The relationship between management accounting systems and perceived environmental uncertainty on managerial performance: a research note

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Published online: 28 Feb 2012.

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The relationship between management accounting systems and perceived environmental uncertainty on managerial performance: a research note

Adebayo Agbejule*

Abstract—This study draws on both contingency and contracting theory to examine the moderating effect of perceived environmental uncertainty (PEU) on the relationship between the use of management accounting system (MAS) and managerial performance in Finnish companies. The responses of 69 managers, drawn from Finnish companies, to a questionnaire survey were analysed using a moderated regression analysis (MRA). The results found support for the hypothesis that the effects of MAS on performance were dependent on PEU. Under high levels of PEU, sophisticated MAS had a positive effect on performance, but under low levels it had a negative effect. Additional analysis showed that PEU interacts with different variations of MAS to influence performance.

1. Introduction

Researchers have suggested that environmental uncertainty has an important influence on the way in which managers process and use management accounting information (Gordon and Narayan, 1984; Gul, 1991; Mia, 1993; Gul and Chia, 1994). Management accounting systems (MAS) researchers (e.g. Chenhall, 2003) defined MAS as a formal system designed for providing managers with the requisite information to facilitate decision making and evaluation of managerial activity. Chenhall and Morris (1986) stated that information needs for decision-making might be considered in terms of general information characteristics. They suggested that each item of information has scope (information may be narrow or broad in its representation), level of aggregation (information may be detailed or aggregated), level of integration (information may be integrated) and timely (information is received in timely manner). Prior studies have supported the view that sophisticated MAS information is useful when the level of uncertainty is high (e.g. Gordon and Narayanan, 1984; Chenhall and Morris, 1986; Gul, 1991; Gul and Chia, 1994). Research studies on the issue of PEU and management accounting systems have tended to either focus on certain information characteristics or a composite measure[1] of management accounting system. In contrast, this study

examines the potential overlap between the dimensions of MAS and how they influence managerial performance. For example, broad scope and integrated information can be provided in an aggregated form as well as in a detailed form. Similarly, the dimensions of scope, integration and aggregation can vary along the dimension of timeliness (Bouwens and Abernethy, 2000).

The purpose of this study is to shed further light on the generalisability issue by replicating and extending the study by Gul (1991) using a Finnish sample. We examine the moderating effect of PEU on the extent of use of the MAS information characteristics and managerial performance. Otley et al. (1994) consider replication 'a much neglected aspect of accounting research'. Accordingly, our first objective is to investigate whether Gul's (1991) findings of two-way interaction between composite measure of MAS and PEU affecting Australian managers' performance can be replicated on a Finnish sample. Our second objective is to investigate how the variations of MAS dimension interact with PEU to improve managerial performance.

Our study attempts to contribute to existing knowledge in several ways. First, we shed some light on the different variation that could exist between the use of MAS, PEU, and managerial performance. Specifically, we examine the two-way interactive effects between PEU and the variations in the use of MAS affecting managerial performance. Secondly, we integrate contracting theory

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[1] Four information characteristics of MAS dimensions added together to obtain one index of MAS.

and extant organisational research based on contingency theory to further our understanding of MAS design. Specifically, we examine different variations of MAS design that incorporates insights from contracting theory[2] and contingency theory,[3] and identify PEU and different variation of MAS that could enhance managerial performance. Another contribution of our study is to provide Finnish evidence related to the use of management accounting systems and managerial performance.

The paper is organised as follows: we begin with a theoretical discussion leading to a statement of our hypotheses. Subsequent sections present our research method, results, and limitations. Suggestions round off the paper.

2. Background literature
Most of the MAS-performance literature has been focused on American, Australian, and British firms. To our knowledge, there is no evidence of the study of this relationship in Finnish firms. In 2003, Finland was ranked as the most competitive country in the world (Cornelius et al., 2003) and consequently this has increased the international interest in the Finnish management accounting and business practices (Granlund and Lukka, 1998).

