

Environmental Uncertainty, Comprehensive Performance Measurement Systems, Performance-Based Compensation, and Organizational Performance

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Abstract

This study explores firms' use of comprehensive performance measures and performance-based compensation in response to the increasingly uncertain competitive environment. Data from a sample of 84 Taiwanese high-tech manufacturing firms revealed an increased use of such systems among firms facing higher perceived environmental uncertainty. We also found performance-based pay to fully mediate the relationship between comprehensive performance measures and employee effort. Finally, employee effort is significantly and positively associated with organizational performance and fully explains the effect of performance-based compensation in increasing organizational performance.

JEL classifications: M40, M52

Keywords: Comprehensive performance measurement, performance-based compensation, employee effort, organizational performance, environmental uncertainty

1. Introduction and Overview

This study examines the extent to which firms' use of comprehensive performance measures and performance-based compensation is responsive to the uncertainty in their competitive environment. It also explores the avenues whereby these management practices affect employee effort and organizational performance. This topic is important because the global economy is becoming increasingly uncertain, with rapid technological advances, constantly changing customer demands, increased

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deregulation and the dismantling of trade barriers Mia and Clarke (1999), Leifer et al (2001), Puranam et al (2006). A firm's management accounting related practices can significantly affect its chances of survival and success in this turbulent environment as per Chenhall and Morris (1986), Kaplan and Norton (2001), Chenhall (2003), Van der Stede et al (2006), Langfield-Smith (2007), and as such improved understanding of how such practices affect firm performance is important to management effectiveness.

Relating to performance measurement, both academics and practitioners have argued that while traditional financial measures are useful for summarizing organizational performance, they are inadequate for meeting the challenges of today's marketplace, as per Eccles (1991), Fisher (1992), Kaplan and Norton (1996), Ittner and Larcker (1998), Neely (1999). Many authors have pushed for improving the financial measures, e.g. Stern et al (2004), while others have promoted increased use of non-financial (including subjective) performance measures, e.g. Kaplan and Norton (1996, 2001). While differences exist across the systems proposed by different authors, they share a common emphasis on tying performance measures to the firm's strategic objectives, as per Hall (2007). The claim is that diverse, balanced and integrated ("comprehensive" for short) performance measurement systems can improve firms' ability to translate strategy into performance targets, communicate expectations to employees, monitor performance, provide feedback for improvement, and motivate employees towards target attainment, as per Van der Stede et al (2006).

Despite the intuitive appeal of comprehensive performance measurement (CPM) systems, extant research into their nature and effects is partial and incomplete. The majority of studies to date have either investigated the link between perceived environmental uncertainty (PEU) and the perceived usefulness of performance measurement systems, such as Gordon and Narayanan (1984), Kren and Kerr (1993), see Tymon et al (1998) and Chenhall (2003) for reviews, or the link between use of these systems and individual -- but not organizational performance, for example Gul and Chia (1994), Chong (1996), see Tymon et al (1998). While Govindarajan (1984) did examine the link to business unit performance, its focus was superiors' evaluation style in using performance information, rather than the extent to which the performance measures are diverse, balanced and integrated. Furthermore, to the extent that performance measurement design is a response to the environment rather than an exogenous firm attribute, eg Tymon et al (1998), Luft and Shields (2003), Chenhall (2007), simultaneously examining all the linkages that flow from PEU to CPM, and from the latter to employee effort and organizational performance, is important for accurately identifying the factors that drive organizational performance and the pathways of their effects.¹

In conducting such an investigation, a further consideration is that firms' design of performance measurement systems often is linked to another key management control: the compensation system. Theoretical models have long stipulated that linking individual performance to monetary rewards increases individual effort and performance, viz Vroom (1964), Lawler (1973), see Bonner et al (2002) for a review.

¹ To the extent that the various elements are inter-related, tests that only consider subsets of the relationships in isolation from the others could yield biased results and inferences. This is because the effects of one factor on another may be affected by the levels of the other factors in the causal chain.

A critical decision in designing performance-based compensation (PBC) systems is the proportion of compensation that is tied to performance outcomes. Employees tend to concentrate on those activities for which their performance is measured, often at the expense of other relevant but non-measured activities, see Hopwood (1974), Hayes et al (1988). A broader range of performance measures can reduce employees' opportunities to "game the system", see Robertson (2005), thus curtailing such dysfunctional effects. Analytical studies by Datar *et al.* (2001), Feltham and Xie (1994), Hemmer (1996), Holmstrom (1979), and Lambert (2001), for example, have demonstrated that in the absence of measurement costs, introducing incentives based on non-financial measures can improve contracting by incorporating information on managerial actions that are not fully captured by financial measures. Baker *et al.* (1994) and Baiman and Rajan (1995) have shown that subjective measures can help to mitigate distortions in managerial effort by "backing out" dysfunctional behaviors induced by incomplete objective performance measures, as well as reduce noise in the overall performance evaluation. Thus, it stands to reason that firms which use more comprehensive performance measures also would have greater assurance of positive outcomes from using PBC, see Banker *et al.* (2000), Ittner *et al.* (1997). To our knowledge, extant research on CPMs has yet to explore the extent to which their performance effects arise from the nature of the performance measures (which has to do with the adequacy of information for coping with uncertainty), or are due to employees increasing their effort in response to the increased use of PBC enabled by more comprehensive performance measures (thus a motivational effect). Correct identification of this causal path can help the effective deployment of CPMs, and our study includes such an investigation.

