A CAUSAL MODEL OF LINKAGES AMONG STRATEGY, STRUCTURE, AND PERFORMANCE USING DIRECTED ACYCLIC GRAPHS: A MANUFACTURING SUBSET OF THE FORTUNE 500 INDUSTRIALS 1990 - 1998

A Dissertation

by

HOGUN CHONG

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2003

Major Subject: Agricultural Economics

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Approved as to style and content by:

David A. Bessler (Chair of Committee)	Mary Zey (Member)
H. Alan Love (Member)	David J. Leatham (Member)
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ABSTRACT

A Causal Model of Linkages among Strategy, Structure and Performance

using Directed Acyclic Graphs: A Manufacturing Subset of

the Fortune 500 Industrials 1990 - 1998. (May 2003)

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This research explored the causal relationships among strategies, corporate structure, and performance of the largest U.S. non-financial firms using Directed Acyclic Graphs (DAGs). Corporate strategies and structure have been analyzed as major variables to influence corporate performance in management and organizational studies. However, their causal relationships in terms of which variables are leaders and followers, as well as the choices of variables to configure them, are controversial. Finding of causal relationships among strategic variables, structural variables, and corporate performance is beneficial to researchers as well as corporate mangers. It provides guidance to researchers how to build a model in order to measure influences from one variable to the other, lowering the risk of drawing spurious conclusions. It also provides managers with information about how important variables would change when certain strategic decisions are made. Literatures from agency theory, transactional cost economics, and traditional strategic management perspective are used to suggest variables essential to analyze corporate performance. This study includes size and multi-organizational ownership hierarchy as variables to configure corporate structure. The variables to configure corporate strategies are unrelated and related diversification, ownership by institutional investors, debt, investment in R&D, and investment in advertisement.

The study finds that most of the variables classified as corporate strategy and corporate structure variables are either direct or indirect causes of corporate accounting performance. Generally, results supports the relational model such that corporate structure leads corporate strategy, and corporate strategy leads corporate performance. Ownership hierarchy structure, unrelated diversification, advertising expenses, and R&D intensity have direct causal influences on corporate accounting performance. Size and related diversification affected corporate accounting performance indirectly, both through ownership hierarchy structure. Theoretical causal relationships from agency theory are less supported than those from transaction cost economics and traditional strategic management perspective. Further this study suggests that, in general, good corporate performance in 1990s was mainly achieved by internal expansion through investment in R&D and advertisement, rather than external expansion of firms through unrelated diversification, related diversification, and expansion of ownership hierarchy.

To my parents and wife

ACKNOWLEDGEMENTS

First and foremost, I would like to express my appreciation to Dr. David Bessler, my committee chair. With his encouragement and guidance, I have completed my graduate studies. His guidance opened up the path to DAG for me. I will always keep in mind the statement he showed me on the first day we met: “Walk before trying to run”.

Special thanks are due to Dr. Mary Zey, for introducing me to several new areas of research topics and for allowing me to use the data I collected while working for her. Her role in my dissertation was more than as a committee member. She taught me organizational analysis.

I would like to take this opportunity to thank other committee members, including Dr. Alan Love, Dr. David Leatham, and Dr. Albert A. Cannella, Jr., who provided me with an education, formally or informally, that will be an invaluable resource in my future career. I really enjoyed the time I worked for Dr. Alan Love as a TA. Some of my favorite times were talking with him before or after class. He also helped me to learn how to prepare and teach a class. I express my thanks to Dr. David Leatham for reminding me that finishing graduate study is just the start of being a professional. The conversations with Dr. Albert A. Cannella, Jr. helped me to believe that I was doing the research in the right way.

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CHAPTER I

INTRODUCTION

The strategy, structure and performance trilogy has been a major topic of research in management and organizational analysis. Corporate strategies and structure have been analyzed as major variables to influence corporate performance in management and organizational studies. However, their causal relationships in terms of which variables are leaders and followers, as well as the choices of variables to configure them, are controversial. Finding of causal relationships among strategic variables, structural variables, and corporate performance is beneficial to researchers as well as corporate mangers. It provides guidance to researchers how to build a model in order to measure influences from one variable to the other, lowering the risk of drawing spurious conclusions. It also provides managers with information about how important variables would change when strategic decisions are made. Chandler (1962) defined structure as the design of an organization through which the enterprise is administrated. Kenneth (1971) defined strategy as the result of a balanced consideration of a firm's skills and resources, the opportunities extant in the economic environment, and the personal desire of management. According to Chandler (1962), Rumelt (1974), and others, an analysis of strategy and performance without structure or an analysis of structure and performance without strategy can show only a piece of the whole

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This dissertation follows the format of the ***Academy of Management Journal.***

fundamental relationship. In his seminal work, Strategy and Structure (1962), Chandler posited and found, through historical case studies of the most successful industrial organizations, that strategy leads to the performance only through diversified structure, the multidivisional form.