2.1. Prior studies
Most empirical studies on MAS-PEU-performance are based on the contingency framework. Empirical research on PEU in MAS-performance relationship has been classified either as antecedent or a moderator variable. For example, using moderated regression analysis, Gul (1991) and Gul and Chia (1994) had PEU as a moderator variable, and found that the effects of MAS on performance were dependent on the level of PEU. These results suggest the need for defining the type of contingency fit used. Venkatraman (1989) and Luft and Shields (2003) suggested that neglecting to specify the exact perspective of fit used in earlier studies may have led researchers to obtain contradictory, mixed, or inconsistent results (see later discussions on type of moderators). As mentioned earlier, prior studies in MAS-performance have focused on one or two information characteristics of MAS such as broad scope (Chong and Chong, 1997), aggregation and broad scope (Gul and Chia, 1994) and broad scope and timeliness (Tsui, 2001), whereas the composite measure of MAS was used in the study of Gul (1991). Researchers (e.g. Chenhall and Morris, 1986) studied each of the four information characteristics of MAS and treated them as conceptually distinct.

Researchers (e.g. Tiessen and Waterhouse, 1983; Christie et al., 2003) have discussed the application of contracting theory to the use of MAS. The availability and use of MAS can also be viewed as

helping to direct the agent's behavior in accordance with the principal's interest. The contracting approach (including agency theory) suggests that MAS will be influenced by a variety of factors including environmental uncertainty (Tiessen and Waterhouse, 1983; Nilakant and Hayagreevia, 1994). However, none of the previous studies on MAS-PEU-performance linkages considered contracting theory.

To summarise, prior studies reveal the different roles of PEU in MAS-performance relationships, and how PEU relates to certain information characteristics of MAS to influence managerial performance. The next section draws on both contingency and contracting theory to examine the moderating effect of PEU on MAS-performance relationship.

2.2. The moderating role of perceived environmental uncertainty
Drawing upon the studies of contingency-based research, Gul (1991) and Gul and Chia (1994) suggested that when PEU is high, managers who use sophisticated reports from MAS could reduce uncertainty and improve managerial decision-making. A sophisticated broad scope MAS provides information related to the external environment and included is information that is economic and non-economic. Narrow scope information has been linked with traditional accounting systems in that these systems typically are limited to providing information that is internally focused, financial, and historically based information. When PEU is high, sophisticated MAS broad scope becomes essential for evaluating competitive actions or market demand. Timely information has the potential to reduce uncertainty. It enables decision makers to continually adjust their activities in response to changes in the environment. Managers would find the need to respond rapidly to changes in the competitive environment and market demand. As a result they would find timely and frequent MAS information particularly useful. The integrated dimension will also become increasingly important as PEU increases owing to its role in providing information for coordination among

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[2] This study relies on the framework of the theory of contracting costs. For detailed discussion of this theory, see Tiessen and Waterhouse (1983) and Christie et al. (2003). The main objective of the firm's contractual design is assumed to be to minimise contracting cost (including agency costs) between specialised factors of production. Accounting is part of contractual design and so it evolves to increase the efficiency of the contracts.

[3] The main proposition of contingency theory is that there must be an appropriate 'fit' between the internal organisation characteristics and the demand created by external environments in order to achieve organisational effectiveness. The notion of 'fit' is the key concept of contingency theory (see Drazi, and Van de Ven, 1985; Chenhall, 2003).

subunits. Galbraith (1973) suggested that, in uncertain situations, relevant information is required at the time and place of task execution and, further, a decentralised structure facilitates this information processing. From an accounting perspective, this suggests that managers operating in uncertain situations will have more autonomy over decision making and will therefore require information which may assist coordination.

From the theory of contracting, accounting plays a vital role in a firm's contractual designs in organisations. Specifically, accounting systems are used in decision rights allocation, performance measurements, and reward mechanism. According to Jensen and Meckling (1992), informational variables are the key to value maximisation (managerial performance) because the quality of decisions is determined by the quality of information available to the decision maker. The co-location of information and decision rights enables the decision maker to make optimal decisions. There are two ways to bring information and decision rights together: (i) transfer the information required for the decision to the decision maker, using information systems such as MAS; or (ii) transfer the decision rights to the person with knowledge. The first approach generates knowledge transfer costs and the second generates control costs. The use of MAS is an example of accounting use in allocation of decision rights. In principle, the design of sophisticated MASs seems to provide the ability to move more knowledge up to the decision maker at lower cost. Minimising the total of knowledge transfer costs and control costs can increase value.