Consistent with our postulate that the various elements are inter-related rather than disjoint pieces, we used partial least squares to simultaneously assess the linkages that flow from PEU through CPM/PCB to employee effort and organizational performance. Data were collected from a sample of 84 Taiwanese manufacturing firms in the telecommunications, electronics, and information technology sector. The results reveal a positive relation between PEU and CPM, and between CPM and PCB. We also find that the use of PBC fully mediates the relationship between CPM and employee effort (EEF). In turn, EEF is significantly and positively associated with organizational performance, and fully mediates the link between PBC and organizational performance.

The remainder of this paper is structured as follows. The next section develops our hypotheses. Then in section 3, we provide details of the methods used to collect data and to test the hypotheses. Section 4 presents the results. Section 5 concludes the paper with a summary and discussion.

2. Hypothesis Development

Environmental uncertainty has been of interest to designers of organizations for many decades e.g., Burns and Stalker (1961), Lawrence and Lorsch (1967), Perrow (1970), and Galbraith (1973). Much of this work has focused on how organizations change their structure in response to changes in the level of environment uncertainty. In the accounting literature, Khandwalla (1972) and Gordon and Narayanan (1984)

were among the earliest studies to investigate management control system responses to environmental uncertainty.

Interest in environmental uncertainty has remained strong in the accounting literature as markets have become increasingly dynamic and innovations have appeared in the design of accounting control systems. The thrust of such innovations has been towards more comprehensive performance measurement systems that involve increased use of non-financial performance measures, recognition of lead-lag relationships, integration of measures across organizational sub-units and hierarchical levels, and tying performance measures to the firm's competitive strategy e.g., the balanced scorecard, Kaplan and Norton (1996) and the Tableau de Bord, Epstein and Manzoni (1998). Empirical research has supported the potential usefulness of broad-scope management accounting information, e.g. Gordon and Narayanan (1984), Chenhall and Morris (1986), Gul and Chia (1994), Chong (1996), Chong and Chong (1997), see Chenhall (2003, 2007) for a review. Consistent with Galbraith's view of uncertainty and uncertainty reduction, the explanation has centered primarily on the gap between information available to individuals versus what they need to cope with uncertainty. While this body of research has only considered some aspects of performance measurement comprehensiveness, it is reasonable to expect that CPM, which goes far beyond just increasing the diversity or scope of performance measures, would further enhance the information that firms and their employees can use in responding to increased uncertainty, see Ittner and Larcker (2001), Kaplan and Norton (1996). This inference is consistent with early work by Khandwalla (1972), who documented an increase of performance measurement sophistication (although in his case solely based on financial measures) in response to increased PEU. Others who have studied the effects of measurement diversity, e.g., Ittner et al (2003) and the use of non-financial performance measures, e.g., Ittner and Larcker (1995) also have attributed the perceived importance or consequences of such changes in performance measurement to the additional information that they provide to individuals in the organization. Thus we hypothesize:

Hypothesis 1: *Use of comprehensive performance measurement systems is positively associated with the level of perceived environmental uncertainty.*²

And, to the extent that CPM serves a decision facilitating role as hypothesized above, it should help to improve organizational performance. A number of prior studies have examined the performance effects of performance measure diversity, with mixed results. Some studies, such as Scott and Tiessen (1999) and Hoque and James (2000), have found positive effects, with the former documenting an increase in team performance from the use of more diverse measures, and the latter reporting performance effects from measurement diversity at the organizational level. In contrast, Ittner *et al.* (2003) failed to find a performance increase from the use of more diverse measures. Besides being limited to only a small part of the causal links ending in organizational performance, these studies have only examined one aspect — diversity — of performance measurement

² Following prior research, we focus on perceptions of uncertainty rather than any objective measures of this variable. This is because it is how people perceive their external environment that affects decision-making in organizations, Dill (1958).

systems. Thus, the need remains to explore whether comprehensive performance measures — ones that are diverse, balanced and integrated — have positive performance effects. As will become clear from our discussion below, our second hypothesis also provides a baseline for differentiating among direct and indirect effects of CPM on organizational performance:

Hypothesis 2: *Use of comprehensive performance measures is positively associated with organizational performance.*

But beyond serving a decision facilitating role, comprehensive performance measures also can have motivational effects. Greater performance measure comprehensiveness also provides employees with a more integrated perspective on how effort exerted in their particular areas of operations translate into overall firm performance. Both expectancy theory, e.g. Lawler (1973), and expected utility theory, e.g. Baiman (1990), suggest that when people have a strengthened or clearer understanding of the link between their effort and performance outcomes, they would be more motivated to exert effort. Thus we hypothesize:

Hypothesis 3: *Use of comprehensive performance measures is positively associated with employee effort.*

Furthermore, as a firm increases the comprehensiveness of its performance measures, it also has increased leeway to employ performance-based compensation (PBC) systems, and it is well established that linking performance outcomes to monetary rewards can motivate increased employee effort, see Bonner and Sprinkle (2002) for a review. Of relevance to our study, it has been noted that if the performance measurement system is too narrow in scope, using it as the basis for compensation can be vulnerable to individuals in the organization “gaming the system,” particularly where superiors have difficulties observing the actions of their subordinates, see Robertson (2005). Since a more comprehensive performance measurement system taps into more aspects of organizational performance, it should reduce the information asymmetry between superior and subordinate. Thus, organizations with more comprehensive performance measures also should have greater assurance of positive effects from using PBC.