However, there are a group of researchers who suggested structure leads strategy. Structure sets the agenda for top manages in making strategic decisions (Hammond, 1990). Pitts (1980) maintained that structure institutionalizes strategy and thereby provides the premises for strategic decision making. Chamberlain (1968) suggested that structure and historical actions constrain firms strategies such that they constrain the set of alternatives from which strategies may be chosen. Contemporary managerial theorists have found the structure → strategy → performance relationship is more important (Hoskisson, Hitt, Johnson, and Moesel,1993). Hill, Hitt, and Hoskisson (1992: 501) summarized the point:

> A significant amount of research on diversification has ignored the importance of implementation on the strategy-performance relationship. By ignoring the effects of organizational characteristics, many prior studies may have produced erroneous or, at best, incomplete results.

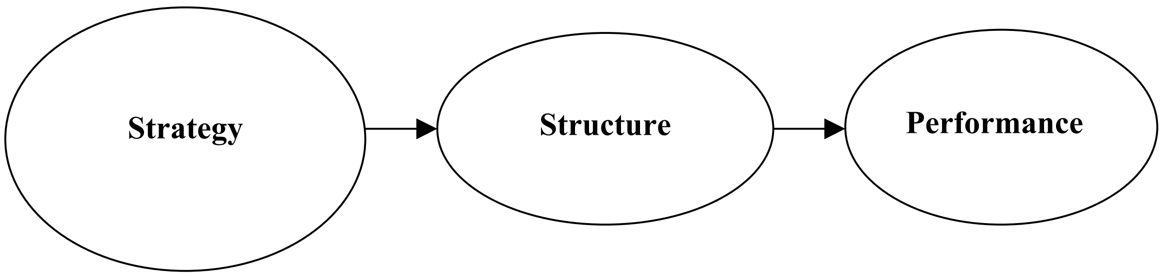
With respect to the corporate diversification strategy, Hoskisson and Hitt (1990: 462) note, there still is no commonly accepted theoretical framework that explains the antecedents of the diversification strategy and the relationship between diversification and firm outcomes such as performance. Indeed despite the large volume of research to answer the question of whether diversification leads to improved corporate performance, these empirical studies have often resulted in contradictory findings (Perry, 1998). A group of strategic management research posits and finds direct relationships between strategies and performance regardless of structure (Amit & Livnat, 1988; Bettis, 1981). To my knowledge analysis showing a direct causal relationship between structure and performance in the absence of strategy has not been published. To illustrate possible causal flows, four dominant relational models of performance, strategy, and structure are presented in Figure 1.1. In fact all present theories on the trilogy of strategy, structure, and performance have been generated by deductive logic from an assumed set of conditions. The true causal relationships among these three components have not been analyzed. Causal relationship are gotten clouded.

For example, performance may increase some strategies and appeared to strategies causing performance. Under some conditions the cost of advertising may not predict performance, but rather performance of the corporation may predict the resources managers can spend on advertising. Likewise, we can question the relationship between the strategy of diversification and performance. Perhaps low corporate performance requires change in diversification strategy.

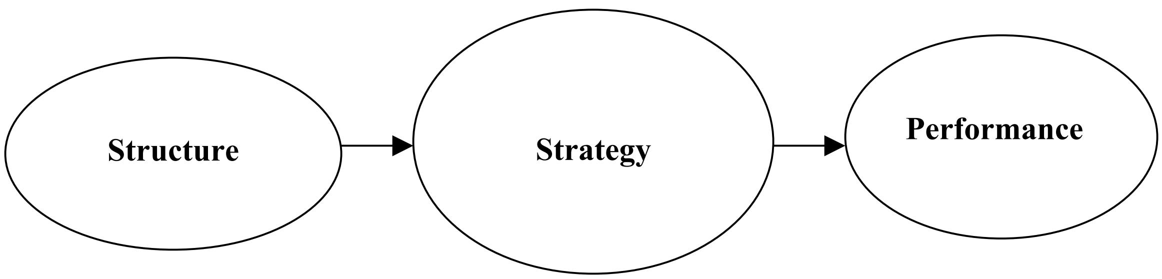
If the predictor variable is performance rather than diversification, then this may result in contradictory findings among existing studies. The true causal relationships can only be defined by the empirical relationships within the corporations. Therefore I do **not** posit the causal links between types of strategy, structure and performance variables but use directed acyclic graphs to reveal the empirical causal relationship. I do posit expected relationships form the finding of current organizational analysis.

Figure 1.1

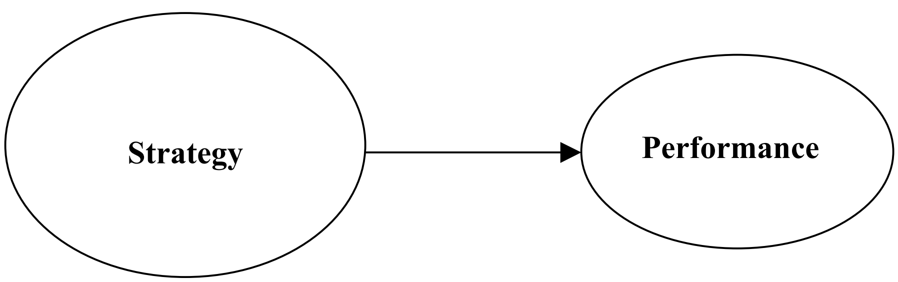
Dominant Relational Models of Performance, Strategy, Structure