Following the contracting explanations, when managers faced with high PEU have better knowledge (information), performance is likely to improve. PEU and knowledge transfer costs are likely to be associated with expected and unexpected changes in the environment. For example, the quantity of information increases when the environment is changing rapidly, and delays in acting on information can cause that knowledge to become obsolete. Increased obsolescence rates and increased information flow increase the specialisation of knowledge (Christie et al., 2003). A delay in acting on sophisticated MAS information reduces its value. For this reason, when PEU is high, managers who receive and use timely MAS information would not only minimise transfer cost but also make timely decisions that can improve performance. Similarly, contracting theory suggests that if knowledge relevant to decision resides at the lower levels of the firm, then decentralization (decision right allocation) reduces knowledge transfer costs (Christie et al., 2003). While providing many general implications for the use of MAS, the theory of contracting in its present form in our study primarily provides insights into how eco-

nomic actors respond to PEU and information provision within the context of improving performance.

In summary, both the contracting theory and organisational theory of PEU share some similar characteristics. Both theories view PEU as a lack of information that can be reduced by the acquisition of more information. In addition, both are concerned with strategies and mechanisms to reduce uncertainty. These mechanisms recognise the existence of different information processing characteristics and the possibility to combine these characteristics. Despite some differences[4] between the two perspectives, the overall conclusion between MAS and PEU is that the more uncertain the external environment, the more important it is that managers require sophisticated MAS information to cope with uncertainty and make decisions that are more appropriate (Chenhall, 2003). However, we argue that each of the dimensions of MAS is part of an organisation's information system and that managers may use different variations of MAS to help them cope with uncertainty. In other words, the critical question in the present study is: will PEU interact with different variations of the use of MAS to improve managerial performance? Or will PEU interact with certain information characteristics of MAS to influence performance?

2.3. Hypothesis

From the discussion above, when PEU is high managers who have sophisticated MAS information will be able to make decisions that are appropriate to cope with uncertainty and, consequently, improve performance. Thus, a high performing organisation is one in which the MAS information is matched with PEU (see Figure 1). Consequently, the following hypothesis is suggested:

H1: The higher the level of perceived environmental uncertainty (X_2), the more positive is the relationship between the use of MAS (X_1) and managerial performance (Y).

The term 'moderator' in this research refers to the role the variable plays within a research concern. According to Stone (1978), 'a moderator is any variable which when systematically varied causes the relationship between two other variables to change' (1978: 26). Sharma et al. (1981) further clarified the concept of a moderator by defining a framework for identifying and analysing the presence of such variables. They

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[4] However, agency theory has been criticised for ignoring some types of uncertainty, like the 'effect uncertainty' (e.g. Nilakant and Hayagreevia, 1994). For example, Nilakant and Hayagreevia (1994) suggested agency theorist overlook the fact that knowledge about the relations between the agent's effort and outcome may be incomplete. This is especially true in organisations where new technologies or products are developed.

Figure 1
The moderating effect* of PEU on the relationship between the use of management accounting system and managerial performance
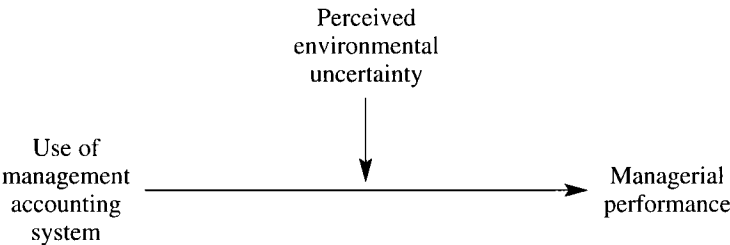
*Sharma et al. (1981) identified two types of moderators: a pure moderator and a quasi moderator. A pure moderator is one in which the moderator significantly interacts with the predictor variable and is not related to the dependent variable. A quasi moderator is one in which the moderator interacts significantly with the predictor variable and is related to the dependent variable.

identified two types of moderators: a pure moderator and a quasi moderator. A pure moderator is one in which the moderator significantly interact with the predictor variable and is not related to the dependent variable. A quasi moderator is one in which the moderator interacts significantly with the predictor variable and is related to the dependent variable. We utilised this framework in our data analysis to determine the nature of our moderator. The interaction approach is consistent with both contingency and contracting theory.

