

Matthew Hall

Do comprehensive performance measurement systems help or hinder managers' mental model development?

**Article (Accepted version)
(Refereed)**

Original citation:

Hall, Matthew (2011) *Do comprehensive performance measurement systems help or hinder managers' mental model development?* [Management Accounting Research](#), 22 (2). pp. 68-83. ISSN 1096-1224 DOI: [10.1016/j.mar.2010.10.002](https://doi.org/10.1016/j.mar.2010.10.002)

© 2010 [Elsevier Ltd.](#)

This version available at: <http://eprints.lse.ac.uk/36703/>
Available in LSE Research Online: August 2014

LSE has developed LSE Research Online so that users may access research output of the School. Copyright © and Moral Rights for the papers on this site are retained by the individual authors and/or other copyright owners. Users may download and/or print one copy of any article(s) in LSE Research Online to facilitate their private study or for non-commercial research. You may not engage in further distribution of the material or use it for any profit-making activities or any commercial gain. You may freely distribute the URL (<http://eprints.lse.ac.uk>) of the LSE Research Online website.

This document is the author's final accepted version of the journal article. There may be differences between this version and the published version. You are advised to consult the publisher's version if you wish to cite from it.

Full text copy of:

Hall, M. 2011. Do comprehensive performance measurement systems help or hinder managers' mental model development? *Management Accounting Research*, 22, 68-83.

ABSTRACT

This study examines whether and how the process of updating and changing mental models (learning) helps to explain how performance measurement systems (PMS) affect individual performance. Although prior studies (e.g., Hall, 2008; Burney and Widener, 2007; Burney et al., 2009) highlight the important role of particular cognitive and motivational mechanisms, such as role clarity and organizational justice, they do not consider how PMS can improve performance by helping individuals to update their mental models and develop learning capabilities. As such, this study investigates relations among comprehensive PMS, two types of learning at the managerial (individual) level (mental model confirmation and mental model building), and managerial performance. Results show that a more comprehensive PMS helps managers to confirm their mental models of business unit operations. In contrast, findings show that a more comprehensive PMS can help managers to build new mental models of business unit operations, but only in specific settings, that is, for managers with a short organizational tenure and/or from a small-sized strategic business unit. Importantly, results also show that both mental model confirmation and mental model building have positive associations with managerial performance.

1. Introduction

In the management accounting literature there is growing recognition of the importance of understanding how and why performance measurement systems (PMS) relate to individual and/or organisational performance. Psychological theories in particular indicate that performance measurement systems affect individual performance through cognitive and motivational mechanisms. Drawing on these theories, Hall (2008) finds that role clarity (cognitive) and psychological empowerment (motivational) mediate the relation between comprehensive PMS and managerial performance. Research by Burney and Widener also shows how attributes of PMS (e.g., technical validity, linking measures to strategy) affect individual performance through role conflict (cognitive) and organizational justice (motivation) (Burney and Widener, 2007; Burney et al., 2009). These studies highlight the important role of particular cognitive and motivational mechanisms in understanding how PMS affect individual performance. However, research indicates that an important way that PMS can improve performance is by helping individuals to update their mental models and develop learning capabilities (e.g., Kaplan and Norton, 1996; Chenhall and Morris, 1993; McKinnon and Bruns, 1992). As such, although this article uses the same data set as Hall (2008), its focus is quite different. Hall (2008) focused upon role clarity and psychological empowerment, whereas the incremental contribution of this article emerges by examining how the process of updating and changing mental models (learning) helps to explain the way in which PMS affect individual performance.

Following from this discussion, I examine the following research question: do comprehensive performance measurement systems (PMS) help or hinder managers' mental model development? Specifically, I investigate how comprehensive PMS

relate to two types of learning at the managerial (individual) level (mental model confirmation and mental model building), and the subsequent links to managerial performance. Results show that a more comprehensive PMS helps managers to confirm their mental models of business unit operations. In contrast, findings show that a more comprehensive PMS can help managers to build new mental models of business unit operations, but only in specific settings, that is, for managers with a short organizational tenure and/or from a small-sized strategic business unit. Importantly, results also show that both mental model confirmation and mental model building have positive associations with managerial performance.

The study contributes to the literature in three ways. First, by investigating the role of learning processes at the managerial (individual) level, the study extends prior research (e.g., Hall (2008), Burney and Widener, 2007, Burney et al., 2009) that has examined how cognitive and motivational mechanisms help to explain links between PMS and managerial performance. Furthermore, as it is the actions and thoughts of individuals within firms that are a necessary condition for organizational learning to occur (Romme and Dillen, 1997; Vandenbosch and Higgins, 1995), a focus on learning at the individual level also helps to understand the processes involved in MCS generating learning at the organizational level more broadly (Chenhall, 2005; Henri, 2006; Widener, 2007).

Second, the results contribute to our understanding of the role of MCS in facilitating different types of learning processes. Prior studies tend to view learning as a single construct (e.g., Henri, 2006; Sprinkle, 2000; Widener, 2007) whereas theories of learning generally refer to two different yet related learning processes, for example, exploitation and exploration (Gupta, Smith and Shalley, 2006; March, 1991), single- and double-loop learning (Argyris and Schon, 1978) and confirming and building

mental models (Festinger, 1957; Flavell, 1963; Norman, 1982; Piaget, 1954). As theorists conceptualize learning along two dimensions, examining multiple dimensions of learning can help to advance understanding of how MCS are related to different types of learning processes. Furthermore, closer attention to the conceptual specification of constructs can help to reduce ambiguity regarding their meaning, which, in turn, can result in more rigorous conclusions concerning the relations between MCS and other constructs, such as learning (c.f., Bisbe, Batista-Foguet and Chenhall, 2007).

Third, by exploring how a characteristic of MCS, comprehensive PMS, relates to learning, the study responds to calls to investigate how specific attributes of MCS affect learning (Otley, 1999; Shields, 1997). This is important as prior research provides a mixed picture, with one line of argument suggesting that MCS can impede the learning process (Argyris, 1977; 1990; Gray, 1990; Hedberg and Jonsson, 1978; Kloot, 1997; Staw and Boettger, 1990), whereas other arguments indicate that MCS can promote creativity and innovation and thus facilitate learning (Chenhall, 2005; Henri, 2006; Kaplan and Norton, 1996b; Neely and Al-Najjar, 2006). This study provides a possible explanation for these conflicting arguments by considering specifically the particular characteristics of MCS that are expected to help or hinder the learning process.

The remainder of the paper is structured in four sections: the next section provides the theoretical framework for the study. The research method, including sample selection and variable measurement, is then presented. This is followed by an analysis of the data using partial least squares regression analysis. The final section discusses the results and implications, outlines the limitations, and suggests avenues for future research.

2. Theoretical framework

2.1. Learning and mental model development

In general, an entity learns if, through the processing of information, the range of its potential behaviours is changed (Huber, 1991)¹. At the organizational level, learning involves the creation of knowledge through the development of systems that acquire, interpret, diffuse and store information (Chenhall, 2005; Henri, 2006; Huber, 1991). Often, it is these systems that can provide a platform upon which individual learning and discovery can be promoted and developed. Whilst organizational learning is not the aggregate of individual learning (Argyris and Schon, 1978), it is the actions and thoughts of individuals within firms that are a necessary condition for organizational learning to occur (Romme and Dillen, 1997; Vandenbosch and Higgins, 1995). In particular, the learning processes of managers are important as they are likely to have a large effect on organizational learning through the interpretation of information for others, the setting of agendas, and the establishment of systems for solving problems (Vandenbosch and Higgins, 1995; 1996).

An important learning process for managers relates to confirming and updating their mental models of how the organization operates. Mental models are

¹ This definition reflects a cognitive, rather than behavioural, approach to learning. Behaviourists view learning as a change in behaviour or performance (Norman, 1982) where learning is understood as modifying behaviour through an appropriate stimulus-response mechanism (Kazdin, 1975). However, learning does not necessarily equate to observable changes in behaviour. In particular, the separation between learning and performance can be large, with changes in behaviour being far removed from the information that produced the change (Vandenbosch and Higgins, 1996). As such, cognitive learning theorists argue that learning represents a change in the *potential* for behaviours, not necessarily a change in behaviour itself (Friedlander, 1983; Huber, 1991; Lovell 1980). Learning may result in new and significant insights that require no immediate behavioural change, as individuals may choose not to reconstruct their behaviour but to change their mental models (Friedlander, 1983). Thus, in this study, learning is viewed as a change in the potential behaviour (changed mental models), not a change in behaviour itself.

subjective, internal representations of systems of relations that can be used to support managers' judgements, decisions and explanations (Birnberg, Luft and Shields, 2007; Markman, 1999; Markman and Gentner, 2001). A manager's mental model of business operations relates to assumptions and expectations about how the business operates and knowledge of how actions, activities and outcomes are related (Kaplan and Norton, 1996a; Lant, Milliken and Batra, 1992; McKinnon and Bruns, 1992; Mintzberg, 1973; Neely and Al-Najjar, 2006).² Managers construct mental models of business operations from their experiences and from the information that they encounter (Vandenbosch and Higgins, 1996). The construction and refinement of managers' mental models involves a process whereby they are continually at work using their experience, knowledge and information to scrutinise and test their mental models of the workings of the organization (Chenhall and Morris, 1993; de-Haas and Algera, 2002; Mintzberg, 1973; Senge, 1990; Vandenbosch and Higgins, 1996). This process reflects the dynamic nature of mental models and the way that they change over time to incorporate new insights and understandings.

Research in cognitive psychology and related studies in organizational settings indicate that this learning process can occur in two distinct yet related ways. Under the first approach, termed mental model confirmation, managers receive new information that fits into their existing mental models of business operations and helps them to confirm what was already held to be true (Flavell, 1963; Piaget, 1954; Vandenbosch and Higgins, 1996). In this situation, new information and experiences

² As mental models are subjective they differ from formal scientific models in three important ways. Incomplete: constructing and changing mental models requires mental effort, therefore, mental models tend to be incomplete (Krishnan, Luft, and Shields, 2005; Markman and Gentner, 2001). Qualitative: individuals do not estimate exact quantities or perform mathematical simulations, but reason about the relative properties of systems, such as the direction of relations and approximate magnitudes (Krishnan, Luft, and Shields, 2005; Markman and Gentner, 2001). Substitution: mental models often substitute more familiar attributes for the attributes of formal scientific models, as familiar attributes are assessed more naturally and are more readily accessible for decision making (Kahneman and Frederick, 2002; Krishnan, Luft and Shields, 2005).

are added to and incorporated within managers' existing mental models of business operations (Friedlander, 1983; Norman, 1982; Vandenbosch and Higgins, 1995). The emphasis is on the refinement, correction and extension of existing mental models within the current set of rules and norms (Argyris and Schon, 1978, Gupta et al., 2006, March, 1991).