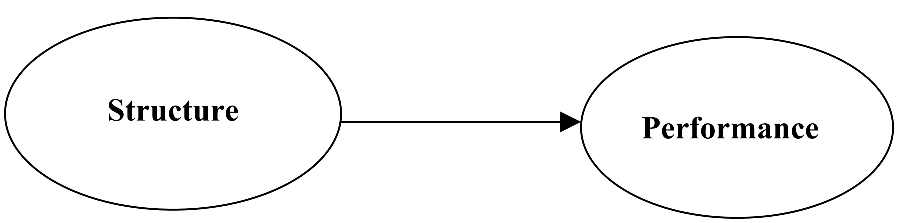
Panel A. Hypothesized Causal Flow I



Panel B. Hypothesized Causal Flow II



Panel C. Hypothesized Causal Flow III



Panel D. Hypothesized Causal Flow IV

The significance of my research is that I: (1) investigate which causal ordering of corporate strategy, corporate structure, and corporate performance is supported by directed acyclic graphs, Such a graph, if it exists, can provide guidance to researchers on modeling corporate performance, (2) conduct a systematic analysis among variables measuring corporate strategy, corporate structure, and corporate performance and thus provide insight on how they are causally related, (3) escape the limitation of previous studies based on cross-sectional data analysis by using longitudinal data analysis and thus provide more stable model, and (4) introduce and measure a structural variable in which one organization controls large numbers of legally separated organizations at several levels, the multi-organizational ownership hierarchy.

Questions related to which variables should be included in the model and how to measure them have been addressed in previous studies. Theoretical and empirical studies in the area are used to specify an initial set of related variables and general hypotheses. The explicit relationships among them will be sorted out using directed acyclic graphs (DAGs), a new method from artificial intelligence and computer science. DAGs offer insights on problems of model specification when dealing with observational data (non-experimental data). The fundamental concept in this method is the notion of d-separation, which formalizes conditional independence among variables (Pearl, 2000).

Keats and Hitt (1988) used LISREL (Joreskog & Sorbom, 1984) and Hoskisson, Hitt, Johnson, and Moesel (1993) used EQS (Bentler, 1989) generate a structural equation model (SEM). But derived Structural Equation Models (SEMs) from EQS or

LISREL do not reveal the direction of causal relationships (Hoyle, 1995; Spirtes, Glymour, & Scheines, 2000). "SEM cannot test directionality in relationships. The directions of arrows in a structural equation model represent the researcher's hypotheses of causality within a system"(Stoelting, 2001). "Regardless of approach, SEM cannot itself draw causal arrows in models or resolve causal ambiguities. Theoretical insight and judgment by the researcher is still of utmost importance" (Garson, 2002).

In this study, DAGs are applied for the construction and interpretation of the causal structure of business corporations' performance. With prior theoretical background and the directed acyclic graph, causal flows among performance and other variables are revealed. I use TETRAD II (Scheines, Sprites, Glymour & Meek, 1994) with directed acyclic graphs (DAGs) on longitudinal data to find a structural model that does not require prior hypotheses of causal flow or time ordering; that is, no hypothetical restrictions are required.

Though Keats and Hitt (1988) measured environment, organizational characteristics, and performance in a different time frame, they performed their analysis on cross sectional data. Hoskisson, Hitt, Johnson, and Moesel (1993) conducted only cross sectional analysis using a two-year average. As Ramanujam and Varadarajan (1989) noted, time dependency of diversification and performance relation is a factor that should be considered in analysis. The few studies that examined the time dependent nature of diversification and performance found that the relationship varies over time (Perry, 1998). The effect of strategies on performance is not stable over time and this instability may create spurious results or no relationship at all, when time effects are not considered. In order to estimate a causal structural model to capture the effect of diversification, multi-organizational ownership hierarchy, and other characteristics on corporate performance appropriately, longitudinal data are collected, that consist of a large number of cross-sectional units from 1990 to 1998, in this study.

The importance of including a sufficient number of relevant variables in the causal analysis cannot be over-emphasized. In order to provide an unbiased model of causal relations from observational data, it is important to have causally sufficient set of variables (Spirtes et al., 2000). When we have a causally sufficient set of variables, there are no omitted common causes for any two or more of the variables included in the study. There have been few studies undertaken to uncover the causal relationship among strategic variables, structural variables, and performance in corporate management. Two studies, which did focus on these relationships, are: Keats and Hitt (1988) and Hoskisson, Hitt, Johnson, and Moesel (1993). However, these studies failed to include investment in research & development (R&D) as well as in advertisement and effects of ownership hierarchy in forming a causally sufficient set of variables. Both studies acknowledged and measured R&D as an important factor. Hoskisson, Hitt, Johnson, and Moesel wrote, "All except R&D, were used in the main structural equation model. Inclusion of R&D severely restricted the sample size" (1993: 225). The form of ownership hierarchy was analyzed by Zey and Swenson (1999), but they did not include R&D and advertising in the study. As an effort to lower the risk of not constructing a causally sufficient set, a new structure variable, multi-organizational ownership hierarchy, along with R&D expense and advertising expense are added in the study.