3. Research method

3.1. Sample and data collection

Data for the study were collected using a survey questionnaire from middle managers working in 11 business units operating in Finland. The number of people employed in each company was between 50 and 2000. Of the 11 companies, two are in the telecommunication industry, two in the construction industry, five in the metal industry, one in the electrical industry, and one in the chemical industry.

The research design involved two stages. The first stage was to have a meeting with a contact manager of each company to explain the purpose of the study, and why certain employee types needed to be selected for the study. The second stage was to distribute the questionnaire to the contact manager who in turn distributed them to the selected participants, who were managers involved in both revenue generating and cost incurring activities for their sub units. The participants were asked to complete and return the questionnaire to the researcher. Of the 124 managers selected for the study, 69 completed and returned the questionnaire, yielding a response rate of 64.5% at the time of the study. These managers were from sales (12%), finance (14%), business controllers

(31%), project management (10%), production (14%), purchasing (4%), research and development (12%), and quality management (5%). On average, the respondents had been employed for 14 years, and had held their current position, on average, for four years.

To examine for response bias, the responses from the first 20% of returns and those from the last 20% were compared, to test if the responses differed between the two groups. Levels of significance were determined for each item using t tests. No differences were identified, which provided some support for the absence of a non-response bias. It is possible that the respondents' functional background may introduce bias. An examination of the mean responses between these groups for the variables listed in Table 2 did not reveal any significant differences.

3.2. Measurement of variables

Appendix A contains an abbreviated copy of the research questionnaire used to measure the reported variables in this study.

Performance. Managerial performance was measured through a self-evaluation on eight dimensions of performance identified by Mahoney et al. (1963): planning, investigating, coordinating, evaluating, supervising, staffing, negotiating and representing. An overall score[5] is calculated by averaging the eight sub-dimensions used as a measure

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[5] Most prior studies used the overall measure for performance as the dependent variable. We did not include this in our questionnaire. However, the high Cronbach's alpha (0.79) for the eight items suggests that this was appropriate. The construct validity of this measure was examined using factor analysis. A single item was extracted which accounted for 57% of the variance with all items achieving factor loading greater than 0.40.

Table 1
Factor loading for MAS instrument

Factor	I	II	III	IV	V
I. BROAGG (broad scope & aggregated)					
Non-economic information	0.766				
External information	0.747				
Different functions	0.683				
α = 0.78					
II. FREQTIM (frequency of reporting)					
Frequency of reporting		0.819			
Speed of reporting		0.641			
α = 0.44					
III. BROAGGINT (broad, aggregated & integrated)					
Non-financial			0.744		
What if analysis			0.686		
Precise target			0.656		
Cost/price information			0.499		
α = 0.76					
IV. TIMAGG (speed and aggregated)					
Automatic receipt				0.741	
Immediate reporting				0.713	
Temporal reports				0.416	
α = 0.68					
V. BROINT (broad & integrated)					
Future oriented					0.722
Organisational effects					0.665
Information other department					0.568
α = 0.61					
Eigen values	3.46	2.27	1.47	1.27	1.09
% of variance	23.06	15.14	9.81	8.49	7.23

for managerial performance.

Perceived environmental uncertainty. The environmental uncertainty items are adapted from Miller and Friesen (1983). The respondents were asked to indicate the rate of change, from slow to rapid, at which products and services become obsolete, the rate of innovation in products/services and in process, and the rate of change in customers' taste and preferences. High numeric scores indicate higher rates of environmental uncertainty. The Cronbach alpha coefficient for PEU was 0.80, indicating satisfactory internal reliability for the scale (Nunnally, 1967). We adopted this version of PEU measurement because it was simple and short and covered most areas that managers are concerned with in terms of their environment (see Appendix 1).