Much of the empirical work to date has examined whether organizations link compensation to performance dimensions other than the financial component, e.g. Banker *et al.* (2000), or the performance implications of including these other dimensions in the performance evaluation system, e.g. Ittner *et al.* (2003). The analytical literature, e.g. Feltham and Xie (1994), Holmstrom (1979), has concluded that measures other than financial ones should be included in management compensation contracts (subject to their cost and risk imposed on the managers) as long as they provide incremental information about managers’ actions. However, this literature has omitted consideration of whether the increased use of CPM is an antecedent to PBC use in organizations.³ Our next hypothesis provides focus to such an investigation:

³ As explained further below, clarifying this link is important to understanding how a firm can best benefit from CPM usage.

Hypothesis 4: *Use of performance-based compensation increases with the use of comprehensive performance measures.*

Numerous studies have investigated whether performance-based compensation increases employee effort, see Bonner and Sprinkle (2002) for a review, and a recent review of the laboratory-based studies, see Bonner *et al.* (2000), has shown PBC to be effective. However, much of this research has been confined to single-goal tasks under low or no uncertainty. In contrast, uncertainty is a fact of life in organizations, where an increased use of PBC also imposes greater risk on individual employees, see Baiman (1990). The likely consequence is that individuals will either demand higher compensation, or withhold effort in the absence of such an adjustment, see Umanath *et al.* (1993). But when the firm uses a more comprehensive performance measurement system, the risks to individual employees under PBC are reduced, and the motivating effects of PBC on effort should become more dominant. This proposition is consistent with Kren and Kerr (1993), who argued that organizations need to invest in better information systems when using PBC under uncertainty. In a study of time-series data in 18 hotels, Banker *et al.* (2000) found that when non-financial measures are included in the compensation contract, managers more closely aligned their efforts to those measures, resulting in increased performance. Scott and Tiessen (1999) and Hoque and James (2000) have reported similar results. Findings like these provide the basis for the following hypothesis.

Hypothesis 5: *Use of performance-based compensation is positively associated with employee effort.*

Taken together, H3, H4 and H5 allow for both direct and indirect effects on EEF from the use of CPMs. As we had explained earlier, the direct effect from CPM to effort is based on the argument that CPM reduces employees' uncertainty in assessing the relation between their inputs and measured outputs, and that this increased expectancy increases individual effort to improve their measured performance. In contrast, the indirect effect is predicated on the use of CPMs facilitating the use of PBCs, with the latter motivating increased effort. Resolving whether CPM only has a direct effect on effort, or whether there is an indirect effect via PBC, and to what extent this indirect effect mediates any direct effect has important implications for how a firm can best leverage the effects of its performance measurement system. For example, if PBC fully mediates the effect of CPM on effort, then the design of CPM cannot be used to increase employee effort except through PBC. On the other hand, if PBC only partially mediates CPM's effects — thus CPM has both a direct and indirect effect (via PBC) on effort — then the design of both CPM and PBC can influence employees' effort choices.⁴

Finally, we recognize that there are two separate routes whereby PBC can affect organizational performance. The prior incentive literature, see Sprinkle (2000) for a review, points to an indirect effect via effort and thus the following proposition:

⁴ More discussion of mediating effects is available in Baron and Kenny (1986), Hartmann and Moers (1999), and Gerdin and Greve (2004).

Hypothesis 6: Employee effort is positively associated with organizational performance.

But the existence of an indirect effect does not preclude there also being a direct effect from PBC to performance. Based on the goal setting literature, see Hirst (1987), to the extent PBC reinforces specific performance targets, individual employees will be motivated to seek more effective means of performing their tasks, without necessarily increasing their effort level. Thus we hypothesize:

Hypothesis 7: *Performance-based compensation is positively associated with organizational performance.*

Taken together, H5, H6 and H7 focus on whether PBC affects organizational performance directly, or indirectly via its impact on EEF. In conjunction with H3 and H4, they provide a structure for understanding how a firm's design of its performance measurement system ultimately translates into impacts on organizational performance.

3. Research Method

3.1 Sample and procedure

We focused on manufacturing companies in the telecommunications, electronics, and information technology sector for two major reasons, the first being to limit extraneous influences due to different industry types. Second, uncertainty is high for firms in this sector due to rapid technological advances and highly competitive markets, see Carey and Nahavandi (1996), Schilling and Hill (1998), Balkin *et al.* (2000).

We used a database of published financial statements (the “*Taiwan Economic Journal Taiwan Data Bank*”) to identify all Taiwanese companies in the target sector with shares that were traded on the Taiwan Stock Exchange or over-the-counter. Of 711 companies identified through this search, we sought a sample of 100 companies in consideration of budgetary constraints and the target respondents' high hierarchical levels. We randomly selected 100 companies, and solicited their participation by approaching a high-level manager (vice president or above) with the aid of accounting and consulting firms. As we encountered (initial) refusals to participate, replacements were randomly selected. In total, we approached 115 companies, of which 106 ultimately participated. Each company provided a contact person for receiving and distributing the surveys.