Objective of the Study

The objectives of this dissertation are:

1. To define through the directed acyclic graphs the causal ordering of various strategy, structure and performance variables.
2. To construct a causal model of corporate performance measured as return on assets.
3. To define the relationship between the effect of multi-organizational ownership hierarchy and corporate performance.
4. To investigate existing predominant theories of corporate performance and their support by way of empirical analysis.

Organization of the Dissertation

This study is organized into six chapters. The second chapter explores theories and previous studies in the areas of management and organizational study to determine a set of variables that constitute a causally sufficient set. The third chapter introduces the directed graph approach. The fourth chapter covers the data, measurement, and discusses the framework of the research method. The fifth chapter covers the DAG results, subsequent model estimation, out-of-sample forecasts and evaluations on alternative models. Discussion and conclusions complete the study.

CHAPTER II

THEORETICAL DEVELOPMENT

The requirement of a sufficient data set to reveal causality does not give the researcher the permission to add just any variables that are collectable or used in the previous studies. The theoretical background of each strategy, structure, and performance variable and its relevancy to the study are carefully reviewed. Based on historical management theory, transaction cost economics, and agency theory, variables from major empirical studies are chosen and measured to represent strategy, structure, and performance. Only variables found in previous empirical researches to predict corporate performance are included in the model.

Three types of variables are examined: (1) performance measured as return on assets (ROA); (2) structure[1] measured as size (SIZE) and multi-organizational ownership hierarchy (MOOH); (3) strategy measured as related diversification (RD), unrelated diversification (UD), debt (DEBT), institutional investors (INST), research and development intensity (R&D), and advertising intensity (ADV). This chapter will examine past relevant studies to define the relationships among ROA and structural and strategy variables. Figure 2.1 gives detailed dominant relational models with variables in each category.

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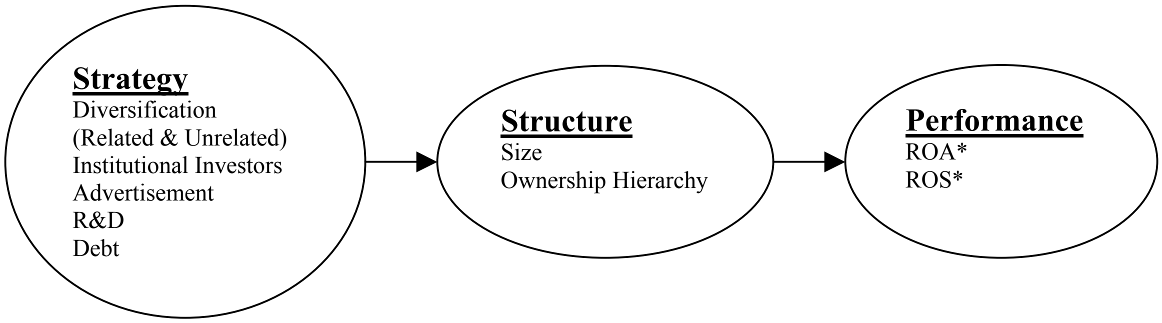
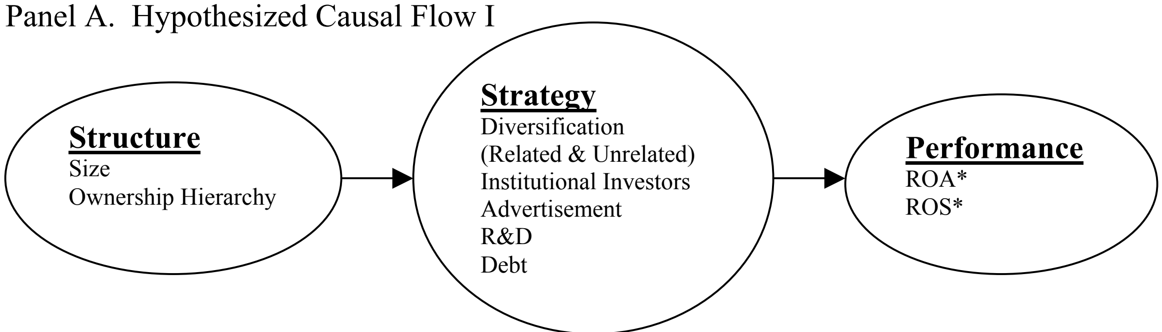
[1] Structure in my study refers to corporate structure and is not to be confused with traditional market structure from industrial organization (IO) economics (Bettis, 1981).