MAS. A 15-item instrument adapted from Chenhall and Morris (1986) was used to measure management accounting system (see Appendix 1). Consistent with the procedure used by Chenhall and Morris, the MAS variables were randomised to reduce the possibility of managers repeating the same score for each question. In this study, the ob-

jective was to measure the extent of use of all the dimensions of MAS. Managers were asked to rate the 'extent of use' of MAS of both broad scope, integration, timeliness and aggregated information available from their organisation's MAS on a seven-point Likert type scale, ranging from 0 (not at all) to 6 (to a great extent). They were asked to consider the extent of use of this information in the context of their daily decision making activities. We used principal component analysis with varimax rotation to determine if all items measuring the MAS construct clustered together or not. Five factors with Eigen values greater than unity emerged from the principal component analysis, with solutions retaining 64% of the total variance of the data (see Table 1).

Following the rotation, the five constructs are Factors 1, 2, 3, 4 and 5 are denoted by the following information characteristics. The first category of MAS (BROAGG) is characterised by accounting information that is non-financial and less detailed. The second category (FREQTIM) is represented by frequency of reporting information. The third category of MAS (BROAGGINT) re-

Table 2
Descriptive statistics (n = 69)

	Mean	Standard deviation	Observed range	Theoretical range
Performance	5.70	1.15	2.63–8.13	1–9
BROAGG	3.01	1.16	0.33–6.00	0–6
FREQTIM	3.76	1.08	0.00–6.00	0–6
BROAGGINT	3.41	0.97	1.00–5.50	0–6
TIMAGG	3.43	1.10	1.00–6.00	0–6
BROINT	3.07	1.11	0.33–6.00	0–6
COMPMAS*	3.33	0.70	1.33–4.83	0–6
PEU	3.56	1.28	1.60–6.60	1–7

*Composite MAS

Table 3
Correlation matrix (Spearman rank)

Variable	1	2	3	4	5	6	7
1. PERF	1.00						
2. BROAGG	0.32**	1.00					
3. FREQTIM	0.03	0.19	1.00				
4. BROAGGINT	0.37**	0.45**	0.38**	1.00			
5. TIMAGG	0.02	0.20	0.03	0.11	1.00		
6. BROINT	0.12	0.29*	0.14	0.44**	0.18	1.00	
7. PEU	0.02	0.15	0.05	0.08	0.06	0.13	1.00

**Significant at the 0.01 level; * Significant at 0.05.

lates to information that is non-financial, less detailed and integrated. The fourth (TIMAGG) is characterised by information that is timely and less detailed, whereas the fifth (BROINT) denotes information that is future-oriented and integrated. In summary, we describe the variations of MAS in the first, third and fifth categories to have similarities with broad scope MASs as the information provided are non-financial and future-oriented. In contrast, the MAS in the second and fourth can be described in terms of frequency of reporting and level of integration. The argument here is that managers in some situations are likely to derive benefits from accounting information that is less detailed and non-financial, and issued in a timely manner. In some cases, information that is integrated, non-financial and less detailed is deemed to be important. The final scores were calculated by summing and averaging the raw scores. The Cronbach alpha coefficients are 0.78, 0.44 0.76, 0.68 and 0.61 for BROAGG, FREQTIM, BROAGGINT, TIMAGG, and BROINT, indicating the reliability of the measures. Table 2 presents

descriptive statistics and Table 3 shows the bivariate correlation matrix for the variables used. We tested our hypotheses using the different variations of MASs generated by the factor analysis.

4. Analysis and results
Hypothesis 1

The hypothesis was tested using multiple regressions (Pedhazur, 1982) based on the following multiplicative model:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_1X_2 + e \qquad (1)$$

Where Y is managerial performance, X_1 is composite measure of MAS, or the five different variations of MAS generated by the factor analysis (BROAGG, FREQTIM, BROAGGINT, TIMAGG, and BROINT), and X_2 is perceived environmental uncertainty, and X_1X_2 is the interaction term, and e is the error term. Examination of the residuals from the regression equation suggested that there were no major violations of assumptions of normality. To support H1, the coefficient b_3 in the regression equation (1) should be significant ($b_3 \neq 0$) and positive. The results of the moderated regression analysis are contained in Table 4. The first of the results presented in Table 4 refers to the composite measure of MAS. The following four[6] regression

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[6] We did not include the regression model for FREQTIM since its reliability did not meet the cut-off point of 0.60 suggested by Nunally (1967). In addition, the interaction equation was not significant.

