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Abernethy, M.; Bouwens, J.F.M.G.; van Lent, L.A.G.M.

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DECENTRALIZATION, INTERDEPENDENCE AND PERFORMANCE MEASUREMENT SYSTEM DESIGN: SEQUENCES AND PRIORITIES

By Margareth A. Abernethy, Jan Bouwens and Laurence van Lent

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Discussion paper

Decentralization, Interdependence and Performance Measurement System Design: Sequences and Priorities*

Margaret A. Abernethy
The University of Melbourne
Parkville Victoria 3052
Australia
E-mail: m.abernethy@ecomfac.unimelb.edu.au

Jan Bouwens
Universiteit Nyenrode
Straatweg 25
3621 BG Breukelen
The Netherlands
E-mail: J.Bouwens@nyenrode.nl

Laurence van Lent
Tilburg University
CentER Accounting Research Group
P.O. Box 90153
5000 LE Tilburg
The Netherlands
E-mail: L.A.G.M.vLent@kub.nl

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Decentralization, interdependence and performance measurement system design: Sequences and priorities

Abstract

We investigate the determinants of decentralization and performance measurement choices in multidivisional firms. We extend the research on the economics of organizational design choices by examining the impact of two important determinants of those choices, namely, subunit interdependencies and knowledge transfer costs. We test our predictions with a simultaneous equation model that captures the endogenous choices relating to the level of decentralization and the use of alternative subunit performance measures using data collected from 78 business units. Our findings are generally consistent with our predictions.

1. Introduction

This study examines empirically two determinants identified as important to organization design choices, namely, subunit interdependencies and knowledge transfer costs (Keating, 1997; Nagar, 1999 a, b). We assess the impact of these factors on choices relating to decentralization and performance metrics using a model that allows for these choices to be made simultaneously. Despite strong theoretical support for the idea that designing elements of an organization control system to "fit" or complement each other (Jensen and Meckling, 1992; Milgrom and Roberts, 1995), our understanding of these design choices remains limited.

Our study is based on the analytical frameworks developed by Jensen and Meckling (1992) and Milgrom and Roberts (1995). The model assesses choices relating to level of decentralization and two forms of subunit performance metrics, namely, aggregated performance measures (eg. profit or ROI) and disaggregated performance measures or what we refer to as specific performance measures (e.g. production expenditure, R&D, sales revenues). The simultaneous equation model can be summarized as follows:

> Decentralization = function (aggregated PMs, specific PMs, subunit interdependence, knowledge transfer costs).
>
> Aggregated PMs = function (decentralization, specific PMs, subunit interdependence, knowledge transfer costs).
>
> Specific PMs = function (decentralization, aggregated PMs, subunit interdependence, knowledge transfer costs).

We test our model using data obtained from a survey of 78 divisional managers of Dutch firms. Our results are generally supportive of our expectations. We find that decentralization is positively and significantly related to knowledge transfer costs and negatively related to levels of subunit interdependencies. The use of aggregated PMs is significantly related to subunit interdependencies. However, the significance and direction of the relation depends on the nature of the interdependencies. When the actions of divisional managers influence the

performance of other divisions the relationship is negative but not significant. However, we found that the use of aggregated PMs increases when the divisional manager's own performance is influenced by actions of other divisional managers. Only knowledge transfer costs and the level of decentralization influenced the use of specific PMs.

The study contributes to the empirical literature on the economics of organization design (Bushman et al., 1995), Keating, 1997; Nagar, 1999a, 1999b) through extension and synthesis of prior models. We extend the Bushman et al. (1995) and Keating (1997) models by examining choices between use of own-level aggregated performance measures and the use of more disaggregated performance measures. We also include two elements of organization design, namely structure and PMSs. This enables an integration of the Nagar (1999a) and Keating (1997) models. Our model further integrates the literature by including the interdependence variable identified as important by Keating (1997) and Bushman et al. (1995) and the "cost of transferring knowledge" variable important in Nagar's models.

The paper is structured as follows. Section 2 develops the hypotheses. This is followed by a description of the method and the results. The final section provides some concluding comments and directions for further research.

2. Theoretical Framework

Theory and earlier evidence suggest that decisions relating to decentralization and PMS choices are made simultaneously and that these choices are influenced by a number of exogenous factors. The impact of interdependencies among subunits and cost of transferring knowledge on these choices is discussed in turn.

2.1 Interdependencies.

Interdependencies among organizational subunits vary along a continuum. At one end of the continuum subunits operate autonomously where the only form of interdependence is

with corporate services, to the other end where subunits have reciprocal interdependencies. This is where subunits are required to trade their intermediate products with each other (Thompson, 1967). In other words, the demand functions of the subunits firm may be dependent or they may have joint supply and cost functions (see Milgrom and Roberts, 1992, p. 108-109, 113-116). The operating externalities created by such dependencies directly influence top management's decision to delegate decision rights. The existence of operating externalities implies that there are benefits to be gained by co-ordinating the activities of the subunits. When local managers are delegated decision rights they will optimize their own subunit's profit rather than consider the impact of their decisions on other units. Hence, *ceteris paribus,* the cost associated with decentralization will increase as operating dependencies increase. Top management will attempt to minimize the opportunity for sub-optimal decision making by centralizing decision making (Christie et al., 1993). In other words, centralization will be the least cost option when interdependencies are high.

Interdependencies will also significantly influence the design and use of PMSs. However, the impact of interdependencies on the use of PMSs is not due to the effect of operating externalities, as such. Rather, it is the influence that interdependencies have on the behaviour of subunit managers when performance is measured based on metrics that are influenced by actions of other subunits. While some attention has been devoted to this issue (Hayes, 1976; Bouwens and Abernethy, 2000; Christie et al., 1993; Gordon and Narayanan, 1984), Keating (1997) and Bushman et al. (1995) were among the first to provide empirical evidence on how interdependencies influence top management's choice of performance metric. They argued that firm level profit would be superior to the subunit profit measure due to the "noise" created by the activities performed in other subunits. Not only does the subunit profit measure become less informative in assessing managerial performance, superiors will also use firm profit to encourage subunit managers to co-operate. In contrast, when

interdependencies are low, subunit profit will become increasingly important. In this setting, it is superior to the firm income as it captures the outcome associated with activities performed only within that subunit.

Based on prior literature, we would thus expect that subunit performance measures would become less important as interdependencies increase. This is expected to be the case with both types of subunit measures – aggregated profit measures as well as specific measures relating to production efficiency, R&D costs and quality.[1] Specific measures are also influenced by actions taken in interdependent subunits and thus will be less informative about the actions of individual subunit managers. In sum, we expect a negative relation between subunit interdependencies and both components of the subunit PMS.

2.2 Knowledge Transfer Costs.

There is some ambiguity in how Nagar (1999a and 1999b) and Christie et al. (1993) define knowledge transfer costs. The variable appears to have two dimensions: one capturing specific knowledge (i.e. knowledge impacted at the subunit level) and a second capturing environmental factors (i.e. competition, strategy, size, growth). While it is possible that the two dimensions are correlated, our model is developed to enable a more careful exposition of the relation among these two dimensions and organization design choices.

2.2.1 Specific Knowledge.

Specific knowledge is information that is impacted at the subunit level. It occurs due to the costs of transferring information to higher levels in the hierarchy. Subordinate managers obtain specific knowledge relating to markets, technology, suppliers and other factors relating to their external environment. The level of specific knowledge increases as

[1]It is possible that a firm could select performance measures that did not include any "noise". However, the way in which the construct is defined in this study does not enable us to make that assumption.

the complexity associated with these factors increases. As complexity increases it becomes more costly to transfer the information required for decision making upwards in the organization. These costs relate not only to the systems required to transmit the information effectively but also the costs of sub-optimal decision making when the cognitive limitations of top management preclude the efficient processing of information. Thus, as the level of specific knowledge increases it comes less costly to decentralize than to invest in processes and systems to increase the information processing capabilities of a centralized management structure.