Under the second approach, termed mental model building, managers' mental models of business operations are rearranged, redefined and developed in order to interpret and incorporate new and potentially contradictory information (Flavell, 1963). In this situation, new information and experiences are not meaningful under managers' existing cognitive structures such that new mental models of business operations are required (Festinger, 1957; Flavell, 1963; Norman, 1982; Piaget, 1954; Vandenbosch and Higgins, 1995). Under mental model building, existing mental models are no longer appropriate for a given situation, with a focus on experimentation and the development of new alternatives, rules and norms (Argyris and Schon, 1978; Gupta et al., 2006, March, 1991).

Over time managers engage in both mental model confirmation and mental model building to ensure successful performance (Gupta et al., 2006; March, 1991). Mental model confirmation aids managers' efficiency and productivity by using existing mental models of business operations to identify and solve problems (March, 1991; Vandenbosch and Higgins, 1995). Mental model building helps promote flexibility, creativity and innovation, which is particularly important in helping managers to deal with uncertain and ambiguous situations (March, 1991; Vandenbosch and Higgins, 1995). Although both learning processes are important, mental model confirmation is the more likely behaviour because mental model building is much riskier, involving new ideas, routines and ways of thinking (March,

1991; Quinn, 1980; Vandenbosch and Higgins, 1996). Furthermore, theories of cognitive dissonance indicate a tendency for individuals to selectively perceive environmental cues so as to confirm existing mental models (Festinger, 1957).

2.2. Management control systems and mental model development

There is much debate in the literature regarding the role for MCS in the learning process. One line of argument suggests that rather than helping managers to learn, MCS impede the learning process (Argyris, 1977; Hedberg and Jonsson, 1978; Staw and Boettger, 1990). In contrast, MCS are also claimed to help managers to learn by promoting curiosity and the questioning of existing rationales (Chenhall, 2005; Henri, 2006; Kaplan and Norton, 1996b).

An issue that has received limited attention in these debates is the characteristics of MCS that are expected to help or hinder the development of managers' mental models. It is likely that some types of information from MCS would be very helpful in confirming and building managers' mental models of business operations, whereas other types of information would not. In particular, more contemporary performance measurement systems seek to provide managers with more extensive feedback about the organization's operations and performance (Burney et al., 2009; Chenhall, 2005; Hall, 2008). For example, systems such as the balanced scorecard aim to provide a broad range of measures, often linked to strategy, to help facilitate the learning process. Making a distinction between the types of feedback provided from MCS is important because the nature and quality of the information that managers receive effects the confirmation and building of managers' mental models (Vandenbosch and Higgins, 1996). In this study the nature and quality

of the information that managers receive from MCS is represented by comprehensive PMS (Hall, 2008). A comprehensive PMS is one that provides performance measures that describe important parts of the SBU's operations and integrates measures with strategy and across the value chain.

Below I develop hypotheses linking comprehensive PMS to mental model confirmation and mental model building, and the subsequent links to managerial performance. First, I argue that comprehensive PMS enhances mental model confirmation (H1). Second, due to cognitive dissonance and the selective perception of information, I argue that comprehensive PMS is only likely to affect mental model building under certain conditions, specifically, for managers with shorter (rather than longer) organizational tenure (H2) and for managers from smaller (rather than larger) sized SBUs (H3). Finally, I expect mental model confirmation and mental model building to be positively associated with managerial performance (H4, H5). Figure 1 provides an overview of the theoretical model.

<insert Figure 1 here>

2.3. Comprehensive PMS and mental model confirmation

Research argues that managers can use feedback from MCS to confirm their mental model of the organization's operations (Chenhall and Morris, 1993; Kaplan and Norton, 1996b; McKinnon and Bruns, 1992; Sprinkle, 2000). McKinnon and Bruns (1992, 206), in their field study of managers' use of accounting information, found that "as managers review their success as reported in accounting reports, they are continuously at work, testing and perfecting their mental model of the relationship

between activities and success as measured by the management accounting system". By describing the operations of the organization more effectively, comprehensive PMS can help managers to test and confirm their mental models of how activities, operations and performance are related. As PMS become more comprehensive, they provide a wealth of empirical observations about the organization's operations, and such observations provide the impetus for the testing and confirmation of managers' mental models (Chenhall and Morris, 1993). Comprehensive PMS, through linking measures to strategy and the value chain, also provide managers with a better understanding of the business, which can help to confirm a manager's mental model of business operations (McKinnon and Bruns, 1992). Research also indicates that managers can use more comprehensive performance information to verify, confirm and validate their beliefs about cause-and-effect relations embedded in a firm's strategy and action plan (Luft and Shields, 2001). In addition, the cause-effect linkages of comprehensive PMS can help managers to clarify and confirm the business model of the organization. As comprehensive PMS increase the amount of information that is reported to managers in the organization (Ullrich and Tuttle, 2004), this helps managers to test and validate the extent to which their mental model is consistent with the reality of the organization (Argyris and Schon, 1978; Huber, 1991). In summary, as PMS become more comprehensive, they provide more of the necessary feedback and empirical observations to help managers in the process of mental model confirmation. This analysis leads to H1:

H1: There is a positive association between comprehensive PMS and mental model confirmation.

2.4. Comprehensive PMS and mental model building

In contrast to the role of comprehensive PMS in mental model confirmation, it is likely to be more difficult for comprehensive PMS to help the process of mental model building. This is because, as noted earlier, individuals have a tendency to selectively perceive environmental cues so as to reinforce existing ideas rather than develop and build new ideas and ways of thinking (Festinger, 1957). This indicates that comprehensive PMS may not be able to help managers build mental models because cues that can challenge and prompt new ways of thinking are selectively perceived, filtered and/or ignored and thus not taken into consideration by managers in their work. In effect, the information from comprehensive PMS that is likely to prompt mental model building (e.g., broad range of measures covering important aspects of operations, links between measures and strategy and across the value chain) is 'provided' to managers, but not necessarily 'received' and incorporated into mental model building processes. This indicates that, due to managers' propensity to selectively perceive information so as to reinforce existing ideas, even the most comprehensive PMS is unlikely to help the process of mental model building.

Research does suggest, however, that managers' tendency to selectively perceive information is not uniform across managers and/or different organizational settings (e.g., Bayer et al., 1997; Ashford, 1986). As such, there may be situations where information from comprehensive PMS is not filtered or ignored and thus is able to help in the process of mental model building. In particular, I argue that it is likely that comprehensive PMS can help mental model building for managers with shorter (rather than longer) organizational tenure and for managers from smaller (rather than larger) sized SBUs.

Prior research indicates that a manager's propensity to selectively perceive environmental cues and filter information depends on the length of time a manager has been working in the organization. For example, Ashford (1986) argues that managers with longer tenures in the organization are more likely to block out information and not obtain feedback because they feel that as 'old timers' they should 'know the ropes'. In this setting, extensive information seeking would undermine their standing as confident and self-assured managers. Similarly, Hambrick and colleagues (Hambrick and Fukutomi, 1991; Finkelstein and Hambrick, 1996) argue that as a manager's tenure in the organization increases, information becomes more finely filtered and distilled. Finally, Garg (2007) argues that as tenure increases managers tend to overlook disconfirming evidence and interpret information in ways that inhibit the development of new ways of thinking.

This analysis indicates that the extent to which managers overlook, not notice and/or selectively interpret information (as indicated by organizational tenure) is likely to affect the impact of comprehensive PMS on mental model building. Consistent with the above research, managers with longer organizational tenure are more likely to overlook, not notice, and/or selectively interpret information. Thus, by extension, such managers are more likely to overlook, not notice and/or selectively interpret information from comprehensive PMS such that comprehensive PMS has little effect on the process of mental model building. In contrast, managers with shorter organizational tenure are more likely to notice a wider range of information, to not overlook information, and to be non-selective in interpreting information. Thus, by extension, such managers are less likely to overlook, not notice and/or selectively interpret information from comprehensive PMS such that comprehensive PMS has a

greater effect on the process of mental model building. This analysis leads to the following hypothesis:

H2: Comprehensive PMS has a more positive effect on mental model building among managers with shorter organizational tenure compared to managers with longer organizational tenure.³

Prior research indicates that the effect of information contained in MCS often depends on how information is used, such as in interactive or diagnostic (Simons, 1990; Widener, 2007), formal and informal (Chenhall and Morris, 1995), or flexible and inflexible (Chenhall, 2003) systems. In particular, although comprehensive PMS provide more information about business operations, it could be used in formal ways that can inhibit managers' more informal information gathering behaviours that are important for promoting creativity (Preston, 1986). In this way, more formal use of comprehensive PMS may discourage mental model building by reaffirming old rationales for action, stifling innovation and novel interpretations, increasing adherence to what is currently defined as correct or successful performance, and camouflaging insights (Argyris, 1977; 1990; Gray, 1990; Hedberg and Jonsson, 1978; Kloot, 1997; Staw and Boettger, 1990).

In particular, MCS in larger firms tend to be used more formally and less flexibly, whereas MCS in smaller firms tend to operate more organically and informally (Bruns and Waterhouse, 1975; Khandwalla, 1972; Merchant, 1981). Bruns and Waterhouse (1975) found that larger firms were associated with an administrative

³ Following Gerdin and Greve (2004; 2008), this expectation represents a statement about the form of the moderation, i.e., I expect that the impact of comprehensive PMS on mental model building will be different in different subgroups (short vs. long organizational tenure). I expect a monotonic interaction because for managers with longer organizational tenure, they are likely to ignore information and thus comprehensive PMS would have no effect on mental model building, rather than a negative effect.

form of control whereas smaller firms were associated with an interpersonal form of control. Importantly, administrative control involved more formal operating procedures and rules and a perceived lack of flexibility, whereas interpersonal control involved more flexibility around interactions and discussions. In addition, Merchant (1981) argued that larger organizations have more formal patterns of communication, and found that as firms get larger, managers reported having less interpersonal interactions with superiors and subordinates.