Figure 2.1

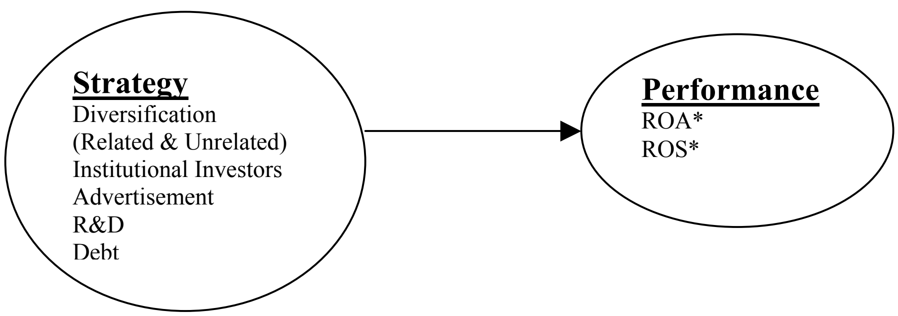
Dominant Relational Models of Performance, Strategy, Structure and Selected Variables[a]



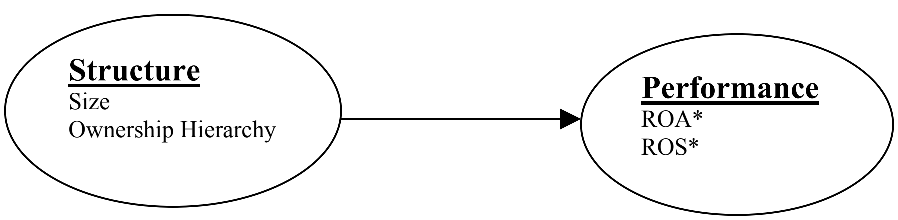
Panel A. Hypothesized Causal Flow I



Panel B. Hypothesized Causal Flow II



Panel C. Hypothesized Causal Flow III



Panel D. Hypothesized Causal Flow IV

[a] Definitions of variables are provided at Table 4.1.

Performance

Though the measurement of performance is an essential prerequisite for research in corporate management, no consensus exists among organizational analysts and management researchers on how to define and measure corporate performance (Perry, 1998). The conceptualization and measurement of performance is not an easy task and depends on how a study depicts the objective of the firm (Keats & Hitt, 1988). My study implicitly assumes that the primary objective of the firm is to maximize its profits. Accounting based indices of returns[2] can be used to assess the firm profitability and thus performance. Accounting performance has been considered as an important outcome variable by both practitioners and strategy analysts (Bettis, 1981; Rumelt, 1974). Along with accounting performance, researches in corporate management have used market performance that is based on movement of stock price. However, accounting profit more directly reflects the impact of corporate strategy on a firm's performance than stock price, because stock price include expectation about future profits and are greatly affected by social factors (Grant, Jammine, & Thomas, 1988).

This study analyzes the accounting performance of the large U.S. firms mainly from manufacturing industries. The accounting performance of a firm can be measured by return on asset (ROA) or return on equity (ROE). The ROA approach is appropriate when analyzing large corporations that can establish and maintain rigorous leverage policies and that have efficient access to the national markets for debt and equity

[2] To distinguish the financial performance measure with the market performance measure using changes in stock price, several previous studies named the financial performance measure as the accounting performance measure (Hoskisson et al, 1993; Hoskisson, Johnson, & Moesel, 1994).

capital. In contrast, the ROE approach is applicable for smaller, private firms whose leverage fluctuate over time and that lack access to the national markets for debt and equity (Barry et al., 1995: 286).

ROA can be viewed as a measure of management's efficiency in utilizing all the assets under its control, regardless of source of financing. By definition, it reflects firm's relative efficiency in the utilization of its assets (Bettis & Hall, 1982). In research on the effects of strategy and structure on performance, ROA is appropriate because these relationships rely on whether efficiency increased or decreased (Habib & Victor, 1991). Hence, ROA is chosen as a primary measure of corporate performance.

Structure

In this study, size and multi-organizational ownership hierarchy are included as structural measures of large U.S. industrial corporations. Structure can be defined as the design of organization through which the corporation is administrated (Chandler, 1962). Then structure follows strategy. Meanwhile, there is a perspective that structure influences strategy (Hammond, 1990). In this view, structure sets the agenda for top managers to make strategic decisions, since critical information and decision making capabilities in larger corporation are dispersed throughout the corporation rather than concentrated in top mangers.

Size

Either as a mediator variable or main effect variable, size has been treated as a major predictor of corporate performance. Rationale for increasing corporation size is generally explained in terms of market share, and economies of scale and scope. Some theorists posit size as the major predictor of certain structural configurations (Pugh et al, 1969; Blau, 1970). Others focus on the relationship between size and strategy, structure and performance. Size is correlated with both related and unrelated diversification strategy, and structure in a way that mediates strategy and structure (Grinyer & Yasai-Ardekani, 1981). Keats and Hitt (1988) include size as the mediator between the strategy and structure in their causal model on corporate performance. They view size having indirect effect on performance via diversification and structure. Armor and Teece (1978) include size in the model to control for the possible effects of economies (or diseconomies) of scale based on the multidivisional form hypothesis (Williamson, 1975), i.e., because size is positively related to an increase in multidivisional form.

Baysinger and Hoskisson (1989: 318) state "…economic reasoning suggests that across all diversification strategies, the managers of large firms in concentrated industries should be more willing to invest in research and development than the managers of small firms…." Thus they posit that diversification does not affect the relationship between size and R&D. They suggest that size and R&D intensity are positively related in a way that larger firm invest more on R&D. A larger firm might be better able to internalize the benefits of R&D investments by enjoying larger economies of scale in R&D. Size is included in my study in order to measure not only the possible direct and indirect effects on ROA; but also the effects of size on strategic and structural variables as a mediator, which may result in increase or decrease corporate performance.