Specific knowledge also influences the reliance and choice of performance measures. Increasing levels of SK at the subunit level limits the ability of the principal to assess whether agents are operating in the firm's best interests. When top management cannot observe agent decisions they will attempt to alleviate or at least minimize the potential for opportunistic behavior by implementing performance measurement systems that capture the output of agent's decisions. The delegation of decision rights which follows from the presence of specific knowledge will prompt supervisors to rely on aggregate performance measures to encourage subunit managers to optimally use the specific knowledge. This would imply an increase of aggregate measure use. There are, however, factors that will mitigate this effect. The presence of specific knowledge also enables subunit managers to manipulate these measures and thus superiors may be reluctant to rely on them for performance evaluation. It is also argued that aggregate measures are often too late (i.e. insensitive to decisions) and/or too crude (not accurate) to assess the effect of managerial decisions (e.g., Kaplan and Atkinson, 1997; Milgrom and Roberts, 1992). After controlling for decentralization, there may be little additional benefit in using these measures as they will insufficiently convey the effect of managerial decisions. This implies that the use of aggregate measure will decrease

when specific knowledge increases. It is, therefore, expected that specific knowledge has a negative effect on the use of aggregate performance measures.

We do, however, expect a positive and significant relation between SK and the use of specific performance measures. In the presence of SK specific measures can be informative about pivotal activities within the subunit. According to Holmstrom (1979) principals will use additional performance measures only when these measures reveal new information about agent's actions at low cost (i.e. marginal benefit > marginal cost). Compared with aggregated measures, specific measures are designed to provide incremental information on the subordinate's performance with respect to the pivotal activities. To the subordinate including specific measures decreases the risk that his contribution is insufficiently captured by the performance measurement system. After controlling for decentralization we, therefore, expect the relation between specific knowledge and specific measures to be positive.

2.2.2 Environmental Conditions

Based on prior research (Christie et al., 1993) we incorporate three variables to capture the knowledge transfer costs associated with environmental factors: growth opportunities, competition and size. Nagar (1999a,b) and Keating (1997) both incorporated growth opportunities and size into their models. We include competition as it has been recognized as a critical factor influencing organizational design choices (Khandwalla, 1972; Christie et al. 1993). It is also conceptually similar to the strategy variable used by Nagar (1999a) and the product heterogeneity construct developed by Christie et al. (1993). We expect environment factors to have differential effects on design choices. Our expectations with respect to these relations are developed in turn.

2.2.2.1 Impact on Decentralization

The ability of top management to effectively "micro manage" at the subunit level becomes increasingly difficult in firms pursuing a growth strategy. The delegation of decision rights enables subunit managers to scan the environment for new opportunities and threats and respond accordingly. Similar arguments apply for firms pursuing strategies that involve high levels of competition. To be successful in a highly competitive environment requires a decision making structure that is flexible, dynamic and adaptable (Khandwalla, 1972). This requires a decentralized structure where subunit managers have the authority to respond quickly to changes in competitive conditions. Size is also an important determinant of decentralization. The sheer volume of information required to manage large organizations makes it impossible or prohibitively costly for decision making to be centralized. The inefficiencies associated with large bureaucratic organizations with centralized decision making structures have long been recognized (Bolton and Dewatripont, 1995; Vancil 1978; Lawrence and Lorsch, 1967). In sum, *ceteris paribus*, decentralization will be the least cost solution in firms that are large, pursuing a high growth strategy and facing intense competition. We, therefore, expect a positive relation between decentralization and growth, size and competition.

2.2.2.2 Impact on Choice of Performance Metric

There is no reason to expect a separate effect of growth or size on choice of performance metric other than through the creation of specific knowledge. For the same reasons as argued in relation to the SK variable, growth and size create the opportunity for the development of specialized knowledge at the subunit level and possibility for moral hazard problems to arise. Thus, the choice of performance metrics will be due to the development of specialized knowledge and top management's attempt to minimize opportunistic behaviour,

rather than any direct effect of growth or size on PMS design. On the other hand, prior literature suggests that competition may in fact directly influence the relative importance placed on performance measures by top management. Khandwalla (1972) is one of the few researchers that have provided evidence on the relation between competition and use of management accounting systems. His findings provide support for the idea that top management's use of accounting performance measures will intensify when competition increases. There is no theoretical reason for expecting that the choice of performance measure (aggregated or specific) will differ dependent on level of competition.

2.3 Summary of Expectations

Table 1 and the following hypotheses summarizes the above discussion:

H1: The level of decentralization decreases as the subunit operating interdependencies increase and increases as the level of subunit specific knowledge, subunit growth opportunities, size and competition increases.

H2: The use of aggregated subunit performance measures decreases when subunit interdependencies increase and increases when competition intensifies.

H3: The use of specific subunit performance measures decreases as subunit interdependencies increase and increases as subunit specific knowledge increases and competition intensifies.

Insert Table 1 here

3. Method

Our sample included corporations listed on the Amsterdam Stock Exchange. We needed firms with more than one division to investigate the hypothesized relation between performance measures and intra-firm dependencies and thus we included only those firms with at least two operating divisions. Divisions were defined as subunits that report directly to the Chief Executive Officer (CEO) or Chief Operating Officer (COO) of the firm. Our first

contact was with the chief financial officer (CFO). We asked the CFO to introduce us to divisional managers within the firm. This resulted in 78 divisions representing 15 industries. [2] In most of the cases, one of the researchers visited the divisional manager on site. This intensive approach increased the support provided by those agreeing to participate and also enabled us to capture qualitative data concerning more general issues relating to organization design. It also provided face validity for the constructs of interest in this study

3.1 Measurement of variables

The measurement of each variable is discussed in turn. The survey instruments used are reproduced in Appendix A. Summary statistics for each variable are presented in Table 2.

Insert Table 2 here

3.1.1 Endogenous variables

3.1.1.1 Level of decentralization.

We measure the level of decentralization using an adapted version of the Gordon and Narayanan (1984) instrument. We include only those items that relate to the degree to which decision rights are assigned to lower level managers. We asked managers to indicate their influence over a range of decisions (e.g. strategic, human resource management, operational, investment and marketing decisions). The measure (DECEN) was obtained by averaging the responses to five survey items. Factor analysis and reliability assessment of the five items supported this approach (see Table 3). Performance measurement system design.

We are specifically interested in the use of subunit aggregated and specific measures. We use Keating's (1997) notion of own-level measures (subunit income or ROI measures) to capture the use of aggregated measures. Aggregated measures (AGG) such as profit or ROI

[2] We did not expect "industry" to be a significant predictor of organization design and thus selected a wide variety of industries to increase the generalizability of the findings. Our analysis supports this expectation.

summarize subunit performance in one measure. We asked respondents to assign weights to the relative importance of AGG measures[3] *vis a vis* other performance metrics.[4]

A separate instrument was used to capture the use of specific performance metrics to circumvent a forced dependence between the two performance measurement constructs. The specific measure variable (SPEC) summed the weights on the two items that capture the use of measures that inform on specific functions (e.g. expenditure and revenue data relating to R&D, marketing, etc.) within the business unit.

3.1.2 Exogenous variables

3.1.2.1 Interdependencies.

To test the relative importance of the two performance metrics we measured interdependence based on the Keating (1997) instrument. The first item asked respondents to identify the extent to which their activities impacted other subunits (IMPACT1), and the second item asked the extent to which their performance was affected by the activities carried out by other subunits (IMPACT2). To be consistent with Keating (1997) we treated each item as a separate measure.

To test the impact of interdependencies on decentralization we used an alternative measure.[5] This measure focuses on the exchange of goods and services between subunits within the firm. The items were purpose-developed to capture operating externalities caused by joint cost and supply functions or dependent demand functions. We asked subunit managers two questions: (1) percentage of incoming supply of goods or service sourced from other subunits in percentage of the total incoming supply of goods, and (2) the percentage of

[3] The Likert type scales Keating and others are problematic in that they allow respondents to answer that all performance measures are important. We wanted respondents to reveal the relative use of performance measures.
[4] A similar approach to create a continuous scale has been successfully used by Govindarajan and Gupta (1984).
[5] Using two separate measures for interdependence helped to identify the simultaneous equations model. There are also substantive reasons for operationalizing this construct differently. In the case of decentralization we are

total outgoing goods provided to other subunits. The variable SUPPLY is the sum of these two percentages.

3.1.2.2 Knowledge Transfer Costs.

Specific Knowledge. Using the six-item scale developed by Dunk (1993), we asked managers to rate their knowledge relative to their superior's in their area of responsibility. The results of the factor analysis (see Table 3) indicated that there was only one common factor. Scale reliability was well above conventional levels (Nunnally, 1951). These results are consistent with Dunk (1993). We summed the scores on the six items to obtain a measure for specific knowledge (SK).