To reduce the threat of common methods bias, where one informant self-reports on all of the constructs in the study, see Podsakoff and Organ (1986) for a discussion, we distributed two different surveys in each firm.⁵ The “Top Management Survey” sought information on the company's external environment, employee effort and a subjective assessment of performance. It was targeted at top-level managers because

⁵ We also conducted the Harman single-factor test for common methods variance. We found no evidence of common methods bias as more than one single factor emerged and no one major factor accounted for the majority of covariance in the independent and criterion variables.

they usually are the most knowledgeable source for this kind of information, particularly with regard to PEU and organizational performance, see Snow and Hrebiniak (1980), Tymon *et al.* (1998). The “Human Resource Manager Survey” was targeted at a high-level human resource or personnel manager, and sought information on the performance measurement system and the compensation system.

Administration of the survey included the following steps. First, because the survey was administered in Chinese, Brislin’s (1986) recommendation of translation and back-translation was followed to ensure conceptual equivalence between the original instruments (in English) and the Chinese versions. Both surveys were first translated into Chinese by a bilingual individual who was not told the objective of the study, then another bilingual person back-translated these into English without having access to the original instruments. Only a few minor changes were made to the Chinese surveys based on comparing the back-translated and original English versions.

Second, each contact person was given explicit instructions on the appropriate type of manager to complete each version of the survey. In addition to level and functional area (top-level or HR manager), each manager had to have a minimum of three years’ tenure at the firm. To encourage truthful responses to sensitive questions, complete confidentiality and anonymity were guaranteed, and a postage-paid, self-addressed envelope was provided for direct return of completed surveys. Since responses were obtained from two different managers in each company, both surveys provided to a company had a common identification code so that they could be combined for analysis, and this was explained in a cover letter to the respondents. Participants who had any questions regarding the survey could contact the Taiwan-based co-author directly to get clarification.

Of the 106 companies that participated, 22 only returned one completed survey. Since our analysis required information from both surveys, these companies were excluded, leaving 84 firms in our final sample. The retained respondents to the Top Management Survey were distributed among positions as follows: chief financial officer (25.5%), vice president (19.8%), chief executive officer (6.6%), chairman of the board (2.8%), vice chairman of the board (2.8%), and others such as general managers, business directors, and special assistants to the chief executive officer (42.5%). On average, the respondents had been in their current jobs for over nine years. The majority of respondents to the Human Resource Manager Survey were managers of human resources (53.8%). The remainder were directors of human resources (12.3%), vice presidents of HRM (0.9%), and others such as general managers and special assistants to the manager of human resources (33%). Their average tenure in the current position was over five years. Thus, both groups of respondents should be sufficiently knowledgeable about their organizations to provide informed responses.

3.2 Measurement of variables

Multi-item scales were used for each variable. All scales were based as closely as possible on prior empirical research. Table 1.1 presents the items comprising each scale in our study.

Table 1.1: Composite Reliability and AVE Scores for Perceived Environmental Uncertainty, Comprehensive Performance Measurement, Performance Based Compensation, Employee Effort, and Organizational Performance

Panel A Perceived Environmental Uncertainty (Composite Reliability=0.841, AVE=0.640)

1-1	How stable is the economic external environment facing your company
1-2	How stable is the technological external environment facing your company
1-3	How stable is the political/regulatory environment facing your company

Panel B Comprehensive Performance Measures (Composite Reliability=0.915, AVE=0.685)

2-1	Performance evaluation uses a mix of financial and non-financial (including subjective) measures
2-2	Performance measures are systematically tied across levels of the company's hierarchy
2-3	A mix of leading (e.g. customer satisfaction) and lagging indicators (e.g. sales) is used to evaluate performance
2-4	Performance evaluation uses a mix of measures that are explicitly identified with different aspects of performance (e.g. customer satisfaction, internal operations, learning and growth)
2-5	Performance evaluation is explicitly tied to the company's competitive strategy

Panel C Performance-Based Compensation (Composite Reliability=0.835, AVE=0.559)

3-1	People's compensation contracts clearly specify how their compensation is based on their performance
3-2	People's compensation increase as their performance increases
3-3	People whose performance ranks in the top 25% receive higher compensation than people who rank in the bottom 25%
3-4	Compensation is directly tied to individual performance

Panel D Employee Effort (Composite Reliability=0.921, AVE=0.795)

4-1	People are always ready to "go the extra mile" for the sake of the company
4-2	People take pride in working hard for the company
4-3	People always put forth a high level of effort at work

Panel E Organizational Performance (Composite Reliability=0.967, AVE=0.743)

	Over the past three years how did your company's performance compare to that of your industry:
5-1	Long run level of firm profitability
5-2	Growth rate of sales and revenues
5-3	Level of return on assets
5-4	Trend of return on assets
5-5	Market share
5-6	Operational and cost efficiency
5-7	Productivity
5-8	Level of return on sales
5-9	Trend of return on sales
5-10	Overall performance