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Table 4
Results of moderated regression analysis

	Coefficient	Value	SE	T	p-value
Constant	b_0	8.590	1.790	4.798	0.00
MAS (composite measure)	b_1	−0.874	0.537	−1.627	0.11
PEU	b_2	−1.447	0.515	−2.850	0.00
MAS*PEU	b_3	0.433	0.153	2.829	**0.00**
R^2=0.21; Adj R^2=0.17; F=5.75, P<0.01					
Constant	b_0	5.958	1.083	5.501	0.00
MAS (BROINT)	b_1	−0.101	0.344	−0.294	ns
PEU	b_2	−0.195	0.296	−0.659	ns
MAS*PEU	b_3	0.065	0.092	0.717	ns
R^2=0.02; Adj R^2=−0.02; F=0.514, P >0.10					
Constant	b_0	6.989	1.004	6.962	0.00
MAS (BROAGG)	b_1	−0.743	0.309	−2.407	0.02
PEU	b_2	−0.416	0.319	−1.305	0.19
MAS*PEU	b_3	0.237	0.096	2.461	**0.02**
R^2=0.18; Adj R^2=0.14; F=4.696, P<0.01					
Constant	b_0	9.139	1.279	7.147	0.00
MAS (TIMAGG)	b_1	−0.969	0.331	−2.933	0.00
PEU	b_2	−0.964	0.333	−2.893	0.00
MAS* PEU	b_3	0.274	0.087	3.145	**0.00**
R^2 =0.14; Adj R^2=0.10; F=3.586, P<0.02					
Constant	b_0	7.684	1.386	5.543	0.00
MAS (BROAGGINT)	b_1	−0.579	0.393	−1.475	0.15
PEU	b_2	−0.997	0.370	−2.693	0.01
MAS*PEU	b_3	0.286	0.104	2.760	**0.00**
R^2=0.23; Adj R^2=0.20; F=6.489; p < 0.001					

models refer individually to each of the four different variations of MAS. The results in Table 4 show that the composite MAS model has an adjusted R square of 17%, and that b_3 is positive and significant (t = 2.829, p = 0.006), indicating an interactive effect of PEU and sophisticated MAS information on performance. The foregoing MRA was replicated for each of the different variations of MASs. The results closely resemble the findings for the composite measure of MAS, with the exception of FREQTIM and BROINT. Our results support the argument of Bouwens and Abernethy (2000) and Gerdin (2005) that there is some potential overlap[7] between the dimensions of MAS. For example, broad scope and integrated dimension of MAS can be provided in a timely manner as well as in an aggregated format. In other words, some variations of MAS are more effective than others during high levels of PEU.

To find out whether a non-monotonic effect exists, the partial derivative of equation (1) over use of MAS information characteristics (X_1) was computed (Southwood, 1978; Schoonhoven, 1981). If $\delta y/\delta x_1$ is always positive and negative over the entire observed range of PEU (X_2), then the relationship between managerial performance (Y) and the

use of MAS information (X_1) may be regarded as non-monotonic. Such relationships can be examined by calculating the 'inflection point' of the slope by equating the partial derivative calculated in equation (1) to zero (Southwood, 1978; Schoonhoven, 1981). The partial derivative of equation (1) with respect to X_1 is shown as follows:

$$\delta y/\delta x_1 = b_1 + b_3 X_2 \qquad (2)$$

The partial derivation of equation (2) gives the following results for Hypothesis H1:

$$\delta y/\delta x_1 = -0.874 + 0.433 X_2 \qquad (3)$$
$$\text{(composite measure of MAS)}$$

First, Equation 3 represents the interactive effect on managerial performance between composite

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[7] We also tested the interaction of each dimension of MAS (timeliness, broad scope, integration, and aggregation) and PEU on performance. Only broad scope and aggregation showed a positive and significant interaction. This confirms our approach that managers that perceive their environment to be uncertain would use different variations of MAS to help reduce uncertainty and improve decisions, which, in turn, may improve managerial performance.