Environmental Conditions. We capture three elements of the environment in which the firm operates, namely, growth opportunities, size and competition. We developed an instrument to measure growth opportunities. The instrument asks managers to rate growth expectations for (1) their own subunit and for (2) the industry in which the subunit operates. The two-item measure allowed for a validation test between the items. We evaluated scale reliability with Cronbach's alpha. The estimated coefficient was 0.77, which is beyond conventional levels. We defined SIZE as the number of employees working in a unit. We measured competition using items introduced into the literature by Khandwalla (1972). This instrument comprises different elements of competition, namely, price, promotion and distribution, product quality, and product variety. We tested whether the construct (COMP) instrument was unidimensional using factor analysis and the results indicate that the four items represent one construct (see Table 3). The alpha reliability of the four items (0.65) also supported the use of a summed measure.

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interested in the jointness of the supply and demand functions while for the PMS constructs we are interested in the way in which managerial actions in relation to other subunits influence the use of performance measures.

3.1.3 Control Variables

Prior literature suggested that we include the following three control variables in our model: (1) subunit performance (Ittner & Larcker, 2000); (2) relative size as a proxy for subunit risk differences (Fama and French, 1993; Kothari et al., 1995) and (3) the intensity of the performance measure as a proxy for the sensitivity and precision of the measure (Banker and Datar, 1989). While we are not interested in the impact of these variables on our dependent variables, their inclusion minimizes the possibility of omitted variable bias.

In order for our model to be identified we used two separate measures, past performance (PPERF) and current performance (CPERF). The two constructs are highly correlated supporting the validity of our approach. We measure performance by asking managers to rate how their subunit performs relatively to competitors, and relatively to what is expected by their superiors. We assessed scale reliability with Cronbach's alpha. Coefficient estimates are 0.59 (CPERF) and 0.68 (PPERF). Relative size was measured as the percentage of sales of the subunit to the total firm or the total of the assets as a percentage to total firm assets. Intensity was captured by asking respondents how well the two performance measures captured the subunit's effort (see Appendix A, 8(iii) and 8(iv)).

We also defined four dummy variables to capture potential industry effects.

INSERT TABLE 3 HERE

4. Results and Discussion

4.1 Correlation analysis

Table 4 presents Pearson and Spearman correlations among all the variables. It appears from Table 4, that decentralization is indeed related to interdependencies (SUPPLY and IMPACT2), specific knowledge (SK), growth opportunities (GROWTH), and SIZE in the way that was predicted. Decentralization is also positively associated with the use of

aggregated measures and negatively associated with specific measures. Consistent with our expectation we find a negative relation between use of aggregated performance measures (AGG) and interdependencies (IMPACT1). The results relating to the specific performance measure variable (SPEC) do not support our expectations. There appears to be no correlation between interdependencies and SPEC and a negative relation between SPEC and specific knowledge. There appears to be no relation between the three choice variables and level of competition (COMP).

4.2 Test of the Model

We use three simultaneous equations to test our model. These equations capture (1) the degree of decentralization, (2) the use aggregated performance measures and (3) the use of specific performance measures and are expressed as follows:

$$(1)\ DECEN_i = \alpha_0 + \alpha_1 AGG_i + \alpha_2 SPEC_i + \alpha_3 SK_i + \alpha_4 SUPPLY_i + \alpha_5 GROWTH_i + \alpha_6 SIZE_i + \alpha_7 PPERF_i + \alpha_8 COMP_i + \varepsilon_i^{DECEN}$$

$$(2)\ AGG_i = \beta_0 + \beta_1 DECEN_i + \beta_2 SPEC_i + \beta_3 SK_i + \beta_4 IMPACT1_i + \beta_5 IMPACT2_i + \beta_6 RSIZE_i + \beta_7 INT\_AGG_i + \beta_8 COMP_i + \varepsilon_i^{AGG}$$

$$(3)\ SPEC_i = \gamma_0 + \gamma_1 DECEN_i + \gamma_2 AGG_i + \gamma_3 SK_i + \gamma_4 IMPACT1_i + \gamma_5 IMPACT2_i + \gamma_6 COMP_i + \gamma_7 CPERF_i + \gamma_8 INT\_SPEC_i + \gamma_9 RSIZE + \varepsilon_i^{SPEC}$$

where all variables are as defined before.

DECEN, AGG and SPEC are the jointly determined endogenous variables and we need to use all three structural equations to adequately describe the observed values. The complication in estimating this system is that ordinary least squares is inconsistent when the disturbances are correlated with the explanatory variables. To solve this problem researchers routinely use ‘instrumental’ variables that are uncorrelated by assumption with the disturbances. Two-stage-least squares (2SLS) is a legitimate instrumental variable estimator

and we use this method to estimate the system. Monte Carlo studies have shown 2SLS to have small-sample properties superior on most criteria to all other estimators. 2SLS is also robust in the presence of multicollinearity and specification errors (Kennedy, 1996). The asymptotic standard errors are, however, unreliable in finite samples. Usually asymptotic standard errors underestimate the true variances. We therefore use a bootstrapping method within the simultaneous equation framework.[6] Jeong and Maddala (1993) discuss a bootstrapping approach in which any relation in the original data between instruments and disturbances is preserved while resampling (see also, Freedman, 1984).[7] The estimation results based on a Jeong/Maddala-type bootstrapping approach with 2000 replications are in Table 5. Jeong and Maddala (1993) note that bootstrap standard errors are "useless" to test hypotheses. They suggest using the bootstrap method directly to construct confidence interval. We conduct our testing accordingly and use the empirical distribution of the parameter estimates to bootstrap confidence intervals.[8]

Insert Table 5 here

The F-statistics show that the three equations are significant at the one per cent, five per cent and 10 per cent level respectively. The adjusted R^2 for the decentralization regression is 43.39 per cent providing strong support for the explanatory ability of the

[6] An earlier example of bootstrapping within a simultaneous equation framework in accounting research is in Deis and Hill (1998).

[7] Recall that the endogeneity of the PMS and organizational design variables was our reason to use 2SLS in the first place. We proceeded as follows. First we estimated the model by 2SLS and computed the estimated residual and the predicted instruments for each equation. We then resampled the data for the original instrument, the estimated residual and the predicted instruments. We used the original instruments and the estimated residual to compute a value for the dependent variable. Finally, we computed the bootstrap estimates of the parameters by using the computed value of the dependent variable, the predicted instruments and the original instruments.

[8] Jeong and Maddala (1993) recommend using a large number of replications (between 1000 and 2000) for the computation of stable confidence intervals, we use 2000 replications. The empirical distribution should not be skewed, but be close to normal. We test the normality assumption for the empirical distribution of all the parameter estimates using a Shapiro-Wilk statistic. The results (not reported) indicate that the null hypothesis of a normal distribution cannot be rejected, except in three cases: SPEC_P and COMP in equation 2 and INT_SPEC in equation 3. Since two of these instances involve control variables (COMP and INT_SPEC) we are not overly concerned with the effects on our study.

independent variables.[9] We also report the original 2SLS results for comparison (Appendix B).

As expected, top management are likely to assign more decision rights to subunits where managers have a high level of specific knowledge (coefficient = 0.10, p-value <0.01). This finding is consistent with the idea that specific knowledge at the local level increases the efficiency of decentralized decision making compared to a centralized decision making structure. We also find evidence that the environmental conditions that represent dimensions of knowledge transfer costs were significant in explaining the extent to which decision rights are delegated. Both growth opportunities (GROWTH) and SIZE are positively related to decentralization (coefficient = 0.28, and 0.17 respectively, both p-value <0.05). We also find support for our prediction relating to interdependencies and decentralization. We argued that interdependencies between subunits raise the coordination cost of decentralization. Local managers are more likely to make locally-optimal decision, ignoring the impact of their decisions on other units. To ensure globally-optimal results, higher manager may be forced to retain certain decision rights. We find that interdependencies between subunits (SUPPLY) are negatively correlated with the level of decentralization in a firm (coefficient = -0.01, p-value <0.05). It was surprising to find no evidence that decentralization choice and PMS design are associated. Both AGG_P and SPEC_P are insignificant.