Hypothesis 1: Size does not have a direct effect on corporate performance, rather size has either an indirect effect or a mediator effect on performance.

Multi-Organizational Ownership Hierarchy[3]

The importance of governance structure in corporate management is well known (Chandler, 1962; Rumelt, 1986; Keats & Hitt, 1988; Hoskisson, Johnson, & Moesel, 1994). Studies of corporate governance generally focus on either the multidivisional form (M-form) hypothesis[4] (Williamson, 1975) or on the vertical financial ownership as a proxy for vertical integration strategy (Mahoney, 1992), both focus on divisions[5], i.e., product lines.

The empirical existence of divisions as the organizing concept of product line in corporations has all but disappeared by 1998[6] (Zey & Swenson, 1999). In this study, I analyze corporate governance structure using subsidiaries[7] rather than divisions. This allows me to analyze governance structure to a greater extent, since multiple levels of governance structure are measurable. Counting levels of subsidiaries facilitates a

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[3] The explanations on theories are borrowed from ***Economics of Strategy*** written by Besanko, Dranove, and Shanley (2000).

[4] The organization and operation of the large enterprise along the lines of the M-form favors pursuit and least-cost behavior more nearly associated with the neoclassical profit maximization hypothesis than does the functional organizational alternative (Williamson, 1975:150).

[5] Separate operating units of a corporation. A division may have its own officers, but it is not incorporated nor does it issue stock (America's Corporate Families, Dun & Bradstreet).

[6] In my study, in 1998 among 190 parent companies in the sample, 100 companies have no division, 66 companies have less than 5 divisions, and 11 companies have more than 10 divisions.

[7] Subsidiary is one whose controlling interest (over 50%) is held by another company (America's Corporate Families, Dun & Bradstreet).

general study of multiple corporations within a parent or executive office, rather than divisions in a single corporation. Subsidiary links indicates not only product flows but also capital flows[8]. As will be explained later in this section, the trend in organizing governance structure in US manufacturing firms in 1980s and 1990s was from the M-form to the multisubsidiary form with one or no division (Zey, 1996; see also the work of Prechel, Boies, & Woods, 1999). However, few studies analyze the governance structure in terms of subsidiaries. To distinguish the current study from previous studies on multidivisional form and vertical financial ownership, it is helpful to introduce a new descriptive concept of the multi-organizational ownership hierarchy (MOOH). MOOH differs from M-form on several significant characteristics. MOOH is a parent corporate holding multiple corporate subsidiaries, which own other subsidiaries. Therefore, MOOH is measured by counting levels of subsidiary ownership. In contrast, the M-form consists of a single corporate entity. The M-form must own all stock regardless of divisions. The M-form organization must be fully capitalized, whereas organization as a MOOH, allows the parent corporation to own only a fraction of its holdings. The divisions are part of the corporate entity, whereas subsidiaries are legally separate organizations. MOOH controls and governs multiple levels of subsidiaries whereas M-form does not.

MOOH can be defined as a vertical ownership structure, in which a central office of holding company controls, multiple, legally separated organizations arranged in a hierarchy. Each hierarchical level below the first level owns additional multiple

[8] Subsidiaries can be production units, selling units, or diversified profit generating units.

levels. Thus MOOH measures the levels of subsidiaries held by the Fortune 500 parent companies.

For the remaining part of this chapter, theories that depict the importance of vertical financial ownership as governance structure are reviewed and distinctions are made between divisions and subsidiaries. This review is necessary because most theories explain vertical financial ownership and multiple-organizational ownership hierarchy, but do not cover the distinction between divisions and subsidiaries.

Each firm's structure is unique. How a firm ought to organize as it grows in size and complexity is the question addressed in the study of organizational form (Armor & Teece, 1978). Researchers following Chandler (1962) and Rumelt (1974) have attempted to categorize corporate structures into five groups based on the major options open to top management and their potential impact on the general management task. An additional task adopted by this group of researchers is to test the hypothesis that multidivisional form is superior to other organizational forms. Based on transaction cost economics (Williamson, 1979; 1981), researches have studied a continuum of governance structures that include spot markets, various contracts, franchising, joint ventures, and hierarchy (vertical financial ownership). Asset specificity, with the cost of production, agency costs, and cost of transactions are major criteria for determining which governance structure is preferred to another in a given environment. An increase of profit can be achieved if the chosen governing structure allows for efficiency of operations within the organization. Formally, the optimal organizational form is determined based on interplay of technical efficiency and agency efficiency. Agency efficiency concerns the efficiency of the exchange process, whereas technical efficiency concerns the efficiency of the production process (Williamson, 1991). Technical efficiency is closely related to the cost of production that relies on economies of scope and economies of scale in Chandler's managerial model (Chandler, 1990). Technical efficiency, narrowly defined, represents the degree to which a firm produces as much as it can from a given combination of inputs. Technical efficiency, more broadly defined, represents whether the firm is using the least-cost production process. In contrast agency efficiency refers to the extent to which the exchange of goods and services in the vertical chain has been organized to minimize agency and transaction costs. Agency costs are the costs associated with slack effort and with the administrative controls to deter slack effort. Mangers are "slacking" when they do not act in the best interest of their firm. Transaction costs include the costs of monitoring, information, administrative time, and negotiations that accompany transactions (Williamson, 1991).

