different departments feel comfortable calling each other when the needs arise (loading 0.81)
3. Managers encourage employees discussing work-related matters with those who are not immediate superiors (loading 0.90)
4. In this organization it is easy to talk with virtually anyone you need to, regardless of rank or position (loading 0.66)

Hierarchy

How many hierarchical levels does your organization have? (number) (Bedford and Malmi, 2015; Scott and Tiessen, 1999)

Integrative Liaison Devices (Cronbach alpha 0.86)

To what extent does the following sentences are representative of the firm situation? (1 very low extent; 7 very high extent). It Refers structural arrangements (vertical?horizontal)(Abernethy and Lillis, 1995; Mintzberg, 1979)

1. In our organization manager committees are set up to allow joint decision making (loading 0.74)
2. In our organization, task forces are set up for collaboration on a specific project (loading 0.80)
3. Interfunctional groups for decisions about products (loading 0.84)
4. In our organization, the budget decisions concerning the selection and financing of long-term investments are made by different work groups or departments working together (loading 0.74)

Boundary Systems (Cronbach alpha 0.87)

To what extent does the following sentences are representative of the firm situation? (1 very low extent; 7 very high extent). Item relates to the use of policies and procedures to guide the day to day work activities of subordinates (Abernethy and Lillis, 1995; Gerdin, 2005; Simons, 1987), and standardized methods of lateral coordination (Ruekert and Walker, 1987). Single measurment based by Prajogo and McDermott (2014)

1. The company has a large number of written rules and policies (loading 0.81)
2. A rules and procedures manual exists and is readily available within this company performance (loading 0.85)
3. The company keeps a written record of nearly everyone's job (loading 0.84)
4. The company keeps records of each employee's performance (loading 0.73)
5. This is a formal orientation program for most new members of this company (loading 0.70)
6. Are sanctions or punishments applied to subordinates who engage in risks and activities outside organisational policy, irrespective of the outcome? (loading 0.49)

Input control (selection and training) (Cronbach alpha 0.85)

When recruiting for managers or coordinators, how much attention your company pay to the following aspects: (1 very low extent; 7 very high extent). It's elicited using four items adapted from Snell (1992) that ask respondents about characteristics of selection and training procedures: the measurement are based on Bedford and Malmi (2015); Hayton (2003)

1. creativity, autonomy, drive for action (loading 0.88)
2. capacity for teamwork, good conflict behavior (loading 0.89)
3. analogy to top managers or property (loading 0.64)
4. In which way does your firm manage the employees selection? (informal / formal and professional) (loading 0.70)
5. the company organizes training and development processes to reinforce firm objectives and expectation (1 very low extent; 7 very high extent). (loading 0.60)

Belief Systems (Cronbach alpha 0.90)
To what extent does the following sentences are representative of the company situation? (1 very low extent; 7 very high extent). Based on the conceptualization of Simons (1995). Items adapted from Bedford and Malmi (2015); Simons (1995)

1. The values, proposes and directions of the firm are codified in formal documents (e.g. mission/value statements, credos, statement of purpose) (loading 0.85)
2. Top management actively communicate core values to subordinates in formal or informal way (loading 0.94)
3. Firm values drive the business choices, especially in conditions of uncertainty (loading 0.83)

Social Control (Cronbach alpha 0.91)
Relating to the extent of shared norms and expectations, and the extent of commitment to firm objectives and values (1 very low extent; 7 very high extent). Is measured through a five item adapted from the instrument used in (Bedford and Malmi, 2015; Hayton, 2003; Kober et al., 2007)

1. The company uses social events to develop and maintain employees commitment (loading 0.76)
2. The work environment encourages employees to fell a part of the company (loading 0.92)
3. The work environment encourages employees to feel a sense of pride in their work (loading 0.94)
4. Virtually the employees can identify and articulate the firm's shared values and norms (loading 0.86)
5. The employees make (or would make) personal sacrifices for the firm out of commitment to the firm's shared values (loading 0.66)

Outcome Measurability (Cronbach alpha 0.93) Reflect the level of outcome measurabilityOuchi (1978); Snell (1992). Based on work of Bedford and Malmi (2015)

1. Standards of desirable performance for subordinates are well defined (loading 0.89)
2. measuring the results achieved by employees you can accurately assess the effectiveness of the work done (loading 0.94)
3. The management has several sources of objective data indicating the Employee Performance (loading 0.89)

Task Programmability (Cronbach alpha 0.91) Reflect the level of task programmability Ouchi (1978); Snell (1992). Based on work of Bedford and Malmi (2015)

1. The actions subordinates take to achieve results are visible to top management (loading 0.83)
2. Effective and ineffective subordinates can be distinguished by observing the actions they take (loading 0.88)
3. The relationship between the actions that subordinates take and the eventual outcomes are well known by top management (loading 0.92)

Unpredictability (Cronbach alpha 0.87)
In the last four years how much predictable/not predictable have been the following changes of the external environment? It is measured through items that represent the primary dimensions of an organization's external environment (Lannelongue et al., 2014)

1. Production processes and techniques (loading 0.67)
2. Consumers and demand (loading 0.76)
3. New products entry (loading 0.90)
4. Competitors' strategies and action (loading 0.81)

Complexity
How many products produce your company ? (1-50; 51-100; > 100) Refers to variety production (Davila, 2005)

Hostility (competitive intensity) (Cronbach alpha 0.66) To what extent does the following sentences are representative of the company situation? (1 very low extent; 7 very high extent). Based on work of Lannelongue et al. (2014)

1. Our competitors are very aggressive in their price decision (loading 0.41)

2. Our competitors constantly propose new products or improved products to our target customers (loading 0.73)
3. Our competitors offer highly substitutive products/services (loading 0.63)
4. Our competitors are larger (loading 0.55)

Entrepreneurial (Cronbach alpha 0.80)
To what extent does your company emphasize the following issues? (1 very low extent; 7 very high extent). Emphasis risk taking and product innovation. Risk taking use the instrument developed by Miller (1982). Product innovation by instrument of Bisbe and Otley (2004)

1. To launch on the market new products before the competitors (loading 0.73)

2. To experiment with new products/technologies (loading 0.91)

Leadership Style
What is the company's predominant leadership style? choose the appropriate category: (Garengo and Bititci, 2007) 1. achievement oriented (the decisions are delegated to third subjects without any interference by the leader; 2. participative (the leader is the facilitator of meetings where the decision are taken; 3. supportive (the decisions are taken by the leader after consultative meetings or talks); 4. directive (all the decisions are taken by the leader)

Partnership
Is the company parent or subsidiary in a group (Yes/No). If Yes, what kind of group is it? Choose the appropriate category: 1. international; 2. national. (Davila and Foster, 2007b; Lavia López and Hiebl, 2014)

Age What is the age of your company? Number of years (Davila and Foster, 2007b; Lavia López and Hiebl, 2014)

Employee
Please, indicate the numbers of employees (No. Employees) (Davila and Foster, 2007b; Lavia López and Hiebl, 2014)

Family business
Family businesses, defined as enterprises where the majority of the shares is in the hands of members of a family (second generation after the founder of the company) (Bloom et al., 2008; Cucculelli et al., 2014; Davila, 2005)
To which category does your company belong?

1. No-family business
2. Family business

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