If larger firms' MCS are used more formally, this may limit the extent to which even more comprehensive PMS can help managers to engage in mental model building. In contrast, if smaller firms operate MCS in a more flexible and informal way, a more comprehensive PMS is more likely to help managers' build new mental models. In this way, the ability of comprehensive PMS to help managers think creatively about business operations, to challenge and question assumptions, and to broaden and expand their outlook of business unit, is more difficult in situations where there are more formal procedures and rules, and less flexibility and interactions between managers.

Following this analysis, I argue that in smaller SBUs, it is likely that comprehensive PMS is used in more flexible and informal ways and thus, in this setting, is more likely to help the process of mental model building. In contrast, in larger SBUs, it is likely that information from comprehensive PMS is used in more formal and less flexible ways and thus, in this setting, is likely to hinder the mental model building process. This analysis leads to the following hypothesis:

H3: Comprehensive PMS has a more positive effect on mental model building among managers from smaller sized SBUs compared to managers from larger sized SBUs.⁴

2.5. Mental models and managerial performance

Managers who are learning can be expected to perform better than those managers who are not learning (Chenhall and Morris, 1993). Engagement in the learning process helps managers to develop higher levels of insight into the organization's operations than those managers who have not been learning (Chenhall and Morris, 1993). Learning increases a manager's understanding of connections between the manager's actions and outcomes (Lant, Milliken and Batra, 1992), which provides the basis for improved managerial performance.

Both mental model confirmation and mental model building are expected to have positive effects on managerial performance. The process of confirming and building mental models of business operations can improve the manager's ability to assess the organization and its environment and to respond to a variety of situations (Vandenbosch and Higgins, 1995; 1996). Managers who can interpret and understand the state of their organizations and decision environments tend to be more successful in manipulating and changing operating situations to their advantage, thus increasing their performance (Hedberg, 1981). Specifically, mental model confirmation aids managers' efficiency and productivity by using existing mental models to identify and solve problems (Vandenbosch and Higgins, 1995), and helps managers to exploit their

⁴ Following Gerdin and Greve (2004; 2008), this expectation represents a statement about the form of the moderation, i.e., I expect that the impact of comprehensive PMS on mental model building will be different in different subgroups (small vs. large sized SBUs). I expect a non-monotonic interaction because the effects of comprehensive PMS on mental model building for each sub-group are likely to be opposite, i.e., a positive effect in the small SBU size subgroup and a negative effect in the large SBU size subgroup.

existing strengths and competencies (March, 1991). Mental model building helps to promote flexibility, creativity and innovation, which is particularly important in helping managers to deal with uncertain and ambiguous competitive environments (March, 1991; Vandebosch and Higgins, 1995). The process of challenging assumptions and preconceptions about how the business operates can help managers to formulate problems and develop a greater number of solutions (Vandebosch and Huff, 1997). Importantly, building mental models helps managers to develop more relevant and improved models of the organization's operations and thus increases performance (Mintzberg, 1973). Furthermore, mental model building helps managers to develop new approaches, procedures and systems to enhance performance (March, 1991). Based on this discussion, it is expected that both mental model confirmation and mental model building will lead to improved managerial performance, resulting in H4 and H5.

H4: There is a positive association between mental model confirmation and managerial performance.

H5: There is a positive association between mental model building and managerial performance.

3. Research Method

3.1. Sample selection and data collection

Data were collected using a questionnaire administered to SBU managers within Australian manufacturing organizations.⁵ A list of 1000 SBU managers of Australian manufacturing firms was obtained from a commercial mailing list provider. Due to cost constraints, 400 managers were selected to form the sampling frame for the study. A four-step implementation strategy was used following the recommendation of Dillman (2000); (1) telephone calls to check data accuracy⁶, (2) a questionnaire package with cover letter, questionnaire and reply paid envelope, (3) a reminder postcard (sent two weeks after questionnaire package) and (4) a follow-up phone call (made two weeks after the reminder postcard). To encourage completion of the questionnaire, participants were informed that their responses were anonymous, promised a summary of the results, and provided with a practitioner article on PMS as a token incentive (Davila, 2000; Dillman, 2000).

Of the 369 distributed questionnaires, 83 were received, which provides a response rate of 22.5%.⁷ The response rate is similar to those reported in recent surveys of SBU managers in Australian manufacturing organizations (Baines and Langfield-Smith, 2003; Gordon and Sohal, 2001; Moores and Yuen, 2001; Samson and Terziovski, 1999; Terziovski and Sohal, 2000), and is considered within acceptable limits.⁸ Due to the relatively low response rate, several tests of non-

⁵ This paper uses the same data set as Hall (2008).

⁶ The contact details of 31 of the 400 SBU managers could not be confirmed because they had ceased employment with the contact organization, the phone number was disconnected or did not answer, or the organization had ceased operations. As such, the questionnaire was sent to 369 SBU managers.

⁷ 16 cases contained missing data: 14 cases with one item missing, one case with two items missing, and one case with four items missing. Little's MCAR test revealed that the missing data were missing completely at random (MCAR) (chi-square=4.424, degrees of freedom=516, p>0.10). As the missing data is MCAR, any imputation method can be used (Hair et al. 1998). As such, the data were replaced using the expectation-maximisation (EM) method in SPSS. The EM approach is an iterative two-stage process where the E-stage makes the best estimates of the missing data and the M-stage makes parameter estimates assuming the missing data are replaced. This occurs in an iterative process until the changes in the estimated parameters are negligible and the missing values are replaced (Hair et al. 1998; Little and Rubin, 1987). This process resulted in a complete data set of 83 responses.

⁸ Baruch (1999) reports an average (standard deviation) response rate for surveys of top managers of 35.5% (13.3%). As Baruch (1999) recommends, the response rate in this study of 22.5% is within one standard deviation of the average.

response bias were conducted. First, the industry representation and SBU size of the 83 respondents was compared to the original list of 1000 SBUs. A chi-square test shows that the proportion of SBUs in each industry category is not significantly different between the sample SBUs and original list SBUs (chi-square=5.981, degrees of freedom=8, $p>0.10$). In addition, an independent samples t -test shows that the mean sample SBU size ($\bar{X}=336.13$) is not significantly different from the mean original list SBU size ($\bar{X}=566.93$) ($t=1.400$, $p>0.10$). Second, early respondents (first 20%) were compared to late respondents (last 20%), with results (not reported) showing that there are no significant differences for any variables. Finally, the follow-up phone calls were used to discuss with approximately 40 non-respondents their reason(s) for not completing the questionnaire. These reasons were receiving too many surveys, time pressures, and company policy not to respond to voluntary surveys, which are similar to the reasons for non-response reported in other studies (for example, Baines and Langfield-Smith, 2003; Chenhall, 2005; Subramaniam and Mia, 2003). Together, these tests indicate that there is no significant non-response bias in the sample. I also examined the extent of common method bias using Harman's one-factor test on the 25 survey questions used to form the constructs. The unrotated factor solution yielded six factors with eigenvalues >1.0 . The first factor explained 30% of the total variance. Overall, these results indicate the absence of significant single-source bias (Podsakov & Organ, 1986; Widener, 2007; Burney et al., 2009).

Demographic information was collected from respondents regarding tenure in current position, tenure in company, age, gender, SBU size (number of employees), and main manufacturing industry. Table 1 reports the descriptive statistics. The average age of respondents was 46.84 years with an average time of employment in

their current position of 5.14 years and in their organization for 10.64 years. Average SBU size was 336.13 employees. Eighty-two respondents were male and one was female. Table 2 reports the manufacturing industry classification of respondents' SBUs.

<Insert Table 1 here>

<Insert Table 2 here>

3.2. Variable measurement

The development of the questionnaire involved a review by three management accounting academics with experience in survey design. The questionnaire was also pilot tested with four SBU managers, who completed the questionnaire and participated in a brief interview. The review process and the pilot test resulted in minor changes to the wording of some items and the layout of the questionnaire.

Mental models: due to the paucity of research examining mental models, new scales were developed to measure mental model confirmation and mental model building. The items were developed by drawing on descriptions of each construct from the literature on mental models and learning (Huber, 1991; March, 1991; Markman and Gentner, 2001; Norman, 1982; Vandenbosch and Higgins, 1995). As noted above, three academics and four SBU managers reviewed the items for clarity and consistency, with only minor changes to the items from this process. The seven-item scale is shown in Table 3, Panel A. Three items relate to mental model confirmation and address the way in which a manager's mental model of his/her business unit is confirmed and maintained (MM1-MM3). Four items relate to mental

model building and address the way in which a manager's mental model of his/her business unit is questioned and developed (MM4-MM7). Respondents were asked to indicate on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree) the extent to which they agreed or disagreed with each statement.

An exploratory factor analysis was used to examine the dimensionality of the scale. Two factors are expected to emerge corresponding to the two mental model components. The results of the factor analysis of the seven items are shown in Table 3, Panel B. Two factors are extracted, with items MM4, MM5 and MM7 loading on the first factor, and items MM1 and MM2 loading on the second factor. Items MM3 and MM6 load on both factors, therefore, these two items were deleted and the factor analysis re-run, with the results reported in Table 3, Panel C. This shows that all items load on the appropriate factors. As such, I construct a mental model confirmation scale, which comprises items MM1 and MM2, and a mental model building scale, which comprises items MM4, MM5 and MM7. The Cronbach (1951) alpha for the mental model confirmation scale is 0.718, which is above acceptable limits (Nunnally, 1978). The Cronbach (1951) alpha for the mental model building scale is 0.610, which, although below the conventional cut-off of 0.70, is above the limit of 0.60 suggested by Hair et al. (1998) for the development of new scales. The reliability and validity of the mental model confirmation and mental model building scales are further assessed in the PLS measurement model.

Comprehensive performance measurement systems: is measured with the nine-item scale developed by Hall (2008). This scale measures the extent to which a PMS describes the important parts of the SBU's operations and integrates measures with strategy and across the value chain. Respondents were asked to indicate a 7-point Likert scale (1=not at all to 7=to a great extent) the extent to which each of the nine

characteristics was provided by their business unit's PMS. Results from Hall (2008) show that the comprehensive PMS scale is unidimensional and exhibits satisfactory reliability and validity.