The adjusted R^2 for the equation relating to the use of aggregate performance measures (Equation 2) indicated that the model has some explanatory ability (i.e. 12.76 per cent). Our expectations are only partially supported. We find an unexpected and significantly positive relation between the impact of other subunits on the performance of the subunit (coefficient = 5.21, p-value <0.10) and the use of aggregated own level performance

[9] Although there is some evidence of multicollinearity in all equations, we are not too concerned about its effects. In Table 7, OLS is still a consistent estimator in the presence of collinearity. What's more, we are able to obtain significance for the variables of interest and therefore we follow Kennedy's (1996) recommendation to do nothing about potential collinearity.

measures. In other words, the greater that the activities of A influence the performance of B, the more B's performance will be measured based on their own profit. This finding is counter-intuitive and at first appears contrary to the notion of informativeness.[10] However, given the top management are aware of the interdependencies existing among subunits, the use of aggregate profit measures has information content about how well a manager is anticipating the effects of other subunit activities on their own activities. While the manager cannot control the activities of the other subunits, they can affect changes in their own subunit by adjusting their own costs, product mix, etc. As Keating (1997) argued in relation to the use of stock price, it may be suboptimal to insulate managers from the effects of what appears to be uncontrollable factors. Merchant (1987, p. 332) argued that inclusion of non-controllable factors in the performance measurement system draw the manager's attention to those issues that are initially beyond his control. This suggests that performance measures that include non-controllable factors will still be informative on the amount of effort the manager puts in to increase 'controllability' of these factors. There were no significant relations with the other two endogenous variables (DECEN_P and SPEC_P).

The specific measure regression, Equation 3, also provides some explanatory power with 11.96 per cent of the variance explained. As predicted, specific knowledge is associated with use of specific measures (coefficient = 2.09, p-value < 0.05). Top management use of specific measures increases with greater level of specific knowledge, which suggests positive payoffs to using these measures.[11] There is, however, no association between interdependencies and the use of specific measures.

The significant association between choice of organization design and the use of specific measures is a core result of our paper. If more decision rights are assigned to local

[10] In literature, 'informativeness' and 'conditional controllability' are used interchangeably (Bushman et al., 1995).

[11] Note that the observed correlation (Table 4) between specific measures and specific knowledge if negative. However, after controlling for the other variables in Equation 3, the relation appears to be positive.

managers, higher-level managers use specific performance measures less (coefficient on DECEN_P = -17.93, p-value <0.01). The direction of this relation is difficult to explain as conventional wisdom would lead us to expect that decentralization goes together with investment in more sophisticated performance measurement systems (Kaplan and Atkinson, 1997; Horngren et al., 1999). Recent work in information economics (Bolton and Dewatripont, 1995), however, suggests that the implementation of more sophisticated PMSs may not be effective. It is argued that such systems would further exacerbate the problem associated with information overload. Recall that top management decentralize to facilitate greater information processing capacity at lower levels of management. Implementation of additional performance measures would increase the amount of information needed to be processed by top management and may be counter-productive to the benefits of decentralization. Alternatively, when firms invest in sophisticated systems top management becomes better informed and are thus able to centralize decision making. In other words, firms will not choose to decentralize and to invest in more sophisticated PMSs. There are costs associated with both these design choices and management will make a trade-off dependent on the relative cost of each.[12] This would suggest that these choices are substitutes rather than complements.[13]

Taken together, the results from the simultaneous equation model suggest that organizational structural decisions and PMS design choices are made sequentially rather than simultaneously. A sequence in structuring organizations means that managers assign decision rights first and only then fit a PMS conditional upon their choice of decision right allocation. Such a sequence would imply that PMS choices do not explain the level of decentralization

[12] The relative cost will be influenced by the presence of other exogenous variables. In this case it would appear to be the level of specific knowledge impacted at the subunit level.

[13] The use of specific measures is also affected by the current performance of the unit. If a unit's performance is lagging (CPERF), higher-level managers will increase the use of specific measures (coefficient = -4.11, p-value < 10%). This is consistent with earlier evidence that a firm's PMS depends on how successful the firm currently is (Ittner and Larcker, 1999).

and at the same time that decentralization explains the use of aggregate and specific measures. Our results indicate that environmental conditions and specific knowledge explain decentralization choices, but this choice is not influenced by performance measurement choices. The use of aggregated performance measures is also not influenced by decisions relating to decentralization. In contrast, decentralization is an important determinant of the use of specific performance measures. Prior studies have found similar results. For example, Nagar (1999b) investigates the simultaneous choice between incentive systems and decentralization and shows that while the incentive system is affected by the degree of decentralization, the latter is not associated with the choice of incentive system. Similarly, evidence from the field suggests that firms are more concerned with getting their structure "right" and then designing their PMS to meet the requirements of the structural arrangements (Abernethy and Lillis, 1995).

4.3 Additional Analysis

The use of a 2SLS approach is motivated by arguments relating to the endogeneity of organization and PMS design choices. Nevertheless, the extent to which endogeneity affects the estimation of the equations is an empirical matter. If there were no interaction between the three equations, OLS and 2SLS estimation would both be consistent, but OLS would be more efficient. We estimate our model again using OLS and report the results in Table 6. The findings of the OLS model are valid only if OLS coefficient estimates do not suffer from simultaneous equation estimate bias. We test whether endogeneity is causing the OLS estimates to be inconsistent using a Durbin-Wu-Hausman test (MacKinnon, 1992). We find that OLS estimates are unbiased in Equations 1 and 2, (F-statistics = 0.90, 0.03; p= 0.41, p=0.97). However, the estimates are biased in Equation 3 (F-statistic = 4.17, p= 0.02). We can therefore use the OLS results of Equations 1 and 2, but not those of Equation 3.

Insert Table 6 here

The OLS results relating to the exogenous variables are qualitatively similar to those reported using 2SLS.[14] There are, however, clear differences between OLS and 2SLS estimation of the endogenous variables (i.e. choice variables). Under OLS estimation, the PMS design variables (AGG and SPEC) are both significant in the decentralization regression (coefficient = 0.01, t-statistic = 1.82 and coefficient = -0.01, t-statistic = -1.74). In Equation 2, the OLS results suggest that DECEN is associated with the use of own-level aggregated measures (coefficient = 8.50, t-statistic = 2.42). While difficult to interpret, the use of specific measures is also negative associated with level of decentralization. This is consistent with the 2SLS result. The OLS results thus provide some evidence (albeit) weak that decentralization is affected by choices in performance measurement. The use of aggregate measures is associated with higher levels of decentralization while the use of specific measures is associated with increased centralization. In turn, decentralization explains the use of aggregated and specific measures in the presence of interdependencies and specific knowledge.

5. Concluding Comments and Caveats

Our findings partly support our expectations in relation to the determinants of organizational design. We find strong evidence for the importance of knowledge transfer costs in determining choices relating to decentralization and the use of specific performance measures. We also find that interdependencies between subunits influences the extent to which top management delegate decision rights and their use of aggregated performance measures. What is of particular interest is that the type of interdependencies influences the use of aggregate measures. Our results do not confirm prior literature that top management

[14] Note that both IMPACT1 and IMPACT2 are significant in Equation 2.

will be reluctant to use aggregated subunit measures in the presence of interdependencies (Keating, 1997; Bushman et al., 1995).[15] It would appear that if a subunit's activities are influenced by the actions of managers in other units, aggregated measures are used to a greater extent. We find support that there is a sequence in choices relating to structure and PMS design. This is contrary to the theoretical predictions of both Milgrom and Roberts (1995) and Jensen and Meckling (1992) and the empirical evidence provided by Nagar (1999a). However, our results are similar to Nagar (1999b) and others (Abernethy and Lillis, 2000) who demonstrate that the relation between organization structural decisions and performance measure choice is likely to be unidirectional.

There are a number of caveats that should be recognized when considering the evidence presented in this paper. First, is the simplicity of the model. While we have extended prior research, we examine only two dimensions of organizational design. There are numerous other elements of organizational design. Second, is the potential for measurement error. Survey data are only able to capture the perceptions of respondents and thus may be subject to bias. However, there is no reason to believe that survey data contains greater measurement error than archival data where data manipulation and record keeping errors also create the potential for measurement error. Third, is the potential for omitted variable bias. While we control for a number of variables likely to influence this bias there is no doubt others.

Despite these limitations, this study has the potential to contribute to our understanding of organizational design, particularly the factors that influence top management's choice of performance measures. Of particular interest are the findings in relation to the use of specific performance measures and the importance of these measures *vis a vis* the use of traditional aggregated profit measures that has dominated much of the

[15] The OLS results relating to IMPACT1 is consistent with the Keating (1997) result.

research in the management accounting literature. Further research designed to empirically assess complementarities among elements of a firm's control system would contribute significantly to our understanding of the economics of organizational design choices.