Figure 2
Relationship between composite measure of MAS (X₁), PEU (X₂), and performance (Y)
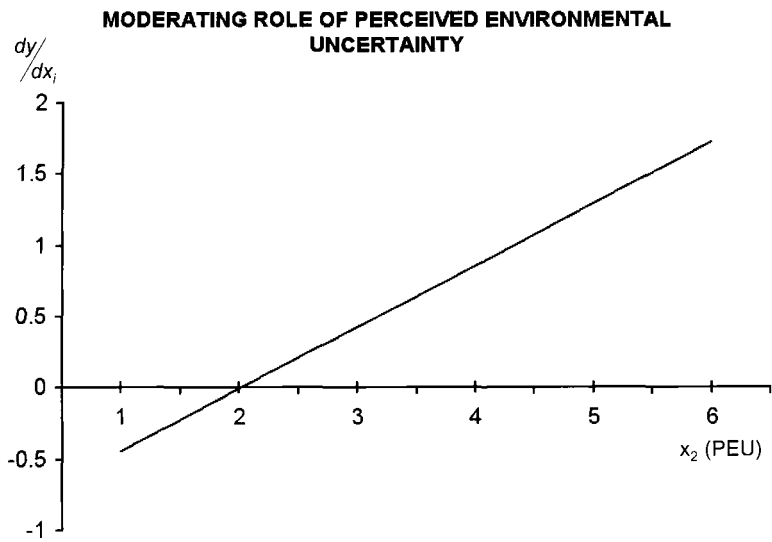
view of MAS and PEU. Figure 2 plots equation (3) using the regression coefficients from Table 3, and the observed range for PEU (of 1.60 to 6.60). The vertical axis represents $\delta y/\delta x_1$ and the horizontal axis the level of PEU. The graph shows that the effect of changes in MAS information on managerial performance is non-monotonic over the observed range of PEU, with a point of inflexion at a value of PEU of 2.02 (determined by setting the partial derivative of equation (3) to zero) lying within the observed range of PEU. Equation (3) will be zero, when X_2 (PEU) has a value of 2.02, which is the inflection point. In other words, equation (3) will be positive when PEU is above 2.02 and negative when PEU is below 2.02. Based on these results and analysis, hypothesis H1 is supported, indicating that there is an interaction between PEU and the composite measure of sophisticated MAS supporting the study of Gul (1991). Similarly, the other significant interactions showed a non-monotonic relationship.

To investigate further this aspect of the interaction, respondents were classified as belonging to either high or low use of MAS and high or low PEU groups (dichotomised at the median). Table 5 shows the mean performance scores for the two levels of use of sophisticated MAS information (composite measure) and PEU. The highest average performance score (6.36) is in Cell 4 (that is a high use of MAS high/high PEU cell), which means that a high use of sophisticated MAS information and high PEU combination is beneficial to performance, and this supports the hypothesis. Note that performance is lowest in Cell in 2, where PEU is high and the use of MAS is low. Similar results were obtained by Gul (1991). Statistical support for this conclusion is provided by ANOVA[8] and a post-hoc test using (Turkey-HSD) and is reported in Table 5.

5. Discussion, limitations and conclusions

The objective of this study was to examine the moderating role of PEU in MAS-performance relationship. The results support those of Gul (1991), and Gul and Chia (1994), and add to scarce empirical research in providing evidence of management beliefs that the use of MAS varies under different environmental conditions. Specifically, the results suggest that the higher the level of PEU, the more positive is the relationship

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[8] The result of the Levene test of homogeneity of variance is non-significant in Table 5 (p > 0.05), showing that there is no reason to believe that the variances of the four groups are different from another, which would violate the homogeneity of the variance assumption of ANOVA. Similar patterns were identified by the different variations of MAS that showed significant interaction.

Table 5
Mean performance scores across low/high PEU and low/high MAS

	Low use of MAS high information			*High use of MAS high information*
Low PEU	$N = 16$			$N = 18$
	$\bar{Y} = 5.562$			$\bar{Y} = 5.680$
	$\sigma_y = 0.942$			$\sigma_y = 1.143$
		Cell 1	Cell 2	
High PEU	$N = 18$			$N = 17$
	$\bar{Y} = 5.236$			$\bar{Y} = 6.363$
	$\sigma_y = 1.134$			$\sigma_y = 0.1.144$
		Cell 3	Cell 4	

Analysis of variance

	df	*Sum of squares*	*Mean squares*	*F-ratio*	*P*
Between groups	3	12.457	4.15	3.48	0.02
Within groups	65	77.511	1.19		
Total	68	89.968			

Note: The results of ANOVA is F (3,3.48), $p < 0.02$. Post hoc Turkey-HSD test* significant at $p < 0.02$ show that, in terms of mean performance score for managers, managers in Cell 4 (that is high use of MAS information and high PEU) scored significantly higher (mean = 6.363) than the mean performance score for managers (5.236) in Cell 3 (low use of MAS and high PEU), and that no other differences were statistically significant.