Managerial performance: is measured by a self-rated nine-item scale developed by Mahoney, Jerdee and Carroll (1965). This scale was used because it was not possible to obtain supervisor ratings of managers' performance as respondents are anonymous. The scale assesses managerial performance along eight dimensions related to planning, investigating, coordinating, evaluating, supervising, staffing, negotiating and representing, and also includes an overall assessment of performance. Respondents were asked to indicate on a 7-point Likert scale (1=well below average to 7=well above average) the extent to which their performance was below average or above average on each item. The Mahoney et al. (1965) scale is frequently used to measure managerial performance in accounting studies (Chalos and Poon, 2000; Chong and Chong, 2002; Marginson and Ogden, 2005; Otley and Fakiolas, 2000; Parker and Kyj, 2006; Wentzel, 2002), with researchers arguing that self-report measures of performance are valid and tend to exhibit less bias than supervisor ratings (Dunk, 1993; Marginson and Ogden, 2005; Parker and Kyj, 2006), and that self-rated subjective measures of subordinate performances are highly correlated with superiors' subjective ratings of subordinate performance and objective measures of subordinate performance (Furnham and Stringfield, 1994; Heneman, 1974; Venkatraman and Ramanujam, 1987). The reliability and validity of the scales is also examined in the PLS measurement model.⁹

⁹ Following Bisbe et al. (2007), it is important to analyse whether constructs are reflective or formative. In reflective models, indicators are manifestations of an underlying construct whereas in formative models indicators are constituent facets of a construct. Table 1 from Bisbe et al. (2007: 801) provides guidelines to determine whether indicators are formative or reflective. For this study, I conclude that the constructs (comprehensive PMS, mental model confirmation, mental model building, and managerial performance) are all reflective because: the indicators are reflections of the construct rather

<Insert table 3 here>

3.3. Partial Least Squares (PLS) regression

PLS regression analysis is used to analyse the data in this study. PLS is a latent variable modelling technique that incorporates multiple dependent constructs and explicitly recognises measurement error (Fornell, 1982) and has been used in a number of accounting studies (Anderson, Hesford and Young, 2002; Chenhall, 2005; Ittner, Larcker and Rajan, 1997; Vandenbosch, 1999). PLS is particularly suited to this study because it makes minimal data assumptions and requires relatively small sample sizes (Wold, 1985).¹⁰

PLS comprises a measurement model and a structural model. The measurement model specifies relations between observed items and latent variables. The structural model specifies relations between latent constructs. In PLS the measurement and structural models are estimated simultaneously (Barclay, Thompson and Higgins, 1995). However, the PLS model is typically interpreted in two stages. First, the reliability and validity of the measurement and model is assessed. Second, the structural model is assessed (Barclay et al., 1995). This ensures that the constructs' measures are reliable and valid before assessing the nature of the relations between

than defining characteristics of the construct (e.g., for comprehensive PMS, the indicators are not defining characteristics of the construct as dropping one/some of the indicators would not alter its conceptual domain), they are expected to covary (e.g., higher scores on one mental model confirmation indicator is expected to relate to higher scores on the other indicators), they have similar content (e.g., the indicators for mental model building all relate to processes of challenging, questioning and changing thinking about business unit operations) and they have the same antecedents and consequences (e.g., higher mental model building is expected to relate positively to all the indicators of managerial performance).

¹⁰ Mardia's (1970) test of multivariate kurtosis revealed that the data are multivariate non-normal ($t = 26.076$, $p < 0.001$). However, unlike covariance-based structural equation modelling techniques such as LISREL, PLS does not require normally distributed data. Because PLS is a regression based technique, it requires ten cases for the most complex regression (Chin, 1998; Vandenbosch, 1999). In this study, the most complex regression is that with managerial performance as the dependent variable, with three independent variables, suggesting a minimum sample size of 30 cases.

the constructs (Barclay et al., 1995; Hair et al., 1998; Hulland, 1999). As such, the results from the measurement model are presented first followed by an examination of the relations between the constructs.¹¹

4. Results

4.1. Measurement model

Statistics from the PLS measurement model are used to examine the psychometric properties of the variables. First, the factor loadings for each variable are examined. As shown in Table 4 all items load above 0.5 on their respective constructs.¹² The reliability of each variable was assessed using Fornell and Larcker's (1981) measure of composite reliability. As shown in Table 5 the composite reliability scores for each variable are above 0.70, which demonstrates acceptable reliability (Nunnally, 1978).

Cronbach's (1951) alpha statistics are also provided, with all variables scoring above 0.70, except for the mental model building scale as noted earlier. Convergent validity of the variables is assessed by examining the average variance extracted (AVE) statistics. Table 5 shows that the AVE for each variable is 0.50 and above, which demonstrates adequate convergent validity (Chin, 1998; Hair et al., 1998).

¹¹ All PLS models were estimated using PLS Graph Version 3.0.

¹² In the initial PLS model two items from the managerial performance scale had factor loadings below 0.5 (Hulland, 1999) (item MP7=0.466 and item MP8=0.285). I removed these two items from the scale as low item loadings add very little to the explanatory power of the model while potentially biasing the estimates of the parameters linking the constructs (Chin, 1998; Hulland, 1999). The reason for the low item loadings is that MP7 and MP8 do not form part of a unidimensional managerial performance scale (Barclay et al. 1995). An explanatory factor analysis (oblique rotation) of the managerial performance scale shows two factors with eigenvalues greater than one, with items MP1-MP6 and MP9 loading on the first factor, and items MP7 and MP8 loading on a second factor.

The AVE statistic is also used to assess discriminant validity by comparing the square root of the AVE statistics to the correlations among the latent variables (Chin, 1998). This tests whether a construct shares more variance with its measures than it shares with other constructs (Fornell and Larcker, 1981). Table 1 shows that the square roots of the AVEs (diagonal) are all greater than the respective correlation between constructs. In addition, Table 4 shows that each item loads higher on the construct it intends to measure than on any other construct (Chin, 1998, Barclay et al., 1995). The results of these two tests demonstrate adequate discriminant validity. Overall, the results from the PLS measurement model indicate that each construct exhibits satisfactory reliability and validity.

<Insert Table 4 here>

<Insert Table 5 here>

4.2. Tests of hypotheses

To examine the relations between the constructs a structural model is estimated in PLS. To partially address endogeneity concerns (Chenhall and Moers, 2007), the structural model also includes job tenure as a control variable as managers with longer tenure in their current job are likely to have access to more information and have developed enhanced learning capabilities. The objective of PLS is to maximise variance explained rather than fit, therefore prediction-orientated measures, such as R^2 , are used to evaluate PLS models (Chin, 1998). PLS produces standardized β s for each path coefficient, which are interpreted in the same way as in OLS regression. As

PLS makes no distributional assumptions, bootstrapping (1000 samples with replacement) is used to evaluate the statistical significance of each path coefficient (Chin, 1998).¹³

4.3. Comprehensive PMS, mental model confirmation and mental model building

I first examine relations between comprehensive PMS, mental model confirmation and mental model building. Results from the full sample are reported in Table 6 and show a positive association between comprehensive PMS and mental model confirmation ($\beta=0.431$, $t=4.548$, $p<0.01$), which supports H1. In contrast, as expected, results show that the association between comprehensive PMS and mental model building is not statistically significant ($\beta=0.168$, $t=1.247$, $p>0.05$).

As outlined in H2 and H3, it is expected that the relation between comprehensive PMS and mental model building is affected by organizational tenure and SBU size. To examine the effect of organizational tenure on the relation between comprehensive PMS and mental model building, I create two subsamples by splitting the full sample at the median value of the organizational tenure variable (9 years). This creates a 'short' organizational tenure subsample ($n=42$, mean tenure=4.05, stdev=2.77) and a 'long' organizational tenure subsample ($n=41$, mean tenure=17.37, stdev=6.22). I then re-estimate the structural model in both the 'short' and 'long' organizational tenure subsamples, as shown in Table 7. To test the hypothesis, I perform a t -test on the difference in regression coefficients on the comprehensive PMS-mental model building path between the two subsamples (Hartmann and Moers, 1999; Gerdin and Greve, 2004; 2008). Results show that the magnitude of the

¹³ Statistical significance is determined using the reported original PLS estimates and bootstrapped standard errors.

regression coefficient on the comprehensive PMS-mental model building path in the ‘short’ organizational tenure subsample ($\beta=0.304$) is greater than the regression coefficient on the comprehensive PMS-mental model building path in the ‘long’ organizational tenure subsample ($\beta=0.193$), however, as the difference in coefficients is not statistically significant (difference=0.110, $t=0.340$, $d.f.=81$, $p>0.05$, two-tailed test), H2 is not supported.^{14 15} As further analysis, I also examine whether, in each subgroup, comprehensive PMS helps or hinders mental model building (see Mia and Chenhall, 1994:9; Hartmann and Moers, 1999: 307). Results show that the effect of comprehensive PMS on mental model building is positive and significant in the ‘short’ organizational tenure subgroup ($\beta=0.304$, $t=1.797$, $p<0.05$) but not significant

¹⁴ I follow Eberl (2010) and use the following t -statistic to assess the statistical significance of the difference in coefficients between the two models:

$$t = \frac{Path_{sample1} - Path_{sample2}}{\sqrt{s.e.^2_{sample1} \frac{(m-1)^2}{(m+n-2)} + s.e.^2_{sample2} \frac{(n-1)^2}{(m+n-2)^2} \cdot \sqrt{\frac{1}{m} + \frac{1}{n}}}}$$

Distributed t_{m+n-2}

with

$Path_{sample1/2}$	original sample estimate for the path coefficient in both subsamples respectively
M	number of cases in sample 1
N	number of cases in sample 2
$s.e._{sample1/2}$	standard error of the path coefficient in both subsamples respectively

¹⁵ As the group comparison approach can be considered suboptimal for continuous variables (Gerdin and Greve, 2008; Henseler and Fassott (2010)), I also construct models to test interaction effects directly in PLS, using the procedure in Henseler and Fassott (2010) and Chin et al. (2003). Unlike moderated regression analysis used in prior management accounting studies, this procedure involves constructing the interaction term using the products of the indicators of the latent independent variable and latent moderator variable, rather than construction of product terms from the latent variables directly. Thus, the interaction term is comprised of $X \times M$ indicators, where X represents the number of indicators of the latent independent variable, and M represents the number of indicators of the latent moderator variable. Prior to creating the products of the interaction terms, the indicators of the latent independent and moderator variables are centred. In this study, to test for the interaction effect of organizational tenure, I estimate a PLS model with comprehensive PMS, organizational tenure, and comprehensive PMS x organizational tenure interaction as independent variables, and mental model building as the dependent variable. Following the procedure above, the interaction term comprises the products of the indicators of comprehensive PMS (X) and organizational tenure (M), resulting in $(X \times M) 9 \times 1=9$ indicators for the interaction term. Results from the PLS structural model show that the path on the interaction term is positive but not statistically significant ($\beta=0.1891$, $t=0.887$, $p>0.05$), which is consistent with the results of the group comparison approach.

in the 'long' organizational tenure subgroup ($\beta=0.193$, $t=0.790$, $p>0.05$). This indicates that comprehensive PMS helps the process of mental model building for managers with a 'short' organizational tenure but has no effect on mental model building for managers with a 'long' organizational tenure.¹⁶

To examine the effect of SBU size on the relation between comprehensive PMS and mental model building, I first create two subsamples by splitting the full sample at the median value of SBU size (210 employees). This creates a 'small' SBU size subsample ($n=41$, mean size=121.29, stdev=63.15) and a 'large' SBU size subsample ($n=42$, mean size=540.20, stdev=620.83). I then re-estimate the structural model in both the 'small' and 'large' SBU size subsamples, as shown in Table 8. As above, I test the hypothesis using a t -test on the difference in the regression coefficient on the comprehensive PMS-mental model building path between the two subsamples.