Table 1: Main effects investigated in this study.

Factor affecting organizational design	**Decentralization level (DECEN)**	**Own-level performance measure (AGG)**	**Specific performance measure (SPEC)**
Knowledge Transfer Costs			
▪ Specific Knowledge (SK)	+	-	+
▪ Environmental Conditions			
-Growth	+		
-Size	+		
-Competition	+	+	+
Subunit interdependencies (SUPPLY/IMPACT1&2)	-	-	-

Table 2

Summary statistics for decentralization (DECEN), use of own-level aggregated performance measures (AGG), use of specific measures (SPEC), specific knowledge (SK), operating interdependencies (SUPPLY), growth opportunities (GROWTH), size of the unit (SIZE), past performance (PPERF), impact of unit on performance of other units in firm (IMPACT1), impact of other units in firm on performance of own unit (IMPACT2), relative size of unit in firm (RSIZE), degree of competition (COMP), intensity of own-level aggregated measures (INT_AGG), intensity of specific measures (INT_SPEC), experience and current performance (CPERF). Sample consists of 78 business units. Data obtained from survey of unit managers.

Variable	Mean	Standard Deviation	Median	Minimum	Maximum
DECEN	5.22	1.05	5.4	2.4	7
AGG	57.28	24.63	50	0	100
SPEC	30.27	21.04	30	0	80
SK	32.82	5.83	33.5	19	42
SUPPLY	32.88	39.15	15	0	150
IMPACT1	4.29	1.87	4	1	7
IMPACT2	4.15	1.85	4	1	7
GROWTH	11.12	1.59	11	8	14
SIZE	5.01	2.26	5	1	8
RSIZE	27.26	20.18	20	1	80
CPERF	9.65	2.14	10	5	14
PPERF	8.94	2.69	9	2	14
INT_AGG	57.78	25.20	52.5	0	100
INT_SPEC	25.09	21.48	20	0	100
COMP	20.28	4.10	21	4	28

Table 3

Results of principal factor and maximum likelihood factor analysis of responses of 78 subunit managers to survey questions about the level of specific knowledge (SK), the level of decentralization (DECEN), competition, growth opportunities (GROWTH), past performance (PPERF) and current performance (CPERF). Reported are factor loadings (standardized regression coefficients) and communality estimates (the variance in the observed variable accounted for by the common factor).

Variable	Factor loading	Communality Estimate (h^2)
SK	Cronbach's alpha = 0.86 Maximum likelihood solution tests: H1 (1 common factor) versus H0 (no common factors), χ^2=202.056, p = 0.00 H1 (> 1 common factor) versus H0 (1 common factor), χ^2=27.440, p = 0.00	
SK1	75	0.556
SK2	72	0.524
SK3	69	0.473
SK4	70	0.488
SK5	62	0.381
SK6	79	0.632
DECEN	Cronbach's alpha = 0.73 Maximum likelihood solution tests: H1 (1 common factor) versus H0 (no common factors), χ^2=71.87, p = 0.00 H1 (> 1 common factor) versus H0 (1 common factor), χ^2=1.716, p = 0.89	
DECEN1	57	0.324
DECEN2	49	0.243
DECEN3	62	0.379
DECEN4	69	0.479
DECEN5	55	0.303
COMP	Cronbach's alpha = 0.64 Maximum likelihood solution tests: H1 (1 common factor) versus H0 (no common factors), χ^2=43.39, p = 0.00 H1 (> 1 common factor) versus H0 (1 common factor), χ^2=4.719, p = 0.09	
COMP1	43	0.185
COMP2	50	0.255
COMP3	58	0.335
COMP4	64	0.416
GROWTH	Cronbach's alpha = 0.74	
PPERF	Cronbach's alpha = 0.65	
CPERF	Cronbach's alpha = 0.58	

Table 4

Pearson (Spearman) correlations below (above) diagonal between (i) own-level aggregated performance measures (AGG), (ii) specific performance measures (SPEC), (iii) level of decentralization (DECEN), (iv) specific knowledge (SK), (v) interdependence between units (SUPPLY), (vi) impact of a manager's action on other units in a firm (IMPACT1), (vii) impact of other unit managers' action on own performance (IMPACT2), (viii) growth opportunities (GROWTH), (ix) current performance (CPERF), (x) size of the unit (SIZE), (xi) relative size of the unit in the firm (RSIZE), (xii) past performance (PPERF), (xiii) intensity of own level aggregated measures (INT_AGG), (xiv) intensity of specific measures (INT_SPEC) and (xv) degree of competition (COMP). Correlations are based on 78 observations. (Prob[ρ=0|r] in parenthesis).

	AGG	SPEC	DECEN	SK	SUPPLY	IMPACT1	IMPACT2	GROWTH	CPERF	SIZE	RSIZE	PPERF	INT_AGG	INT_SPEC	COMP
AGG	1	-0.14 (0.22)	0.32 (0.00)	0.12 (0.29)	-0.13 (0.26)	-0.28 (0.01)	-0.11 (0.33)	0.05 (0.65)	-0.07 (0.55)	0.12 (0.30)	-0.22 (0.06)	0.18 (0.11)	0.34 (0.00)	-0.20 (0.07)	0.05 (0.67)
SPEC	-0.13 (0.27)	1	-0.36 (0.00)	-0.13 (0.25)	0.04 (0.72)	0.05 (0.66)	-0.00 (0.97)	-0.33 (0.00)	-0.30 (0.01)	-0.39 (0.00)	0.11 (0.32)	-0.13 (0.27)	-0.00 (0.97)	-0.19 (0.09)	-0.11 (0.35)
DECEN	0.30 (0.01)	-0.44 (0.00)	1	0.52 (0.00)	-0.25 (0.02)	-0.17 (0.13)	-0.28 (0.01)	0.32 (0.00)	0.32 (0.00)	0.28 (0.01)	-0.12 (0.30)	0.21 (0.07)	0.08 (0.51)	0.13 (0.25)	0.08 (0.48)
SK	0.14 (0.22)	-0.19 (0.08)	0.57 (0.00)	1	0.01 (0.92)	-0.02 (0.83)	-0.06 (0.59)	0.11 (0.34)	0.55 (0.00)	0.01 (0.92)	-0.05 (0.66)	0.47 (0.00)	0.07 (0.55)	-0.04 (0.75)	0.16 (0.17)
SUPPLY	-0.13 (0.26)	0.02 (0.83)	-0.22 (0.06)	0.08 (0.46)	1	0.56 (0.00)	0.61 (0.00)	-0.02 (0.84)	-0.21 (0.07)	-0.13 (0.28)	0.16 (0.16)	-0.05 (0.69)	-0.07 (0.52)	-0.01 (0.94)	0.16 (0.15)
IMPACT1	-0.27 (0.02)	0.06 (0.62)	-0.15 (0.18)	-0.02 (0.84)	0.51 (0.00)	1	0.65 (0.00)	0.06 (0.63)	-0.06 (0.63)	-0.00 (0.99)	0.46 (0.00)	-0.18 (0.11)	-0.21 (0.06)	0.07 (0.52)	0.13 (0.24)
IMPACT2	-0.11 (0.34)	0.01 (0.91)	-0.26 (0.02)	-0.07 (0.55)	0.56 (0.00)	0.66 (0.00)	1	0.09 (0.44)	-0.17 (0.13)	-0.13 (0.26)	0.35 (0.00)	-0.27 (0.02)	-0.30 (0.01)	0.06 (0.58)	0.27 (0.02)
GROWTH	0.07 (0.57)	-0.35 (0.00)	0.41 (0.00)	0.13 (0.26)	-0.12 (0.30)	0.06 (0.61)	0.10 (0.41)	1	0.05 (0.69)	0.01 (0.96)	-0.01 (0.93)	-0.07 (0.54)	-0.19 (0.09)	0.27 (0.02)	0.06 (0.62)
CPERF	-0.07 (0.53)	-0.31 (0.01)	0.36 (0.00)	0.56 (0.00)	-0.08 (0.48)	-0.05 (0.65)	-0.16 (0.15)	0.05 (0.64)	1	0.13 (0.27)	-0.08 (0.50)	0.61 (0.00)	-0.02 (0.85)	0.10 (0.36)	-0.00 (0.99)
SIZE	0.10 (0.37)	-0.38 (0.00)	0.29 (0.01)	0.05 (0.68)	-0.14 (0.24)	-0.01 (0.93)	-0.14 (0.21)	0.02 (0.83)	0.05 (0.64)	1	0.08 (0.48)	-0.01 (0.94)	0.00 (0.99)	0.04 (0.73)	0.35 (0.00)
RSIZE	-0.28 (0.01)	0.12 (0.29)	-0.17 (0.13)	-0.11 (0.34)	0.16 (0.17)	0.45 (0.00)	0.40 (0.00)	-0.08 (0.48)	-0.12 (0.30)	0.06 (0.61)	1	-0.12 (0.30)	-0.20 (0.08)	-0.04 (0.70)	0.07 (0.52)
PPERF	0.18 (0.11)	-0.15 (0.20)	0.19 (0.09)	0.43 (0.00)	0.11 (0.33)	-0.20 (0.07)	-0.27 (0.02)	-0.10 (0.38)	0.52 (0.00)	0.02 (0.90)	-0.12 (0.31)	1	0.12 (0.28)	0.02 (0.86)	-0.05 (0.67)
INT_AGG	0.28 (0.01)	-0.01 (0.96)	0.01 (0.96)	0.04 (0.72)	-0.07 (0.50)	-0.18 (0.10)	-0.28 (0.01)	-0.20 (0.08)	0.04 (0.70)	-0.01 (0.95)	-0.18 (0.11)	0.12 (0.31)	1	-0.71 (0.00)	0.08 (0.47)
INT_SPEC	-0.15 (0.18)	0.03 (0.78)	0.12 (0.30)	-0.02 (0.83)	0.04 (0.76)	0.08 (0.50)	0.05 (0.69)	0.19 (0.10)	0.07 (0.52)	0.02 (0.87)	-0.07 (0.50)	0.03 (0.79)	-0.71 (0.00)	1	-0.08 (0.48)
COMP	0.04 (0.73)	-0.06 (0.59)	0.10 (0.39)	0.13 (0.25)	0.00 (0.99)	0.09 (0.41)	0.17 (0.13)	0.06 (0.60)	-0.03 (0.78)	0.37 (0.00)	0.07 (0.52)	-0.07 (0.53)	0.11 (0.34)	-0.06 (0.63)	1