As explained further below, we used partial least squares (PLS) to test the hypotheses. PLS provides a composite reliability score (equivalent to Cronbach alpha) for assessing

the convergent validity of each construct, and the average variance extracted (AVE) to assess its divergent validity, see Fornell and Larcker (1981).⁶ The generally acceptable level of AVE is 0.50 or higher, see Hair *et al.* (1998). In addition, the square root of the average AVE for each construct should exceed the correlations shared between the construct and other constructs in the model, see Fornell and Larcker (1981). Table 1.1 contains all the indicators included in the PLS model as well as the composite reliability score for each construct. It shows that all of our constructs exceed the suggested 0.70 cut-off for composite reliability, see Nunnally and Bernstein (1994). We report the AVE for each construct and the comparison of the square root AVE in Tables 1.2 and 3 respectively. All of our constructs meet both thresholds. Further, we report the loadings as well as the t-statistics for each item making up a particular construct in Table 1.2. All items load above 0.65 and all loadings are significant.

Table 1.2: Indicator Loadings and T-Statistics

Item	Loading	T-Statistic
Perceived Environmental Uncertainty (PEU) Composite Reliability = 0.841, AVE = 0.640		
1-1	0.879	7.902
1-2	0.820	6.883
1-3	0.689	3.778
Comprehensive Performance Measures (CPM) Composite Reliability = 0.915, AVE = 0.685		
2-1	0.730	10.934
2-2	0.844	29.042
2-3	0.814	15.789
2-4	0.882	33.356
2-5	0.860	24.212
Performance-Based Compensation (PBC) Composite Reliability = 0.835, AVE = 0.559		
3-1	0.781	14.033
3-2	0.791	15.824
3-3	0.647	6.284
3-4	0.763	11.582
Employee Effort (EEF) Composite Reliability = 0.921, AVE = 0.795		
4-1	0.878	23.983
4-2	0.890	25.703
4-3	0.905	42.210
Organizational Performance (PF) Composite Reliability = 0.967, AVE = 0.743		
5-1	0.882	38.945
5-2	0.805	17.633
5-3	0.882	34.704

⁶ Unlike the Cronbach Alpha index, the composite reliability index reflects the differential weights used by PLS for the indicators underlying each construct.

5-4	0.892	41.492
5-5	0.829	25.753
5-6	0.889	38.593
5-7	0.847	19.986
5-8	0.888	28.166
5-9	0.810	19.135
5-10	0.892	41.613

Perceived Environmental Uncertainty

Perceived environmental uncertainty was measured with questions adapted from Khandwalla's (1977) instrument. Respondents were asked how stable/dynamic was the firm's external environment on three dimensions: economic, technological and political. The 7-point response scale was anchored by 1 = "very stable" and 7 = "very dynamic." The composite reliability score is 0.841 and the AVE is 0.640.

Use of Comprehensive Performance Measures

To measure the extent to which a firm used a comprehensive performance measurement system, we developed five statements based on an extensive review of the literature, see Abernethy and Lillis (1995), Epstein and Manzoni (1997, Fisher (1992), Hoffercker and Goldenberg (1994), Maisel (1992), Kaplan and Norton (1992, 1996, 2001), Provost and Leddick (1993), and Scott and Tiessen (1999). Respondents were asked to indicate on a 7-point Likert scale the extent to which they agreed or disagreed (1 = "strongly disagree" and 7 = "strongly agree") that each statement applied to their company: "Performance evaluation uses a mix of financial and non-financial (including subjective) measures," "Performance measures are systematically tied across levels of the company's hierarchy," "A mix of leading (e.g., customer satisfaction) and lagging indicators (e.g., sales) is used to evaluate performance," "Performance evaluation uses a mix of measures that are explicitly identified with different aspects of performance (e.g., customer satisfaction, internal operations, learning and growth)," and "Performance evaluation is explicitly tied to the company's competitive strategy." The composite reliability score is 0.915 and the AVE is 0.685.

Use of Performance-based Compensation

Questions used to measure the use of performance-based compensation were adapted from Chow *et al.* (1999) and Shields and Young (1993). Respondents were asked to indicate on a 7-point Likert scale the extent to which they agreed or disagreed (1 = "strongly disagree" and 7 = "strongly agree") that each of these statement applied to their company: "People's compensation contracts clearly specify how their compensation is based on their performance," "People's compensation increase as their performance increases," "People whose performance ranks in the top 25% receive higher compensation than people who rank in the bottom 25%," and "Compensation is

directly tied to individual performance.” The composite reliability score is 0.835 and the AVE is 0.559.

Employee Effort

Three questions were used to measure employee effort. Respondents were asked to indicate their degree of agreement or disagreement (1 = “strongly disagree” and 7 = “strongly agree”) with these statements: “People are always ready to “go the extra mile” for the sake of the company,” “People take pride in working hard for the company,” and “People always put forth a high level of effort at work.” The composite reliability score is 0.921 and the AVE is 0.795.