Results show that the magnitude of the regression coefficient on the comprehensive PMS-mental model building path in the 'small' SBU size subsample ($\beta=0.524$) is greater than the regression coefficient on the comprehensive PMS-mental model building path in the 'large' SBU size subsample ($\beta=-0.219$), and that the difference is statistically significant (difference=0.743, $t=3.417$, d.f.=81, $p<0.01$, two-tailed test), thus supporting H3.¹⁷ I examine the monotonicity of this effect using the signs of the regression coefficients in the two-subsamples (Hartmann and Moers, 1999: 307). As

¹⁶ I also perform t -tests on the difference in regression coefficients for the other paths in the model, with results showing no statistically significant differences between the short and long organizational tenure subgroups: comprehensive PMS-mental model confirmation (difference=0.241, $t=1.218$, d.f.=81, $p>0.05$, two-tailed test), mental model confirmation-managerial performance (difference=0.239, $t=1.095$, d.f.=81, $p>0.05$, two-tailed test), and mental model building-managerial performance (difference=0.208, $t=0.782$, d.f.=81, $p>0.05$, two-tailed test).

¹⁷ Using the same procedure outlined above, to test for the interaction effect of SBU size, I estimate a PLS model with comprehensive PMS, SBU size, and comprehensive PMS x SBU size interaction as independent variables, and mental model building as the dependent variable. The interaction term comprises the products of the indicators of comprehensive PMS (X) and SBU size (M), resulting in (X x M) 9 x 1=9 indicators for the interaction term. Results from the PLS structural model show that the path on the interaction term is negative and statistically significant ($\beta=-0.550$, $t=1.995$, $p<0.05$), which is consistent with the results of the group comparison approach.

the sign of the regression coefficient is positive in the ‘small’ SBU size subsample and negative in the ‘large’ SBU size subsample, this indicates a non-monotonic interaction. Finally, as above, I examine the statistical significance of the comprehensive PMS-mental model building path in each subsample. Results show that the effect of comprehensive PMS on mental model building is positive and significant in the ‘small’ SBU size subgroup ($\beta=0.524$, $t=4.132$, $p<0.01$) and negative but not significant in the ‘large’ SBU size subgroup ($\beta=-0.219$, $t=-1.225$, $p>0.05$). This indicates that comprehensive PMS helps the process of mental model building for managers in a ‘small’ SBU but has no effect on mental model building for managers in a ‘large’ SBU.¹⁸

<Insert Table 6 here>

<Insert Table 7 here>

<Insert Table 8 here>

4.4. Mental model confirmation, mental model building and managerial performance

In relation to the effect of mental models on managerial performance, results from the full sample in Table 6 show that there is a positive association between mental model confirmation and managerial performance ($\beta=0.348$, $t=3.196$, $p<0.01$) (H4), and a positive association between mental model building and managerial performance ($\beta=0.440$, $t=5.006$, $p<0.01$) (H5).¹⁹

¹⁸ I also perform *t*-tests on the difference in regression coefficients for the other paths in the model, with results showing no statistically significant differences between the small and large SBU size subgroups: comprehensive PMS-mental model confirmation (difference=0.168, $t=0.919$, d.f.=81, $p>0.05$, two-tailed test), mental model confirmation-managerial performance (difference=0.036, $t=0.134$, d.f.=81, $p>0.05$, two-tailed test), and mental model building-managerial performance (difference=0.153, $t=0.553$, d.f.=81, $p>0.05$, two-tailed test).

¹⁹ I also analyse the statistical significance of the indirect effects in the full sample model using a bootstrapping procedure. Common techniques used to test for indirect effects include the Sobel test and the three-step procedure of Baron and Kenny (1986). However, recent research in the methodological literature indicates that bootstrapping is often the preferred approach because the more common techniques are only robust under large sample sizes and/or for data that follows a multivariate normal distribution (see, for example, Preacher and Hayes, 2004; 2008; Mackinnon et al. 2004). Following

The above analysis supports the expectation that both mental model confirmation and mental model building have independent, positive associations with managerial performance. In practice, however, managers will be engaged in both forms of mental modelling at the same time. Thus, in this setting, it is of interest to examine the managerial performance effects from different levels of mental model confirmation and mental model building. Based on the discussion for H4 and H5, it is likely that highest managerial performance would occur when both mental model confirmation and mental model building are high, and lowest performance would occur when mental model confirmation and mental model building are low.

Following the same procedure as above for testing interaction effects, I estimate a PLS model with mental model confirmation, mental model building, and mental model confirmation x mental model building interaction as independent variables, and managerial performance as the dependent variable.²⁰ Results from the PLS structural model show that the path on the interaction term is negative and statistically significant ($\beta=-2.17$, $t=1.920$, $p<0.05$). To further investigate the nature of the interaction, I used median splits to create ‘low’ and ‘high’ subgroups for both mental model confirmation and mental model building, and then examine differences in the mean managerial performance scores for each of the four subgroups, as shown in

this, as the sample in this study is relatively small and the data does not follow a multivariate normal distribution, the bootstrapping approach is more appropriate. For each of the 1000 bootstraps, I multiply the estimated coefficients for each direct path to calculate an estimated coefficient for the indirect effect (e.g., multiply comprehensive PMS-mental model confirmation path coefficient by the mental model confirmation-managerial performance path coefficient for each of the 1000 bootstraps). I determine statistical significance by rank-ordering the 1000 indirect effect coefficients and examine the percentage above (for negative effects)/below (for positive effects) zero (for a more comprehensive description of this procedure, see Preacher and Hayes (2008: 883-884), and, for an example in the accounting literature, see Hall and Smith (2009)). Results show that the comprehensive PMS-mental model confirmation-managerial performance path is significant (mean indirect effect=0.160, $p=0.003$). In contrast, the comprehensive PMS-mental model building-managerial performance path is not significant (mean indirect effect=0.081, $p=0.102$).

²⁰ Following the procedure above, the interaction term comprises the products of the indicators of mental model confirmation (X) and mental model building (M), resulting in (X x M) 2 x 3=6 indicators for the interaction term. For the sake of brevity, the full results of the PLS models using interaction terms have not been reproduced but are available from the author upon request.

Table 9. As expected, lowest performance occurs where both mental model confirmation and mental model building are low (Cell A), with the mean score in Cell A significantly lower than the mean scores in all other subgroups (all $t > 2.644$).²¹ Contrary to expectations, highest performance occurs where mental model confirmation is low and mental model building is high (Cell C). However, a comparison of the mean scores in Cells B, C and D reveals they are not statistically different from each other (all $t < 2.644$). Overall, this analysis indicates that managerial performance is highest where either (or both) mental model confirmation and mental model building is high (Cells B, C and D), and managerial performance is lowest when both mental model confirmation and mental model building are low (Cell A). This suggests that for managers with low levels of both mental model confirmation and mental model building, performance can be enhanced by developing capabilities to engage in further mental model confirmation *and* further mental model building.²²

<insert Table 9>

5. Discussion

²¹ Using Dunn's (Bonferonni) test, the critical t-value for experiment-wide $\alpha=0.05$ is 2.644 (6 comparisons).

²² To ensure the results are robust to the specification of different mediators, I also test a model that includes mental model confirmation and mental model building in the model tested in Hall (2008). That is, I estimate a structural model in PLS with the following variables: comprehensive performance measurement systems, role clarity, psychological empowerment, mental model confirmation, mental model building and managerial performance. The results from this model for the mental model variable paths are qualitatively similar to those reported in Table 6, i.e., the paths from comprehensive PMS to mental model confirmation ($\beta=0.427$, $t=4.307$, $p<0.01$), mental model confirmation to managerial performance ($\beta=0.233$, $t=2.449$, $p<0.01$), and mental model building to managerial performance ($\beta=0.263$, $t=3.099$, $p<0.01$) are positive and significant, and the path from comprehensive PMS to mental model building is not significant ($\beta=0.169$, $t=1.351$, $p>0.05$). Further, the results concerning the estimated paths between comprehensive PMS, role clarity, psychological empowerment and managerial performance are qualitatively similar to those reported in Hall (2008). Given space limitations, the full results of this model are not reported, but are available from the author upon request.

This study examined relations among comprehensive PMS, two types of learning (mental model confirmation and mental model building), and managerial performance. Findings indicate that a more comprehensive PMS can help managers to engage in learning processes related to mental model confirmation. This result points to the way in which a more comprehensive PMS, through describing the operations of the business more effectively, provides managers with the necessary feedback to verify and confirm their mental models of business operations. In contrast, findings show that a more comprehensive PMS can help managers to build new mental models of business unit operations, but only in specific settings, that is, for managers with a short organizational tenure and/or from a small-sized strategic business unit. This finding helps to further our understanding of the tension between those who argue that formal systems, like comprehensive PMS, stifle innovation and new ways of thinking (e.g., Hedberg and Jonsson, 1978; Preston, 1986; Staw and Boettger, 1990) and those who argue that BSC-like systems can generate ‘double-loop’ learning effects (e.g., Kaplan and Norton, 1996). Although preliminary, the findings indicate that the effect of MCS, like comprehensive PMS, on mental model building is neither uniformly constraining or enabling, but depends on particular characteristics of managers and on how information from MCS is used. This indicates that neither of the above arguments is correct, insofar as MCS can help *and* hinder the learning process in particular situations. As such, much can be gained from a more nuanced and context-specific examination of how particular MCS characteristics can help or hinder the development of mental models.