Table 5.

Two stage least squares estimation of the relation between the degree of decentralization (DECEN), the use of own-level aggregated performance measures (AGG) and the use of specific measures (SPEC) and (i) specific knowledge (SK), (ii) interdependence between units (SUPPLY), (iii) growth opportunities (GROWTH), (iv) size of a unit (SIZE), (v) past performance (PPERF), (vi) impact of the actions of unit on the performance of other units (IMPACT1), (vii) impact of the actions of other managers on the performance of own unit (IMPACT2), (viii) relative size of unit in firm (RSIZE), (ix) the degree of competition (COMP), (x) the current performance (CPERF), (xi) the intensity of own-level aggregated measures (INT_AGG) and (xii) the intensity of specific measures (INT_SPEC). The suffix _P denotes predicted values from first-stage regression.

$$(1)\ DECEN_i = \alpha_0 + \alpha_1 AGG\_P_i + \alpha_2 SPEC\_P_i + \alpha_3 SK_i + \alpha_4 SUPPLY_i + \alpha_5 GROWTH_i + \alpha_6 SIZE_i + \alpha_7 PPERF_i + \alpha_8 COMP_i + \varepsilon_i^{DECEN}$$

$$(2)\ AGG_i = \beta_0 + \beta_1 DECEN\_P_i + \beta_2 SPEC\_P_i + \beta_3 SK_i + \beta_4 IMPACT1_i + \beta_5 IMPACT2_i + \beta_6 RSIZE_i + \beta_7 INT\_AGG_i + \beta_8 COMP_i + \varepsilon_i^{AGG}$$

$$(3)\ SPEC_i = \gamma_0 + \gamma_1 DECEN\_P_i + \gamma_2 AGG\_P_i + \gamma_3 SK_i + \gamma_4 IMPACT1_i + \gamma_5 IMPACT2_i + \gamma_6 COMP_i + \gamma_7 CPERF_i + \gamma_8 INT\_SPEC_i + \gamma_9 RSIZE + \varepsilon_i^{SPEC}$$

Based on 78 observations. Standard errors in parenthesis. Coefficient estimates and standard errors are based on a bootstrapping procedure with 2000 replications. Industry dummies are included but not reported. Significance is based on the empirical distribution of the parameter estimates. *, **, *** denotes 10%, 5% and 1% significance levels (two-tailed) respectively.

	P.S.	DECEN	P.S.	AGG	P.S.	SPEC
Constant		-1.9587 (2.3196)		11.4750 (51.9683)		125.298 (41.4135)***
AGG_P	+	0.0029 (0.0070)			?	-0.3050 (0.4126)
SPEC_P	?	0.0131 (0.0172)	?	0.0866 (0.3937)		
DECEN_P			+	10.0131 (9.8159)	?	-17.9278 (7.9784)***
SK	+	0.0989 (0.0196)***	-	-0.4391 (1.0128)	+	2.0889 (1.0153)**
SUPPLY	-	-0.0056 (0.0031)**				
GROWTH	+	0.2768 (0.1081)**				
SIZE	+	0.1674 (0.0760)**				
PPERF	+	0.0142 (0.0429)				
IMPACT1			-	-4.0025 (2.624)	-	-0.2080 (3.1169)
IMPACT2			-	5.2051 (2.916)*	-	-3.3440 (3.1938)
RSIZE			+	-0.1838 (0.1837)	+	0.0154 (0.2337)
INT_AGG			+	0.2693 (0.1690)		
COMP	+	-0.0348 (0.0246)	+	-0.5142 (0.8407)	+	-0.2542 (0.8424)
CPERF					-	-4.1123 (2.2918)*
INT_SPEC					+	0.0955 (0.2208)
NOBS		78		78		78
ADJ. R2		43.39%		12.76%		11.96%
F-statistic		6.366		2.024		1.871
Prob(F)		0.0001		0.0397		0.0548

Table 6.

Ordinary least squares estimation of the relation between the degree of decentralization (DECEN), the use of own-level aggregated performance measures (AGG) and the use of specific measures (SPEC) and (i) specific knowledge (SK), (ii) interdependence between units (SUPPLY), (iii) growth opportunities (GROWTH), (iv) size of a unit (SIZE), (v) past performance (PPERF), (vi) impact of the actions of unit on the performance of other units (IMPACT1), (vii) impact of the actions of other managers on the performance of own unit (IMPACT2), (viii) relative size of unit in firm (RSIZE), (ix) the degree of competition (COMP), (x) the current performance (CPERF), (xi) the intensity of own-level aggregated measures (INT_AGG) and (xii) the intensity of specific measures (INT_SPEC):

$$(1)\ DECEN_i = \alpha_0 + \alpha_1 AGG_i + \alpha_2 SPEC_i + \alpha_3 SK_i + \alpha_4 SUPPLY_i + \alpha_5 GROWTH_i + \alpha_6 SIZE_i + \alpha_7 PPERF_i + \alpha_8 COMP_i + \varepsilon_i^{DECEN}$$

$$(2)\ AGG_i = \beta_0 + \beta_1 DECEN_i + \beta_2 SPEC_i + \beta_3 SK_i + \beta_4 IMPACT1_i + \beta_5 IMPACT2_i + \beta_6 RSIZE_i + \beta_7 INT\_AGG_i + \beta_8 COMP_i + \varepsilon_i^{AGG}$$

$$(3)\ SPEC_i = \gamma_0 + \gamma_1 DECEN_i + \gamma_2 AGG_i + \gamma_3 SK_i + \gamma_4 IMPACT1_i + \gamma_5 IMPACT2_i + \gamma_6 COMP_i + \gamma_7 CPERF_i + \gamma_8 INT\_SPEC_i + \gamma_9 RSIZE + \varepsilon_i^{SPEC}$$

Based on 78 observations. Standard errors in parenthesis. *, **, *** denotes 10%, 5% and 1% significance levels (two-tailed) respectively. Industry dummies are included but not reported.