An alternative theory initiated from Grossman and Hart (1986) and Hart and Moore (1990), explains the desirability of vertical financial ownership as a governance structure in a different way. Their theory focuses on the importance of asset ownership and control. This theory begins with the critical observation that the resolution of the make-or-buy decision determines ownership rights. It is based on the common belief that most contracts are incomplete in a way that individuals cannot contemplate all possible contingencies. If contracts were complete, it would not matter who owned the assets. The owner of an asset may grant another party the right to use it, but the owner retains all rights of control that are not explicitly stipulated in the contract. These are known as residual rights of control. When ownership is transferred along with the residual rights, the legal rights of the selling party are fundamentally changed. By emphasizing asset ownership, the theory identifies an important dimension of vertical financial ownership. It also suggests that there is a degree of vertical financial ownership depending on the extent to which one party or the other controls specialized assets, i.e., asset specificity (Williamson, 1975).

Vertical financial ownership is one governance structure through which vertical integration may be achieved. The core concept of vertical financial ownership is the elimination of contractual or market exchanges and the substitution of internal transfers within the boundaries of the firm (Williamson, 1975; Mahoney, 1992).

Considering the number of studies of vertical financial ownership[9] over the last few decades, it is surprising that MOOH, that measures the ownership of subsidiaries, have barely been addressed, especially with respect to causal analysis of corporate performance. A corporate can own a lower level entity in the form of a division or a subsidiary. The distinction between division and subsidiary is substantial and it is well summarized by Zey (1998)[10]. It suggests that there are advantages for the parent company when it owns it's lower level in the form of subsidiary, rather than as a division. This is reflected in the empirical data from the 1980s and 1990s that will be

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[9] Long list of the studies on vertical financial ownership is provided from Mahoney (1992).

[10] Zey offers a more detailed description. Here I note the most important. A division is part of the parent company, while a subsidiary is a separate entity legally only owned by a parent company (at least more than 50%). Subsidiaries issuing their own stocks and bonds are embedded directly in the market in which they compete, while divisions do not issue stocks or bonds. Subsidiaries can have own lower levels, divisions don't. Legal liability firewalls separate the parent company from its first level subsidiaries and each level thereafter reduces the parent company's financial liability. This is not the case for divisions.

presented in Chapter V. To facilitate the understanding of how MOOH is organized, I present two parent corporations from 1998 data. Table 2.1 contains two 1998 corporations as an example of ownership hierarchy. In both cases, the parent company, the lowest level subsidiary ,and subsidiaries between the parent company and the lowest level subsidiary are closely related in terms of primary SIC code[11]. Usually the highest level subsidiary, which is linked to the lowest level subsidiary in Table 2.1, is one of the major entities held by the parent corporation. Brown & Root Holding Inc., a second level subsidiary of Halliburton, owns 19 of 54 subsidiaries at third level. Occidental Petroleum Investment Co Inc., a first level subsidiary of Occidental Petroleum, owns 10 of 14 subsidiaries at second level. Sales volume is not always lower for subsidiary in lower level in the ownership hierarchy. Often a lower level subsidiary has higher sales volume than the owning subsidiary above it in the ownership hierarchy.

An ultimate parent company is required to own more than 50 percent of its first level subsidiary and 25 % of its second level subsidiary. Also a first level subsidiary is required to own more than 50 percent of the level below it and a second level subsidiary owns more than 50 percent of the third level subsidiaries it holds and so on. This implies that the financial relationship between an ultimate parent company and its first level subsidiary is stronger than the one between an ultimate parent company and its second level subsidiary. The control relationship between the parent company and lower

[11] Relatedness among a parent companies and subsidiaries in terms of primary SIC code becomes less significant as a parent company has significant numbers of divisions. However, in 1998 among 190 parent companies, only 11 of them have more than 10 divisions.

Table 2.1
An Illustrative Example of Ownership Hierarchy Focusing on Lowest Level Subsidiary[a]

	Number of subsidiaries	Name of subsidiary	SIC codes[b]	Sales
Halliburton Co (SIC: 1389, 1629, 8711) (Sales: 7.3 MMM)				
Level 1	1	Halliburton Delaware Inc.	1629, 1611, 8711	NA
		↓		
Level 2	4	Brown & Root Holding Inc.	8711, 1629, 1541	3.3 MMM
		↓		
Level 3	54	Brown & Root Inc.	1629, 8711, 1611	2.5 MMM
		↓		
Level 4	6	Brown & Root Technical Services Inc.	8711	300 M
		↓		
Level 5	3	Global Drilling Services Inc	1629	77 M
		↓		
Level 6	1	Global Arabian Co for engineering & Construction Pro.	1629	170 M
Occidental Petroleum (SIC: 2812, 2869, 2865) (Sales: 10.5 MMM)				
Level 1	6	Occidental Petroleum Investment Co Inc.	1311, 2812, 2869	4.4 MMM
		↓		
Level 2	14	Occidental Chemical Holding Corp.	2869, 3089, 2873	4.3 MMM
		↓		
Level 3	14	OXY Chemical Corp	2869, 2873, 2874	1.8 MMM
		↓		
Level 4	19	OXY C H Corp.	2869,3089,2685	1.7 MMM
		↓		
Level 5	3	Occidental Chemical Corp.	2812, 2869, 2819	2.6 MMM
		↓		
Level 6	1	Interore Corp	5191	12.1 MM