Results related to mental models and managerial performance indicate that both mental model confirmation and mental model building have strong positive associations with managerial performance. This is consistent with the benefits that

flow from increased mental model confirmation, such as greater exploitation of existing strengths and competencies, and benefits from increased mental model building, such as greater flexibility, innovation and creativity (March, 1991; Vandebosch and Higgins, 1995). Given the strong effect of both mental model confirmation and mental model building on managerial performance, the study indicates that much can be gained from investigating how aspects of MCS may help to develop these two types of managers' learning capabilities.

The results of the study contribute to the literature in several ways. The findings shed light on the process of knowledge generation and learning at the managerial (individual) level. This contributes to the emerging body of literature that examines how particular cognitive and motivational mechanisms explain the effects of PMS on performance (Hall, 2008; Burney and Widener, 2007; Burney et al., 2009), as well as research that examines links between MCS and learning processes in organizations more broadly (Chenhall, 2005; Henri, 2006; Kloot, 1997; Widener, 2007). Using theories of learning from cognitive psychology, the study identified two different yet related learning processes, mental model confirmation and mental model building. By identifying two key dimensions of managers' learning processes, the study provides a conceptual advance in our understanding of the effects of MCS on different types of learning processes. Such an approach is also consistent with recommendations to pay careful attention to the conceptual specification of constructs in theory-based management accounting research (Bisbe, Batista-Foguet and Chenhall, 2007). The study also responds to calls to investigate how specific attributes of MCS affect learning (Otley, 1999; Shields, 1997) by identifying a key element of MCS, comprehensive PMS, which facilitates the learning process.

The study is subject to several limitations. The study presents statistical associations that are consistent with the theory developed in the paper. However, such associations present necessary but not sufficient conditions for proof of causal relationships among the variables in the model. Job tenure was included in the analysis to partially address endogeneity concerns; however, it is possible that there are other correlated variables that were omitted from the model. Although several tests indicate an absence of non-response bias, the relatively low response rate is a limitation of the study. Finally, there are issues related to variable measurement. Although managers are considered the best judges of their own performance (Brownell, 1995), future research would benefit from confirmation of managers' ratings using supervisor ratings, if possible within the research design. The measures used for mental model confirmation and mental model building were novel and several items from the original instrument were discarded due to reliability concerns. Thus, further research is needed to refine and validate this instrument. Finally, organizational tenure and SBU size were used as proxies for the extent to which managers selectively perceive information and the way that comprehensive PMS are used. Future research would benefit from the use of instruments to measure these underlying constructs more directly.

The study points to several avenues for future research. As the results of the study show that MCS can affect learning at the managerial level, there is wide scope to investigate how other characteristics of MCS, such as different forms of cost information or different elements of the levers of control framework (Simons, 1995; Widener, 2007), relate to mental model confirmation and mental model building. In particular, the strong effect of mental model building on managerial performance indicates that much can be gained by examining how elements of MCS may be able to

facilitate the building of managers' mental models. Prior research indicates that the propensity of managers to learn from information provided by MCS is influenced by different types of incentive contracts (Sprinkle, 2000). As such, future research could investigate how feedback from more contemporary MCS, like comprehensive PMS, is related to learning processes under different incentive arrangements. A further avenue for future research is to consider how the personal styles and preferences for different managers may affect the role of MCS in facilitating learning. For example, differences in learning preferences or cognitive styles are likely to influence whether and how managers use MCS in learning processes (Cheng, Luckett and Schulz, 2003; Chenhall and Morris, 1991). Further research could also examine how other variables, such as different strategies, levels of uncertainty, and the need for innovation effect the way in which comprehensive PMS relates to mental model building. Finally, this study examined the relation between MCS and learning processes among SBU managers from manufacturing firms. Thus, investigation of how MCS help or hinder learning in more knowledge-intensive firms (e.g., Ditillo, 2004) represents a promising line of inquiry.

Table 1
Descriptive statistics and correlations

Variable	Mean	Standard Deviation	<i>Correlations</i>							
			CPMS	MMC	MMB	MP	Job Tenure	Organiza tional tenure	Age	SBU size
CPMS	4.657	1.289	0.840							
MMC	5.175	0.794	0.443**	0.883						
MMB	5.490	0.805	0.153	0.278*	0.750					
MP	5.405	0.610	0.322**	0.447**	0.531**	0.707				
Job Tenure (years)	5.14	5.95	0.123	0.171	-0.072	0.043	-			
Organizational tenure (years)	10.64	8.37	0.220*	0.071	-0.152	0.000	0.477**	-		
Age (years)	46.84	8.38	0.180	0.204	0.098	0.069	0.453**	0.371**	-	
SBU size (no. of employees)	336.13	497.03	0.033	-0.052	0.082	0.025	-0.067	0.180	0.017	-

n=83

*p<0.05, **p<0.01 (two-tailed)

CPMS – comprehensive performance measurement system, MMC – mental model confirmation, MMB- mental model building, MP – managerial performance

Diagonal elements are the square roots of the AVE statistics. Off-diagonal elements are the correlations between the variables calculated in SPSS

Table 2

Manufacturing industry classification

ANZSIC ^a Manufacturing industry classification	Frequency	%
21 – Food, beverage and tobacco	8	9.64
22 – Textile, clothing, footwear and leather	3	3.61
23 – Wood and paper products	6	7.23
24 – Printing, publishing and recorded media	3	3.61
25 – Petroleum, coal, chemical and associated products	12	14.46
26 – Non-metallic mineral products	4	4.82
27 – Metal products	11	13.25
28 – Machinery equipment	25	30.12
29 – Other	11	13.25
Total sample	83	100

a ANZSIC – Australia and New Zealand Standard Industrial Classification

Table 3
Mental model scale items and factor analysis

Panel A: Items

Mental Model Confirmation

My beliefs about the operations of my business unit are regularly confirmed and supported MM1

My views about the operating situation of my business unit are often maintained and validated MM2

I regularly verify my assumptions about the operations of my business unit MM3

Mental Model Building

I regularly challenge and question my assumptions about the way my business unit operates MM4

I often think creatively about the operations of my business unit MM5

I often change and re-orient my thinking about the way my business unit operates MM6

I continually broaden and expand my outlook of my business unit MM7

Panel B: Factor analysis of all mental model scale items

Item	Factor loadings	
	MMB	MMC
MM1	-0.003	-0.829
MM2	0.175	-0.792
MM3	0.523	-0.511
MM4	0.643	-0.112
MM5	0.621	-0.086
MM6	0.602	0.471
MM7	0.795	-0.042
Eigenvalue	2.618	1.390
% variance explained	37.395%	19.860%

Panel C: factor analysis of mental model items – MM3 and MM6 removed

Item	Factor loadings	
	MMB	MMC
MM1	-0.125	-0.930
MM2	0.185	-0.818
MM4	0.727	0.014
MM5	0.692	-0.082
MM7	0.818	0.054
Eigenvalue	2.100	1.189
% variance explained	42.00%	23.78%

n=83

MMB – mental model building, MMC – mental model confirmation

Table 4
Factor loadings from PLS measurement model

Item	CPMS	MMC	MMB	MP
CPMS1	0.919	0.430	0.207	0.319
CPMS2	0.777	0.325	0.082	0.238
CPMS3	0.837	0.328	0.146	0.303
CPMS4	0.802	0.255	0.163	0.200
CPMS5	0.904	0.467	0.111	0.241
CPMS6	0.852	0.331	0.166	0.313
CPMS7	0.860	0.363	0.124	0.251
CPMS8	0.738	0.335	0.058	0.251
CPMS9	0.851	0.456	0.116	0.251
MM1	0.443	0.855	0.143	0.287
MM2	0.355	0.909	0.357	0.540
MM4	0.112	0.201	0.713	0.372
MM5	0.109	0.255	0.751	0.435
MM7	0.131	0.206	0.785	0.407
MP1	0.261	0.324	0.346	0.652
MP2	0.219	0.293	0.309	0.577
MP3	0.246	0.262	0.333	0.708
MP4	0.185	0.392	0.373	0.718
MP5	0.220	0.244	0.435	0.749
MP6	0.268	0.424	0.442	0.743
MP9	0.167	0.408	0.414	0.782

CPMS – comprehensive performance measurement system, MMC – mental model confirmation, MMB – mental model building, MP – managerial performance.
n=83

Table 5
Reliability and average variance extracted (AVE) statistics

Variable	Cronbach Alpha	Composite Reliability	AVE
CPMS	0.946	0.955	0.705
MMC	0.718	0.876	0.779
MMB	0.610	0.794	0.562
MP	0.824	0.874	0.500

n=83

CPMS – comprehensive performance measurement system, MMC – mental model confirmation, MMB – mental model building, MP – managerial performance

Table 6
 Full sample PLS structural model results: path coefficients, t statistics and R²

Dependent Variables	Independent Variables			R ²
	Comprehensive PMS	Mental Model Confirmation	Mental Model Building	
Comprehensive PMS	-	-	-	0.015
Mental Model Confirmation	0.431 (4.548**)	-	-	0.268
Mental Model Building	0.168 (1.247)	-	-	0.034
Managerial Performance	-	0.348 (3.196**)	0.440 (5.006**)	0.410

n=83

Each cell reports the path coefficient (t-value).

*p<0.05, **p<0.01 – one-tailed tests.

Blank cells indicate the path was not tested in the PLS model.

Table 7

Short vs. long organizational tenure PLS structural model results: path coefficients, t statistics and R²

Panel A: Short organizational tenure (n=42)

Dependent Variables	Independent Variables				R ²
	Comprehensive PMS	Mental Model Confirmation	Mental Model Building	Job Tenure	
Comprehensive PMS	-	-	-	0.214 (1.637)	0.049
Mental Model Confirmation	0.348 (1.946)*	-	-	0.047 (0.365)	0.131
Mental Model Building	0.304 (1.797)*	-	-	-0.234 (-2.022)*	0.116
Managerial Performance	-	0.199 (1.405)	0.614 (5.313)**	0.205 (1.639)	0.529

Panel B: Long organizational tenure (n=41)

Dependent Variables	Independent Variables				R ²
	Comprehensive PMS	Mental Model Confirmation	Mental Model Building	Job Tenure	
Comprehensive PMS	-	-	-	-0.026 (0.196)	0.001
Mental Model Confirmation	0.589 (6.792)**	-	-	0.255 (2.231)*	0.404
Mental Model Building	0.193 (0.790)	-	-	0.054 (0.409)	0.040
Managerial Performance	-	0.438 (2.574)**	0.406 (1.653)*	-0.069 (0.435)	0.429

Each cell reports the path coefficient (t-value).