Organizational Performance

Given the lack of consensus regarding a valid cross-industry measure of corporate performance Tan *et al.* (1999), we followed the approach used by Tan *et al.* (1998) and Tan *et al.* (1999) to solicit senior managers’ perceptions of their firms’ overall performance. Respondents were asked to indicate how well their firm had performed over the past three years as compared to their industry (1 = “One of the worst,” 7 = “One of the best”) on the following dimensions: “Long run level of firm profitability,” “Growth rate of sales and revenues,” “Level of return on assets,” “Trend of return on assets,” “Market share,” “Operational and cost efficiency,” “Productivity,” “Level of return on sales,” “Trend of return on sales,” and “Overall Performance.” The composite reliability score is 0.967 and the AVE is 0.743.

3.3 Missing data

There were only 15 missing data points across the entire set of survey responses, equal to 0.6% of the total data points possible from the returned surveys. Little’s MCAR test indicated that the missing data were completely random, thus allowing us to use any imputation method, Hair *et al.* (1998). We elected to use the expected-maximization (EM) method, see Dempster *et al.* (1977), in SPSS 14 to replace missing data. This method involves a two-stage process – expectation (E) and maximization (M). The E stage involves replacing missing values with the best possible estimates, while the M stage involves making parameter estimates based on the imputed values. The two stages are repeated until the changes in the values become negligible, see Little and Rubin (1987), Hair *et al.* (1998).

4. Analysis and results

4.1 Descriptive statistics

Given the high internal consistency of each measured variable, we created a latent variable for each construct by obtaining the arithmetic average of its component

scores. Table 2 presents the descriptive statistics, and Table 3 provides the bivariate correlations among the main latent variables of interest. The latter shows that Perceived Environmental Uncertainty (PEU) is significantly correlated only with the use of Comprehensive Performance Measures (CPM). CPM in turn is significantly correlated with both Performance-based Compensation (PBC) and Employee Effort (EEF). PBC is significantly correlated with EEF as well as Organizational Performance (PF), and EEF is significantly correlated with PF.

Table 2: Descriptive Statistics

Variable	Mean	SD	Actual Range		Theoretical Range	
			Min	Max	Min	Max
PEU	4.67	1.070	2.33	7.00	1.00	7.00
CPM	4.56	1.179	1.60	7.00	1.00	7.00
PBC	4.51	1.027	2.49	7.00	1.00	7.00
EEF	4.00	0.879	3.00	7.00	1.00	7.00
PF	4.60	1.019	2.30	6.90	1.00	7.00
N=84						

PEU = Perceived Environmental Uncertainty

CPM = Comprehensive Performance Measure

PBC = Performance Based Compensation

EEF = Employee Effort

PF = Organizational Performance

Table 3: Correlation of Variables from PLS Model and (Square Root of AVE)

	PEU	CPM	PBC	EEF	PF
PEU	(0.800)				
CPM	0.229*	(0.828)			
PBC	0.097	0.631**	(0.748)		
EEF	0.194	0.237*	0.330**	(0.892)	
PF	0.133	0.181	0.310**	0.646**	(0.862)

PEU = Perceived Environmental Uncertainty

CPM = Comprehensive Performance Measure

PBC = Performance Based Compensation

EEF = Employee Effort

PF = Organizational Performance

* $p < 0.05$ (2-tailed)

** $p < 0.01$ (2-tailed)

4.2 Testing the hypothesized relationships

As was noted earlier, we used partial least squares (PLS) to simultaneously test all of the hypothesized linkages.⁷ PLS is a causal modeling technique that overcomes many

⁷ We used PLS Graph 3.0 to analyze our data.

theoretical and estimation problems present in some of the more well known structural modeling programs, such as LISREL and AMOS, see Hulland (1999), and has become increasingly popular in management accounting studies, see Chenhall (2004, 2005) for examples of PLS applications in management accounting research). In particular, this method does not make assumptions about (a) data distributions to estimate model parameters, (b) observation independence, or (c) variables’ metrics, see Barclay *et al.* (1995). As compared to more traditional techniques like ordinary least squares (OLS) regression, PLS also has the advantage of being less vulnerable to measurement errors in variables and the effects of outliers, see Wilcox (1998). These attributes make PLS particularly suitable for testing multivariate main and indirect effects models, especially for small sample sizes as in the present study, see Wold (1985), Sosik and Dworakivsky (1998). PLS generates estimates of standardized β s (i.e., path coefficients) for the model paths, which can be used to measure the relationships between latent variables as in OLS regressions, see Chenhall (2004), and see Sambamurthy and Chin (1994) for more information on PLS. In PLS, bootstrapping provides a basis for evaluating parameter estimates, and we used this technique with 1,000 sample replacement to assess the significance of each path coefficient, see Chin (1998b), Chin and Gopal (1995).

Figure 1 shows the overall model used to test our hypotheses. Table 4 presents the standardized path coefficients and t-statistics. It is inappropriate in PLS to use overall goodness-of-fit measures, which are traditionally reported in LISREL or AMOS, as PLS does not make distributional assumptions, see Chin (1998a). Instead, fit is determined in terms of convergence and discriminate validity between the constructs used as well as the R^2 (reported in Table 4) associated with each endogenous variable.