*See Corston and Colman (2003) for discussion of this test.

between the use of MAS and performance. In addition, our study identified five variations of MAS dimensions: non-financial and aggregated, frequency of reporting, non-financial, aggregated and integrated, timely and aggregated, and non-financial and integrated. For example, broad scope MASs was significantly represented in the four variations of MAS dimensions and thus suggests that broad scope information that provides a wide range of qualitative and quantitative information, financial and non-financial, as well as ex-post and ex-ante information is vital for managers in decision making during the perceived environmental conditions, and is required in many different forms (Gordon and Narayanan, 1984; Ansari, 1997).

A number of directions for further research emerge from this study. For example, by developing a taxonomy of information types and identifying the impact of PEU on their transferability and importance, researchers can narrow the gap between research in MAS and research in economics. Further research could expand the model to include variables such as size, product customisation, and organisational structures such as layers and spans of control. For example, Vickery et al. (1999) found that product customisation promotes fewer layers for small and not large firms.

Some limitations are noted in the present study.

First, participants of the eleven companies were selected for study by their representatives, and hence the sample was not strictly random. Consequently, some caution is necessary before generalising the results. Second, the regression model of performance explained a variance (adjusted $R^2 = 17\%$ for the composite MAS model) indicating that variables other than the use of MAS and PEU are at work in affecting performance. Potential variables include product customisation (Bouwens and Abernethy, 2000) and leadership style (Otley and Pierce, 1995). The use of a self-rating scale to measure managerial performance is likely to have higher means values (higher leniency errors) in the score (Prien and Liske, 1962; Thornton, 1968). Finally, our study suffers from the usual limitations associated with the questionnaire survey method (see Oppenheim, 1966). Despite the above limitations, our study, together with those of others (Chenhall and Morris, 1986; Gul, 1991; Gul and Chia, 1994), constitutes an attempt to systematically evaluate the role of perceived environmental uncertainty on the relationship between MAS and managerial performance and, as a result, improves the likelihood that MAS will help managers improve their performance and that of their organisations.

Appendix A
Perceived environmental uncertainty
Indicate the rate of change for the following (1 = very slow and 7= very rapid)

PEU 1: The rate at which products and services become outdated.
PEU 2: The rate at which marketing practices are changing.
PEU 3: The tastes and preferences of customers in your industry.
PEU 4: Actions of competitors.
PEU 5: The rate of change of product/service technology.

MAS Measurement
(Arranged in random order)

Broad scope:
1. Information that relates to possible future events (if historical information is most useful for your needs, mark the lower end of the scale).
2. Non-financial information that relates to production and market information such as growth share etc. (If you find that a financial is most useful for needs, please mark the lower end of the scale.)
3. Non-economic information, such as customer references, relations, attitudes of government and consumer bodies, competitive threat.
4. Information on broad factors external to your organisation, such as economic conditions, population growth, technological developments, etc.

Timeliness:
5. Requested information arrives immediately upon request.
6. Information supplied to you automatically upon its receipt into information systems or as soon as processing is completed.
7. There is no delay between an event occurring and the relevant information being reported to you.
8. Reports are provided frequently on a systematic, regular basis, e.g., daily reports, weekly reports.

Aggregation
9. Information in forms, which enable you to conduct what if analysis.
10. Information on the effects of events on particular time periods (e.g., monthly/quarterly/annual summaries, trends, comparisons, etc.
11. Information in formats suitable for input into decision models (such as: discounted cash flow analysis or incremental/marginal analysis).

Integration
12. Cost and price information of departments of your business unit.
13. Presence of precise targets for each activity performed in all sections within your department
14. Information that relates to the impact that your decisions have on the performance of other departments.
15. Information on the impact of your decisions through out your business unit, and the influence of other individual's decision on your area of responsibility.

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