*p<0.05, **p<0.01 – one-tailed tests

Blank cells indicate the path was not tested in the PLS model.

To create sub-samples of short and long organizational tenure, the full sample was split at the median number of years in the organization of 9 years.

Table 8
Small vs. large business units PLS structural model results: path coefficients, t statistics and R²

Panel A: Small SBUs (n=41)

Dependent Variables	Independent Variables				R ²
	Comprehensive PMS	Mental Model Confirmation	Mental Model Building	Job Tenure	
Comprehensive PMS	-	-	-	0.096 (0.696)	0.009
Mental Model Confirmation	0.538 (4.970)**	-	-	0.315 (2.872)**	0.421
Mental Model Building	0.524 (4.132)**	-	-	-0.028 (0.265)	0.272
Managerial Performance	-	0.410 (2.991)**	0.528 (4.787)**	-0.126 (1.321)	0.609

Panel B: Large SBUs (n=42)

Dependent Variables	Independent Variables				R ²
	Comprehensive PMS	Mental Model Confirmation	Mental Model Building	Job Tenure	
Comprehensive PMS	-	-	-	0.120 (0.885)	0.014
Mental Model Confirmation	0.370 (2.482)**	-	-	-0.080 (-0.719)	0.136
Mental Model Building	-0.219 (-1.225)	-	-	-0.191 (-1.308)	0.045
Managerial Performance	-	0.374 (1.684)*	0.375 (1.471)	0.237 (1.170)	0.306

Each cell reports the path coefficient (t-value).

*p<0.05, **p<0.01 – one-tailed tests

Blank cells indicate the path was not tested in the PLS model.

To create sub-samples of small and large SBUs, the full sample was split at the median number of employees in business unit of 210.

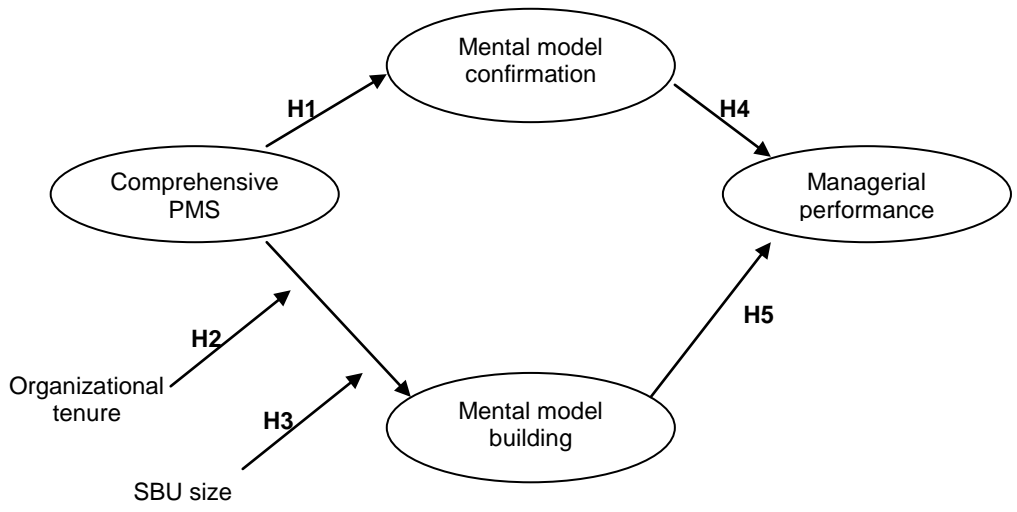
Table 9

Two-way interaction of mental model confirmation and mental model building-mean scores of managerial performance

		Mental model confirmation	
		Low	High
Mental model building	Low	A	B
		X=4.942 SD=0.439 n=31	X=5.592 SD=0.745 n=10
	High	C	D
		X=5.757 SD=0.461 n=13	X=5.679 SD=0.478 n=29

Each cell reports the mean (standard deviation) managerial performance score

Figure 1
Theoretical model



References

- Anderson, S.W., Hesford, J.W., Young, S.M., 2002. Factors influencing the performance of activity based costing systems: a field of study of ABC model development time in the automobile industry. *Accounting, Organizations and Society* 27:195-211.
- Argyris, C., 1977. Organizational learning and management information systems. *Accounting, Organizations and Society* 2:113-129.
- Argyris, C., Schon, D., 1978. *Organizational learning*. Reading: Addison-Wesley Publishing Co.
- Argyris, C., 1990. The dilemma of implementing controls: the case of managerial accounting. *Accounting, Organizations and Society* 15:503-511
- Ashford, S.J., 1986. Feedback-seeking in individual adaptation: a resources perspective. *Academy of Management Journal* 29(3), 465-487.
- Baines, A., Langfield-Smith, K. 2003. Antecedents to management accounting change: a structural equation approach. *Accounting, Organizations and Society* 28:675-698.
- Barclay, D., Thompson, R., Higgins. C., 1995. The partial least squares (PLS) approach to causal modelling: personal computer adoption and use as an illustration. *Technology Studies* 2:285-309
- Baron, R. M., Kenny, D. A., 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology*, 51, 1173-1182.
- Baruch, Y., 1999. Response rate in academic studies – a comparative analysis. *Human Relations* 52:421-438.
- Beyer, J.M., Chattopadhyay, P., George, E., Glick, W.H., Pugliese, D., 1997. The Selective Perception of Managers Revisited. *The Academy of Management Journal*, 40(3), 716-737.
- Birnberg, J. G., Luft, J., Shields, M.D., 2007. Psychology theory in management accounting research. In: Chapman, C.S, Hopwood, A.G., Shields, M.D., *Handbook of Management Accounting Research*, Oxford, Elsevier, 113-135.
- Bisbe, J., Batista-Foguet, J., Chenhall, R.H. 2007. Defining management accounting constructs: A methodological note on the risks of conceptual misspecification. *Accounting, Organizations and Society* 32:789-820.
- Brownell, P. 1995. *Research Methods in Management Accounting*. Melbourne: Coopers & Lybrand.
- Bruns, W.J., Waterhouse, J.J., 1975. Budgetary control and organization structure. *Journal of Accounting Research* 13:177-203.
- Burney, L.L., Widener, S.K., 2007. Strategic Performance Measurement Systems, Job-Relevant Information, and Managerial Behavioral Responses — Role Stress and Performance. *Behavioral Research in Accounting*, 19: 43-69.
- Burney, L.L., Henle, C.A., Widener, S.K., 2009. A path model examining the relations among strategic performance measurement system characteristics, organizational justice, and extra- and in-role performance. *Accounting, Organizations and Society*, 34(3-4): 305-321.
- Chalos, P., Poon, M.C., 2000. Participation and performance in capital budgeting teams. *Behavioral Research in Accounting* 12:199-229.
- Cheng M.M., Luckett, P.F., Schulz, A.K.D., 2003. The effects of cognitive style diversity on decision making dyads: an empirical analysis in the context of a complex task. *Behavioral Research in Accounting* 15:39-62.

- Chenhall, R.H., 2003. Management control systems design within its organizational context: findings from contingency-based research and directions for the future. *Accounting, Organizations and Society* 28:127-168.
- Chenhall, R.H., 2005. Integrative strategic performance measurement systems, strategic alignments of manufacturing, learning and strategic outcomes: an exploratory study. *Accounting, Organizations and Society* 30:395-422.
- Chenhall, R.H., Moers, F., 2007. The Issue of Endogeneity within Theory-Based, Quantitative Management Accounting Research. *European Accounting Review* 16:173-195.
- Chenhall, R.H., Morris, D., 1991. The effect of cognitive style and sponsorship bias on the treatment of opportunity costs in resource allocation decisions. *Accounting, Organizations and Society* 16:27-46.
- Chenhall, R.H., Morris, D., 1993. The role of post completion audits, managerial learning, environmental uncertainty and performance. *Behavioral Research in Accounting* 5:170- 186.
- Chenhall, R.H., Morris, D., 1995. Organic decision and communication processes and management accounting systems in entrepreneurial and conservative business organizations. *Omega, International Journal of Management Science*, 23(5), 485-497.
- Chin, W.W., 1998. The partial least squares approach to structural equation modelling. In: Marcoulides, G.A., *Modern Methods for Business Research*, Mahwah, Lawrence Erlbaum, 295-336.
- Chin, W.W., Marcolin, B.L., Newsted, P.N., 2003. A partial least squares latent variable modelling approach for measuring interaction effects: results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research*, 14(2), 189-217.
- Chong, V.K., Chong, K.M., 2002. Budget goal commitment and informal effects of budget participation on performance: a structural equation modelling approach. *Behavioral Research in Accounting* 14:65-86.
- Cronbach, L.J., 1951. Coefficient alpha and the internal structure of tests. *Psychometrika*: 297-334.
- Davila, T., 2000. An empirical study on the drivers of management control systems' design in new product development. *Accounting, Organizations and Society* 25:383-409.
- De-Haas, M., Alegra, J.A., 2002. Demonstrating the effect of the strategic dialogue: participation in designing the management control system. *Management Accounting Research* 13:41-69.
- Dillman, D.A., 2000. *Mail and Internet Surveys: The Tailored Design Method*. New York: John Wiley & Sons.
- Ditillo, A., 2004. Dealing with uncertainty in knowledge intensive-firms: the role of management control systems as knowledge integration mechanisms. *Accounting, Organizations and Society* 29:401-421.
- Dunk, A.S., 1993. The effects of job-related tension on managerial performance in participative budgetary settings. *Accounting, Organizations and Society* 18:575-585.
- Eberl, M., 2010. An application of PLS in multi-group analysis: the need for differentiated corporate-level marketing in the mobile communications industry. In: Esposito Vinzi, V., Chin, W.W., Henseler, J., Wang, H. *Handbook of partial least squares*. Heidelberg: Springer, 487-514.
- Festinger, L., 1957. *A cognitive theory of dissonance*. Evanston: Row Petersen.