	P.S.	DECEN	P.S.	AGG	P.S.	SPEC
Constant		0.329 (1.034)		15.178 (24.496)		84.098 (19.416)***
AGG	+	0.006 (0.003)*			?	0.002 (0.105)
SPEC	?	-0.008 (0.005)*	?	0.069 (0.142)		
DECEN			+	8.499 (3.508)**	?	-10.218 (2.895)***
SK	+	0.094 (0.017)***	-	-0.305 (0.555)	+	0.900 (0.561)
SUPPLY	-	-0.005 (0.002)**				
GROWTH	+	0.171 (0.064)***				
SIZE	+	0.086 (0.046)*				
PPERF	+	-0.016 (0.037)				
IMPACT1			-	-3.849 (1.931)**	-	0.850 (1.685)
IMPACT2			-	4.681 (2.142)**	-	-2.271 (1.825)
RSIZE			+	-0.205 (0.147)	+	0.092 (0.128)
INT_AGG			+	0.258 (0.120)**		
COMP	+	-0.020 (0.023)	+	-0.411 (0.695)	+	-0.038 (0.596)
CPERF					-	-2.728 (1.375)*
INT_SPEC					+	0.075 (0.111)
NOBS		78		78		78
ADJ. R2		53.80%		16.57%		17.44%
F-statistic		9.150		2.390		2.356
Prob(F)		0.0001		0.0147		0.0139

REFERENCES

Abernethy, M.A. and Lillis, A.M. (1995), The Impact of Manufacturing Flexibility on Management Control System Design, *Accounting, Organizations and Society*, 20(4), pp. 241-258.

Bolton, P. and M. Dewatripont (1995), The Time and Budget Constraints of the Firm, *European Economic Review*, 39(3-4), pp. 691-699.

Bouwens, J. and Abernethy, M.A. (2000), The Consequences of Customization on Management Accounting System Design, *Accounting, Organizations and Society*, 25(3), pp. 221–241

Bushman, R.M., Indjejikian, R.J. and Smith, A. (1995), Aggregate Performance Measures in Business Unit Manager Compensation: The Role of Intra Firm Interdependencies, *Journal of Accounting Research* (33 Supplement), pp. 101-128.

Christie, A.A., M.P. Joye, and R.L. Watts (1993), Decentralization of the Firm: Theory and Evidence, Working-paper, University of Rochester.

Deis, D.R. and Hill, R.C. (1998), An Application of the Bootstrap Method to the Simultaneous Equations Model of the Demand and Supply or Audit Services, *Contemporary Accounting Research* 15(1), pp. 83-99.

Dunk, A.S. (1993), The Effect of Budget Emphasis and Information Asymmetry on the Relation Between Budgetary Participation and Slack, *The Accounting Review* 68(2), pp. 400-410

Fama, E.F. and French, K.R**.** (1993), Common Risk Factors in Returns on Stocks and Bonds, *Journal of Financial Economics*, 33, pp. 3-56

Freedman, D. (1984), On Bootstrapping Two-Stage Least Squares Estimates in Stationary Linear Models, *Annals of Statistics* 12(3), pp. 827-842.

Gaver, J. and K. Gaver (1993), Additional Evidence on the Association between the Investment Opportunity Set and Corporate Financing, Dividend and Compensation Policy, *Journal of Accounting and Economics*, pp. 125-160.

Gordon, L.A. and Narayanan, V.K. (1984), Management Accounting Systems: An Empirical Evaluation, *Accounting, Organizations and Society*, 9(1), pp. 33-47-

Govindarajan, V. and Gupta, A.K. (1985), Linking Control Systems to Business Unit Strategy: Impact on Performance, *Accounting, Organizations and Society*, 10(1), pp. 51-66

Hayes D.C. (1977), The Contingency Theory of Managerial Accounting, *Accounting Review*, 52(1), pp. 22-39.

Holmstrom, B. (1979), Moral Hazard and Observability, *Bell Journal of Economics*, 10, pp. 74-91

Horngren, C. T., G. Foster, and S.M. Datar (1999), *Cost Accounting : a Managerial Emphasis*, Prentice Hall.

Ittner, C.D., D. Larcker and J.P. MacDuffie (1996), Manufacturing Flexibility, Worker Compensation Practices, and the Allocation of Decision Rights in Automobile Assembly Plants, Working-paper, University of Pennsylvania.

Ittner, C.D. and Larcker, D.F. (1999), The Effects of Performance Measure Diversity on Incentive Plan Outcomes, working paper The Warton School, University of Pennsylvania

Ittner, C.D. and Larcker, D.F. (2000), Assessing Empirical Research in Managerial Accounting: a Value Based Perspective, *Journal of Accounting and Economics*, forthcoming

Jensen, M.C. and Meckling, W.H. (1992) Specific and General Knowledge and Organizational Structure, in: Werin, L. and Wijkander, H. (Eds.) *Contract Economics*, Blackwell Publishers, Cambridge.

Jeong, J. and Maddala, G.S. (1993), A Perspective on Application of Bootstrap Methods in Econometrics, In: Maddala, G.S., Rao, C.R. and Vinod, H.D. (eds.) *Handbook of Statistics*, vol. 11, Elsevier Science: Amsterdam.

Kaplan, R.S. and A.A. Atkinson (1998), *Advanced Management Accounting*, Prentice Hall, Upper Saddle River, NJ, 3rd edition.

Keating, A.S. (1997), Determinants of Divisional Performance Evaluation Practices, *Journal of Accounting and Economics*, 24, pp. 243-274

Kennedy, P. (1996), *A Guide to Econometrics*, MIT Press, Cambridge, MA, 4th edition.

Khandwalla, P.N. (1972), The Effect of Different Types of Competition on the Use of Management Controls, *Journal of Accounting Research*, 10(2), pp. 275-285

Kothari, S.P., Shanken, J. and Sloan, R.G. (1995) Another Look at the Cross-section of Expected Stock Returns, *Journal of Finance* (50)1 pp. 185-224

Luft, J. and Shields, M. (2000), Mapping management accounting: making structural models from theory-based empirical research ,Working paper, Michigan State University

Merchant, K.A., (1987), Disregarding the controllability principle, in: J. Bruns and R.S. Kaplan (Eds.), *accounting and management, field study perspectives*, pp316-338, Harvard Business School Press.

Milgrom, P. and Roberts J. (1992), *Economics, Organization and Management*, Prentice-Hall, Upper-Saddle River, NJ.

Milgrom, P. and Roberts, J. (1995), Complementarities and Fit: Strategy, Structure and Organizational Change in Manufacturing, *Journal of Accounting and Economics*, 19, pp. 179-208

Mohr, L.B. (1971), Organizational Technology and Organizational Structure, *Administrative Science Quarterly*, (16), pp. 444-459

MacKinnon, J.G. (1992), Model Specification Tests and Artificial Regressions, *Journal of Economic Literature*, pp. 102-146.

Nagar, V. (1999a), Interrelations Among a Firm's Delegation and Incentive Compensation Choices, Working-paper, University of Michigan Business School.

Nagar, V. (1999b), Organizational Design Choices in Retail Banking, Working-paper, University of Michigan Business School.

Nunnally (1951), *Psychometric Theory*, McGraw-Hill, New York.

Smith, C. and Watts, R. (1992), The Investment Opportunity Set and Corporate Financing, Dividend and Compensation Policies, *Journal of Financial Economics*, 32, pp. 263-293.

Thompson, J.D. (1967), *Organizations in Action*, Mcraw-Hill, New York.

Vancil, R.F. (1978), Decentralization: managerial ambiguity by design, Dow-Jones, Irwin, Homewood, Ill.

Appendix A: Instruments

1. Decentralization (DECEN)

In this section we would like you to compare your influence with the influence of your superior on the following decisions.

i. Strategic decisions (e.g., development of new products; enter and develop new markets; your unit's strategy).
ii. Investment decisions (e.g., acquiring new assets and financing investment projects; information systems)
iii. Marketing decisions (e.g., campaigns; pricing decisions)
iv. Decisions regarding internal processes (setting production/sales priorities; inputs used and/or processes employed to fill orders; contracting input suppliers).
v. Human resources decisions (e.g., hiring/firing; compensation and setting career paths for the personnel employed within your unit; reorganizing your unit; creation of new jobs)

If you and/or any of your subordinates make the decision without the knowledge of your supervisor, you and/or others of your unit are considered to have *all* influence.