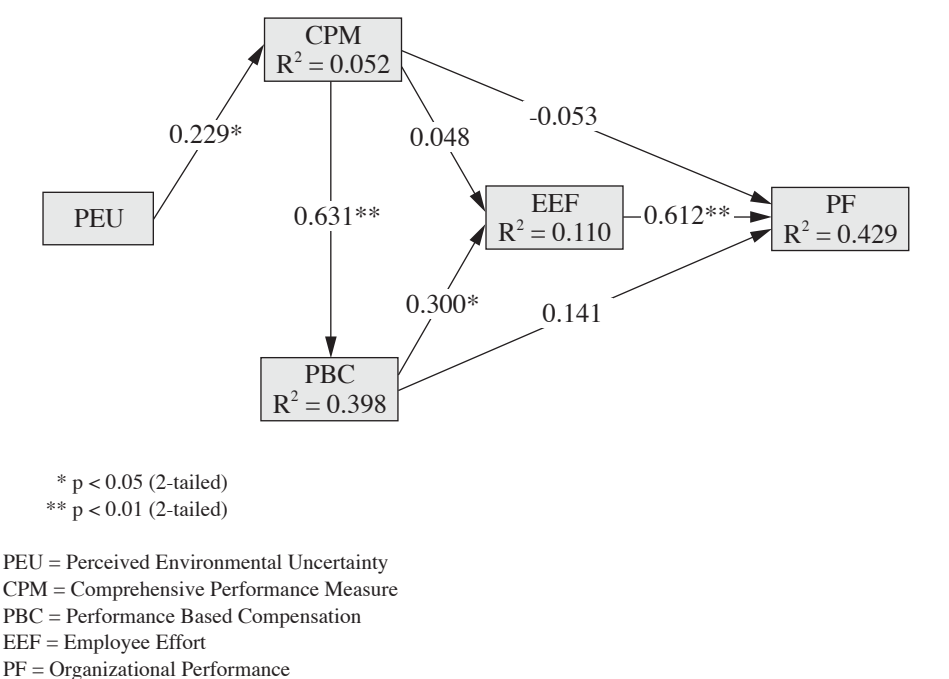


Figure 1

Table 4: PLS Results - standardized path coefficients and (*t*-statistics), R^2

Independent Variables	CPM	PBC	EEF	PF
PEU	0.229 (2.388)*			
CPM		0.631 (8.367)**	0.048 (0.361)	-0.053 (0.534)
PBC			0.300 (2.198)*	0.141 (1.391)
EEF				0.612 (9.072)**
Adjusted R^2	0.052	0.398	0.110	0.429

PEU = Perceived Environmental Uncertainty

CPM = Comprehensive Performance Measure

PBC = Performance Based Compensation

EEF = Employee Effort

PF = Organizational Performance

* $p < 0.05$ (2-tailed)

** $p < 0.01$ (2-tailed)

Hypothesis 1 stipulated that perceived environmental uncertainty is positively associated with use of comprehensive performance measurement systems. Our results (reported in Table 4 and Figure 1) show that PEU is significantly and positively related to CPM ($\beta=0.229$, $t=2.388$, $p<0.05$, two-tailed). Thus, H1 is supported.

Hypothesis 2 postulated that the use of comprehensive performance measures is positively associated with organizational performance. We do not find a significant bivariate correlation between CPM and PF (0.181, $p>0.05$, Table 3), nor do we find a significant relationship once the direct effects of EEF and PBC on PF are controlled for ($\beta=-0.053$, $t=0.534$, $p>0.05$, Table 4 and Figure 1). Thus, H2 is not supported.

Hypothesis 3 predicted a positive relation between use of comprehensive performance measures and employee effort. The positive and significant bivariate correlation between CPM and EEF (0.237, $p<0.05$, Table 3) lends some initial support to this hypothesis. However, once the effect of PBC is included in our structural model, the path between CPM and EEF becomes insignificant ($\beta=0.048$, $t=0.361$, $p>0.05$, Table 4 and Figure 1). Thus, H3 also is not supported.

Hypothesis 4 stipulated that use of performance-based compensation increases with the use of comprehensive performance measures. This prediction is supported, as Table 4 and Figure 1 show that the 0.631 path coefficient between CPM and PBC in the structural model is statistically significant ($t=8.367$, $p<0.01$, two-tailed).

Hypothesis 5 stated that the use of performance-based compensation is positively associated with employee effort. Both the bivariate correlation between PBC and EEF (0.330, $p<0.01$, Table 3) and path between PBC and EEF in the structural model after controlling for the effect of CPM on EEF ($\beta=0.300$, $t=2.198$, $p<0.05$, two-tailed, Table 4 and Figure 1) are significant. These results provide support for H5.

In addition, the results for H3, H4 and H5 together indicate that the relationship between CPM and EEF is fully mediated by PBC, according to the guidelines of Baron and Kenny (1986). This is because the direct effect between CPM and EEF (without taking PBC into account) starts off as significant (bivariate correlation of 0.237, $p < 0.05$, Table 3), but loses its statistical significance once PBC is added to the model ($\beta = 0.048$, $t = 0.361$, $p > 0.05$), while both the paths from CPM to PBC ($\beta = 0.631$, $t = 8.367$, $p < 0.01$, two-tailed) and PBC to EEF ($\beta = 0.300$, $t = 2.198$, $p < 0.05$, two-tailed) are significant. In other words, once the effect of the increased use of performance-based compensation is taken into account, the increased use of comprehensive performance measures has no additional effect on employee effort.