- Finkelstein, S., Hambrick, D.C., 1996. *Strategic Leadership: Top Executives and Their Effects on Organizations*, West Publishing Company, Minneapolis.
- Flavell, J.H., 1963. *The development psychology of Jean Piaget*. New York: D Van Nostrand.
- Fornell, C., 1982. *A Second Generation of Multivariate Analysis*. New York: Praeger.
- Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research* 18:39-50.
- Friedlander, F., 1983. Patterns of individual and organizational learning. Pp. 192- 220 in *The executive mind*, edited by S Srivastva. San Francisco: Jossey-Bass Publishers.
- Furnham, A., Stringfield, P., 1994. Congruence of self and subordinate ratings of managerial practises as a correlate of superior evaluation. *Journal of Occupational and Organizational Psychology* 67:57-67.
- Garg, V.K., 2007. *Toward resolving executive leadership paradox in punctuated equilibrium model of organization evolution*, working paper.
- Gerdin, J., Greve, J., 2004. Forms of contingency fit in management accounting research—a critical review. *Accounting, Organizations and Society* 29(3-4), 303-326.
- Gerdin, J., Greve, J., 2008. The appropriateness of statistical methods for testing contingency hypotheses in management accounting research. *Accounting, Organizations and Society*, 33(7-8), 995-1009.
- Gordon, J., Sohal, A.S., 2001. Assessing manufacturing plant competitiveness – an empirical field study. *International Journal of Operations and Production Management* 21:233-253.
- Gray, B., 1990. The enactment of management control systems: a critique of Simons. *Accounting, Organizations and Society* 15:145-148.
- Gupta, A.K., Smith, K.G., Shalley, C.E., 2006. The interplay between exploration and exploitation. *Academy of Management Journal* 49:693-706.
- Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 1998. *Multivariate Data Analysis*. Upper Saddle River: Prentice Hall.
- Hall, M., 2008. The effect of comprehensive performance measurement systems on role clarity, psychological empowerment and managerial performance. *Accounting, Organizations and Society* 33(2-3), 141-163.
- Hall, M., Smith, D., 2009. Mentoring and turnover intentions in public accounting firms: A research note. *Accounting, Organizations and Society*, 34(6-7), 695-704.
- Hambrick, D.C, Fukutomi, G.D.S., 1991. The seasons of a CEO's tenure. *The Academy of Management Review* 16(4), 719-742.
- Hartmann, G.H., Moers, F., 1999. Testing contingency hypotheses in budgetary research: an evaluation of the use of moderated regression analysis. *Accounting, Organizations and Society* 24(4), 291-315.
- Hedberg, B., Jonsson, S., 1978. Designing semi-confusing information systems for organizations in changing environments. *Accounting, Organizations and Society*.
- Heneman, H., 1974. Comparisons of self- and superior-rating of managerial performance. *Journal of applied Psychology* 59:638-642.
- Henri, J., 2006. Management control systems and strategy: a resource-based perspective. *Accounting, Organizations and Society* 31:529-558.

- Henseler, J., Fassott, G., 2010. Testing moderating effects in PLS path models: an illustration of available procedures. In: Esposito Vinzi, V., Chin, W.W., Henseler, J., Wang, H. Handbook of partial least squares. Heidelberg: Springer, 713-735.
- Huber, G P., 1991. Organizational learning: the contributing process and literatures. *Organization Science* 2:88-115.
- Hulland, J., 1999. Use of partial least squares (PLS) in strategic management research: a review of four different studies. *Strategic Management Journal* 20:195-204
- Ittner, C.D., Larcker, D.F., Rajan, M.V., 1997. The choice of performance measures in annual bonus contracts. *The Accounting Review* 72:231-255.
- Kahneman, D., Frederick, S., 2002. Representativeness revisited: attribute substitution in intuitive judgement. In: Gilovich, T., Griffin, D., Kahneman, D. Heuristics and biases: the psychology of intuitive judgement. Cambridge: Cambridge University Press, 713-735.
- Kaplan, R.S, Norton, D.P., 1996a. Translating strategy into action: the balanced scorecard. Boston: Harvard Business School Press.
- Kaplan, R.S, Norton, D.P., 1996b. Using the balanced scorecard as a strategic management system. *Harvard Business Review*, January-February: 75-85.
- Kaplan, R.S, Norton, D.P., 1996c. Strategic learning & the balanced scorecard. *Strategy & Leadership*: 18-24.
- Kazdin, A.E., 1975. Behaviour modification in applied settings. Homewood, IL: Dorsey Press.
- Khandwalla, P.N., 1972. The effect of different types of competition on the use of management controls. *Journal of Accounting Research*: 275-285.
- Kloot, L., 1997. Organizational learning and management control systems: responding to environmental change. *Management Accounting Research* 8:47-73.
- Krishnan, R., Luft, J., Shields, M., 2005. Effects of accounting-method choices on subjective performance measure weighting: experimental evidence on precision and error covariance. *The Accounting Review* 80:1163-1192.
- Lant, T.A., Milliken, F.J., Batra, B., 1992. The role of managerial learning and interpretation in strategic persistence and reorientation: an empirical exploration. *Strategic Management Journal* 13:585-608.
- Little, R.J.A., Rubin, D.B., 1987. *Statistical Analysis with missing Data*. New York: Wiley.
- Lovell, R.B., 1980. *Adult Learning*. New York: Wiley.
- Luft, J.L., Shields, M.D., 2001. Why does fixation persist? Experimental evidence on the judgement performance effects of expensing intangibles. *The Accounting Review* 76:561-587.
- Mackinnon, D.P., Lockwood, C.M., Williams, J., 2004. Confidence limits for the indirect effect: distribution of the product and resampling methods. *Multivariate Behavioral Research* 39(1), 99-128.
- Mahoney, T.A., Jerdee, T.H., Carroll, S.J., 1965. The job(s) of management. *Industrial Relations*: 97-110.
- March, J.G., 1991. Exploration and exploitation in organizational learning. *Organization Science* 2:71-87
- Marida, K.V., 1970. Measures of multivariate skewness and kurtosis with applications. *British Journal of Mathematical and Statistical Psychology* 28:205-214.

- Marginson, D., Ogden, S., 2005. Coping with ambiguity through the budget: the positive effects of budgetary targets on managers' budgeting behaviours. *Accounting, Organizations and Society* 30:435-456.
- Markman, A.B., 1999. *Knowledge Representations*. Mahway: Lawrence Erlbaum Associates, Inc.
- Markman, A.B, Gentner, D., 2001. Thinking. *Annual Review of Psychology* 52:223-247.
- McKinnon, S.M., Bruns, W.J., 1992. *The Information Mosaic*. Boston: Harvard Business School Press.
- Merchant, K.A., 1981. The design of the corporate budgeting system: influences on managerial behaviour and performance. *The Accounting Review* 56:813-829.
- Mia, L., Chenhall, R.H., 1994. The usefulness of management accounting systems, functional differentiation and managerial effectiveness. *Accounting, Organizations and Society* 19(1), 1-13.
- Mintzberg, H., 1973. *The nature of managerial work*. New York: Harper & Row.
- Moore, K., Yuen, S., 2001. Management accounting systems and organizational configuration: a life-cycle perspective. *Accounting, Organizations and Society* 26:351-389.
- Neely, A., Al-Najjar, M., 2006. Management learning not management control: the true role of performance measurement. *California Management Review* 48:101-114.
- Norman, D.A., 1982. *Learning and Memory*. San Francisco: W H Freeman.
- Nunnally, J C., 1978. *Psychometric Theory*. New York: McGraw Hill Book Company.
- Otley, D., Fakiolas, A., 2000. Reliance on accounting performance measures: dead end or new beginning?" *Accounting, Organizations and Society* 25:497-510.
- Parker, R.J., Kyi, L., 2006. Vertical information sharing in the budget process. *Accounting, Organizations and Society* 31:27-45.
- Piaget, J., 1954. *The Construction of reality in the Child*. New York: Basic Books.
- Podsakoff, P.M., Organ, D.W., 1986. Self-reports in organizational research: Problems and prospects. *Journal of Management*, 12, 531-543.
- Preacher, K.J., Hayes, A.F., 2004. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods* 36, 717-731.
- Preacher, K.J., Hayes, A.F., 2008. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods* 40(3), 879-891.
- Quinn, J.B., 1980. *Strategies for Change: Logical Incrementalism*. Homewood: Irwin.
- Romme, G., Dillen, R., 1997. Mapping the landscape of organizational learning. *European management Journal* 15:68-78.
- Samson, D., Terziovski, M., 1999. The relationship between total quality management practices and operational performance." *Journal of Operations Management* 17:393-409.
- Senge, P., 1990. *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday/Currency.
- Shields, M. D., 1997. Research in Management accounting by North Americans in the 1990's. *Journal of Management Accounting Research* 9:3-61.
- Simons, R., 1995. *Levers of Control*. Boston: Harvard Business School press.
- Sprinkle, G.B., 2000. The effect of incentive contracts and learning and performance. *The Accounting Review* 75:299-326.

- Staw, B.M., Boettger, R.D., 1990. Task revision: a neglected form of work performance. *Academy of Management Journal* 33:534-559.
- Subramaniam, N., Mia, L., 2003. A note on work-related values, budget emphasis and managers' organizational commitment. *Management Accounting Research* 14:389-408.
- Terziovski, M., Sohal, A.S., 2000. The adoption of continuous improvement and innovation strategies in Australian manufacturing firms." *Technovation* 20:539-550.
- Ullrich, M.J., Tuttle, B.M., 2004. The effects of comprehensive information reporting systems and economic incentives on managers' time-planning decisions. *Behavioral Research in Accounting*, 16, 89–105.
- Vandenbosch, B., 1999. An empirical analysis of the association between the executive support system and perceived organizational competitiveness. *Accounting, Organization and Society* 24:77-92.
- Vandenbosch, B., Higgins, C.A., 1995. Executive support systems and learning: a model and empirical test. *Journal of Management Information Systems* 12:99-130.
- Vandenbosch, B., Higgins, C.A., 1996. Information acquisition and mental models: an investigation into the relation between behaviour and learning. *Information Systems research* 7:198-214.
- Vandenbosch, B., Huff, S.L., 1997. Searching and scanning: how executives obtain information from executive information systems. *MIS Quarterly* March:81-107.
- Venkatraman, N., Ramanujam, V., 1987. Measurements of business economic performance: an examination of method convergence. *Journal of Management* 13:109-122.
- Wentzel, K., 2002. The influence of fairness perceptions and goal commitment on managers' performance in a budget setting. *Behavioural Research in Accounting* 14:247-271.
- Widener, S.K., 2007. An empirical analysis of the levers of control framework. *Accounting, Organization and Society*. 32:757-788.
- Wold, H., 1985. Systems analysis by partial least squares. In *Measuring the unmeasurable*, edited by P Nijkamp, H Leitnet and N Wrigley. Dordrecht: The Netherlands: Martinus Nijhoff.