		My unit has all influence			*My superior and I have about the same influence*			*My superior has all influence*	
(i)	Strategic decisions	1	2	3	4	5	6	7	n/o
(ii)	Investment decisions	1	2	3	4	5	6	7	n/o
(iii)	Marketing decisions	1	2	3	4	5	6	7	n/o
(iv)	Decisions regarding internal Processes	1	2	3	4	5	6	7	n/o
(v)	Human resource decisions	1	2	3	4	5	6	7	n/o

2. Aggregated performance measures (AGG)

Indicate the weights your supervisor assigns to each of these measures to assess your unit's performance. We would like you to indicate these weights for each of these measures. Your answers should total 100%.

i. Stock-price related measures ____ %
ii. Firm-level performance measures (e.g., firm output, firm ROI, firm profit margins, firm income) ____ %
iii. Measures summarizing the total performance of **your unit** (e.g., your unit's income, unit EVA or ROI, unit output) ____ %
Iv. Measures that provide performance information on specific aspects within your business unit (e.g., R&D, production efficiency or quality programs, unit product costs) ____ %
v. Other measures not mentioned (please specify)……. ____ %

Total **100%**

3. Specific performance measures (SPEC)

Indicate the weights your supervisor (implicitly or explicitly) assigns to each of these measures to assess your unit's performance. We would like you to indicate these weights for each of these measures. Your answers should total 100%.

i.	Stock-price related measures	%
ii.	Profitability measures (e.g., ROI, profit margins, income)	%
iii.	Cost measures (e.g., production cost measures, R&D cost)	%
iv.	Revenue measures	%
v.	Non-financial performance information on strategy, marketing and investments (e.g., customer satisfaction, market share, R&D progress)	%
vi.	Non-financial performance measures on internal processes and human resources (e.g., productivity, quality or employee training projects)	%
vii.	Other non-financial measures not mentioned (please specify)_____ _____	_____%
	Total	**100%**

4. Interdependencies

This section relates to the relationships between your unit and other organizational units.

	No impact at all			*Some impact*			*A very significant impact*	
(a) To what extent do your unit's actions impact on work carried out in **other** organizational units of your firm (IMPACT1).	1	2	3	4	5	6	7	n/o
(b) To what extent do actions of managers of other units of the firm impact work carried out in **your** particular unit(IMPACT2).	1	2	3	4	5	6	7	n/o

(c) What percentage of your total production is delivered to other organizational units of your firm? %

(d) What percentage of your total production uses inputs acquired from other organizational units of your firm %

5. Growth

(a) What is your expectation with respect to the growth opportunities that exist within the *industry* in which you compete?	1	2	3	4	5	6	7	n/o
(b) What is your expectation with respect to the growth opportunities your *specific unit* faces?	1	2	3	4	5	6	7	n/o

6. Competition

		No competition						*Very intensive competition*	
(a)	How intensive is the price competition your unit faces?	1	2	3	4	5	6	*7*	n/o
(b)	How intensive is the competition in promotion and distribution (marketing) your unit faces?	1	2	3	4	5	6	7	n/o
(c)	How intensive is the competition in product quality your unit faces?	1	2	3	4	5	6	7	n/o
(d)	How intensive is the competition in product variety your unit faces	1	2	3	4	5	6	7	n/o

7. Performance

		Worse than the market			*About the same as the market*			*Better than the market*	
(a)	How well **does** your unit perform compared to the performance of similar units in competing firms?	1	2	3	4	5	6	7	n/o
(b)	How well **did** your unit perform last year compared to other units or similar units in competing firms?	1	2	3	4	5	6	7	n/o
		Worse than expected			*About the same as expected*			*Better than expected*	
(c)	How well **does** your unit perform compared to what is expected by your superior?	1	2	3	4	5	6	7	n/o
(d)	How well **did** your unit perform last year compared to what was expected by your superior?	1	2	3	4	5	6	7	n/o

8. Performance measurement system intensity.

(e) Please indicate the extent to which the following performance measures reveal the performance of your unit **accurately**. In this context, accurateness means that your unit's effort is well reflected in the performance measure. We would like you to compare the accurateness of the measures below. If the performance measures are all equally accurate in your unit, each measure (i – v) receives 20%. If one measure is more accurate, it will receive a weight of more than 20%. Hence, your answers should total 100%

i.	Stock-price related measures	%
ii.	Measures jointly summarizing the performance of your and other units (e.g., firm wide profit)	%
iii.	Measures summarizing the total performance of your unit (i.e., your unit's income, total output of your unit)	%
iv.	Measures that provide performance information on specific aspects within your organizational unit (e.g., R&D, production efficiency or quality programs)	%
v.	Other measures not mentioned (please specify)…….	_____%
	Total	**100%**

Table Appendix B.

Two stage least squares estimation of the relation between the degree of decentralization (DECEN), the use of own-level aggregated performance measures (AGG) and the use of specific measures (SPEC) and (i) specific knowledge (SK), (ii) interdependence between units (SUPPLY), (iii) growth opportunities (GROWTH), (iv) size of a unit (SIZE), (v) past performance (PPERF), (vi) impact of the actions of unit on the performance of other units (IMPACT1), (vii) impact of the actions of other managers on the performance of own unit (IMPACT2), (viii) relative size of unit in firm (RSIZE), (ix) the degree of competition (COMP), (x) the current performance (CPERF), (xi) the intensity of own-level aggregated measures (INT_AGG) and (xii) the intensity of specific measures (INT_SPEC). The suffix _P denotes predicted values from first-stage regression.

$$(1)\ DECEN_i = \alpha_0 + \alpha_1 AGG\_P_i + \alpha_2 SPEC\_P_i + \alpha_3 SK_i + \alpha_4 SUPPLY_i + \alpha_5 GROWTH_i + \alpha_6 SIZE_i + \alpha_7 PPERF_i + \alpha_8 COMP_i + \varepsilon_i^{DECEN}$$

$$(2)\ AGG_i = \beta_0 + \beta_1 DECEN\_P_i + \beta_2 SPEC\_P_i + \beta_3 SK_i + \beta_4 IMPACT1_i + \beta_5 IMPACT2_i + \beta_6 RSIZE_i + \beta_7 INT\_AGG_i + \beta_8 COMP_i + \varepsilon_i^{AGG}$$

$$(3)\ SPEC_i = \gamma_0 + \gamma_1 DECEN\_P_i + \gamma_2 AGG\_P_i + \gamma_3 SK_i + \gamma_4 IMPACT1_i + \gamma_5 IMPACT2_i + \gamma_6 COMP_i + \gamma_7 CPERF_i + \gamma_8 INT\_SPEC_i + \gamma_9 RSIZE + \varepsilon_i^{SPEC}$$

Based on 78 observations. Standard errors in parenthesis. Industry dummies are included but not reported. Significance is based on the empirical distribution of the parameter estimates. *, **, *** denotes 10%, 5% and 1% significance levels (two-tailed) respectively.

	P.S.	DECEN	P.S.	AGG	P.S.	SPEC
constant		-2.1311 (2.5131)		8.1076 (41.3847)		124.3693 (30.8843)***
AGG_P	+	0.0027 (0.007)			?	-0.3293 (0.3436)
SPEC_P	?	0.0138 (0.0196)	?	0.1083 (0.3427)		
DECEN_P			+	10.4732 (8.3935)	?	-17.8821 (6.6724)***
SK	+	0.1001 (0.0200)***	-	-0.4732 (0.8212)	+	2.0887 (0.8781)**
SUPPLY	-	-0.0055 (0.0028)*				
GROWTH	+	0.2874 (0.1189)**				
SIZE	+	0.1690 (0.0872)*				
PPERF	+	0.0149 (0.0478)				
IMPACT1			-	-3.9109 (1.9580)**	-	-0.0973 (2.2227)
IMPACT2			-	5.0419 (2.5467)*	-	-3.2466 (2.4819)
RSIZE			+	-0.2061 (0.1487)	+	0.0203 (0.1690)
INT_AGG			+	0.2669 (0.1259)**		
COMP	+	-0.0349 (0.0289)	+	-0.4271 (0.7009)	+	-0.2012 (0.7084)
CPERF					-	-4.0923 (1.8502)*
INT_SPEC					+	0.1040 (0.1446)
NOBS		78		78		78
ADJ. R2		43.39%		12.76%		11.96%
F-statistic		6.366		2.024		1.871
Prob(F)		0.0001		0.0397		0.0548