Finally focusing on firm performance, hypothesis 6 stipulated that employee effort is positively associated with organizational performance. Our results show both a significant bivariate correlation between EEF and PF (0.646, $p < 0.01$, Table 3) as well as a significant path between EEF and PF once the direct effect of PBC on PF is included in the model ($\beta = 0.612$, $t = 9.072$, $p < 0.01$, two-tailed, Table 4 and Figure 1). We thus find support for H6.

In hypothesis 7, we proposed that performance-based compensation is positively associated with organizational performance as well. While our results show a significant bivariate correlation between PBC and PF (0.310, $p < 0.01$, Table 3), the path in the structural model once EEF is included is not significant ($\beta = 0.141$, $t = 1.391$, $p > 0.05$, two-tailed, Table 4 and Figure 1). Thus H7 is not supported.

A further insight is available from taking the results for H5, H6 and H7 as a package, namely, that the relationship between PBC and PF is fully mediated by EEF. More specifically, the significant bivariate correlation between PBC and PF (0.310, $p < 0.01$, Table 3) becomes statistically insignificant in the structural model ($\beta = 0.141$, $t = 1.391$, $p > 0.05$) once EEF is included, while the paths from PBC to EEF ($\beta = 0.300$, $t = 2.198$, $p < 0.05$) and from EEF to PF ($\beta = 0.612$, $t = 9.072$, $p < 0.01$, two-tailed) are significant. Thus, the effect of PBC on organizational performance is totally explained by its effect on employee effort.

5. Summary and Discussion

Applying the partial least squares causal modeling technique to data from 84 Taiwanese firms in the telecommunications, electronics, and information technology sector, our results provide support to the following picture: firms respond to environmental uncertainty by increasing their use of comprehensive performance measurement systems. This increase, in turn, enables an increased use of performance-based compensation systems, and the latter motivates employees to increase their effort at work. Finally, the increased employee effort positively impacts organizational performance. Beyond the path to organizational performance from employee effort, neither comprehensive performance measurement nor performance-based compensation has additional impacts on organizational performance.

In their writing explicating and promoting use of the balanced scorecard, Kaplan and Norton (1996) have argued for the use of PBC based on the scorecard measures once the organization is used to its application (p. 283). While our study does not examine this

linkage at the level of specific performance measures, we do show that firms increase their use of performance-based compensation under more comprehensive performance measurement systems. Combined with our finding that the effect of CPM on employee effort is fully mediated by the increased use of PBC that accompanies the increased use of CPM, this result strongly supports viewing the performance measurement and compensation systems as an integral whole. Moreover, the existence of multiple mediating effects — that of PBC on the relation between CPM and EEF, and that of EEF between PBC and PF — strongly endorses our use of a causal modeling technique that simultaneously considers all of the linkages among the variables, rather than examining relations in a piecemeal fashion.

Given the potential importance of the issues explored in this study, further research is needed to test its findings' robustness, refine its methodology, and increase its scope. Within the scope of the current study, there is room for obtaining responses from more managers per firm, increasing the number of firms in the sample, expanding the set of industries included, and sampling from other national settings beyond Taiwan. Another point worthy of note is that all of the data used in this study were obtained by means of a survey. It is well known that self-reported data are vulnerable to intentional and unintentional biases (e.g., social desirability, faulty and selective recall, see Podsakoff and Organ (1986)). We have tried to reduce measurement error in the design and administration of the survey through the use of multiple respondents in each firm, consisting of a high-level manager and a human resource manager. We also have undertaken extensive assessment of the psychometric properties of each construct and provided evidence of each measure's reliability and validity. And by using PLS to analyze our structural model, we have attempted to reduce measurement error as PLS simultaneously assesses the measurement model along with the structural model. While these measures increase confidence in the findings, there remains room for further refinements, including obtaining data from other sources, such as firms' internal documents. An added impetus for method triangulation is that, as compared to other approaches (e.g., cases studies, experiments and archival analysis), survey data have limited ability to illuminate the nature of processes, causal relationships, and issues of "how" and "why", see Birnberg *et al.* (1990).

As for extending the scope of analysis, it is useful to recognize that many variables are multi- rather than uni-dimensional. For example, we had only measured the comprehensiveness of performance measurement and performance-based compensation at a generic level. There is room for expanding the details sought, perhaps to the level of the specific performance measures used, e.g., Van der Stede *et al.* (2006). Doing so will permit a more precise matching between performance measurement and compensation (e.g., the relative weights placed on financial and non-financial performance measures), thus a more powerful test of performance effects. Beyond dis-aggregation, there is room for broadening the set of variables in the analysis. For example, future research could examine how individuals' risk preferences may affect their response to different forms and mixes of performance measurement and compensation. Furthermore, it is well known that performance measurement is only one aspect of companies' internal management systems. Other important aspects include the degrees of centralization/decentralization, human resource management practices, organizational culture, and the

behavior of people in superior positions, e.g., Bae and Lawler (2000), Daft (2001), Jung *et al.* (2003). It is important to explore how these other components of management systems and processes work together with performance measurement and compensation to affect organizational success.

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