[a] Source: America’s Corporate Families: the Billion Dollar Directory. 1998. Parsippany, NJ: Dun & Bradstreet Inc.
[b] SIC codes 1389 is oil and gas field services, 1629 is heavy construction, 8711 is engineering services, 2812 is alkalies and chlorine manufacturing, 2869 is industrial organic chemicals, and 2865 is cyclic organic crudes and intermediates and organic dyes and pigments manufacturing.

level subsidiary weakens as the number of levels increases. Accordingly the top manager in the central office of the parent company may monitor or control fewer levels of subsidiaries to a greater extent. The possibility of less control from the top manager on lower subsidiaries may give the managers of lower level subsidiaries more potential to deviate from the ultimate parent company and pursue its own goals; behave opportunistically which means self-interest with guile (Williamson, 1975).

It is a working hypothesis of this study that if an ultimate parent company makes its multi-organization ownership hierarchy deeper, it can generate more free capital that would otherwise be used in acquiring the holdings, i.e., in other words, it can control a defined magnitude of assets with smaller amount of capital. Possible advantages and disadvantages of the multi-organizational ownership hierarchy can offset each other to determine the optimal level of MOOH. The expansion of multi-organizational ownership hierarchy may be beneficial to the ultimate parent company until it reaches optimal level MOOH and then either less beneficial or harmful. This scenario can be tested by revealing the relation between performance and the level of ownership hierarchy. As ownership hierarchy structure becomes deeper, the capability of a parent firm to control its capital structure may become weaker. When control of capital structure passes through increasing level of hierarchy, the risk of loss of control increases with each additional level.

The importance of including multi-organizational ownership hierarchy in the study can be showed in a different way. Benefits of efficient strategies have been defined as synergy and financial economies (Hill, Hitt, & Hoskisson, 1992). Synergistic economies are associated with related diversification (Teece, 1980; Willig, 1978). Financial economies are associated with unrelated diversification (Teece, 1982; Williamson, 1975). All these benefits are closely related with expansion of firms. A firm may expand both horizontally and vertically. Diversification, neither related or unrelated, can distinguish vertical and horizontal expansion. Multi-organizational ownership hierarchy is a measure that allows us to measure the expansion as a vertical ruler. As a firm grows in size and changes it's organizational strategies including diversification, it may expand horizontally or vertically or in both directions. Multi-organizational ownership hierarchy is included in the study as a structural variable to incorporate vertical financial ownership and to distinguish vertical expansion with horizontal expansion.

Hypothesis 2: The proliferation of the ownership hierarchy is directly related to performance, because as the hierarchy is extended the executive officer loses control over lower level. Thus I expect proliferation of MOOH to reduce performance.

Strategy

Related and unrelated diversification, ownership concentration by institutional investors, debt, research and development intensity, and advertising intensity are included in the study to measure strategy of the large U.S. industrial corporations.

Diversification

Strategic management perspective. Corporate diversification has been a dominant research stream in the field of strategic management and industrial economics for the past thirty years. This is not surprising since one of major tasks of corporate mangers is to answer the question: What business should the firm be in? (Sambharya, 2000). The volume of research on diversification indicates the importance and relevance of the topic (Perry, 1998). The increase in number of measures and techniques of firm diversification is an easily observed reflection of its importance (Sambharya, 2000).

The relationship between diversification and firm performance has been analyzed from many perspectives. Major incentives for diversifying a firm into related businesses are economies of scale, synergies and economies of scope, and market power because they all increase ROA. Risk pooling, reduction of probability of bankruptcy, and economies of internal capital markets are the major incentives for diversifying into unrelated businesses (Perry, 1998; Hill & Hoskisson, 1987).

Economies of scale refers to the decline of unit cost as the volume of production increases (Porter, 1985). The firm, by using its given resources more fully, is able to move down its average cost curve and thus enjoy an advantage over competing firms (Singh & Montgomery, 1987). When the union of two entities brings more opportunities that are not available otherwise, the two entities can enjoy synergistic economies. Synergy or economy of scope can be realized from using common infrastructures, including resources that are more or less tangible such as marketing and R&D operations, production facilities, and distribution systems and intangible such as brand names (Perry, 1998). Market power exists when market participants have the ability to influence price, quantity, and the nature of product in the market place (Shepherd, 1970). When a firm expands its business into related product areas, it may take existing technology, marketing, or specialized management that can help in developing competencies superior to those of the competition (Montgomery & Singh, 1984).

Risk pooling, reduction of probability of bankruptcy, and economies of internal capital market are ways of explaining potential benefits from unrelated diversification. As long as the earnings for two segments of businesses are not perfectly correlated, combining the two segments will reduce the variance of earnings for the organization. As earnings are stabilized through unrelated expansion, the probability of bankruptcy falls and the diversified company's risk perceived by the lending institutions decreases (Bettis, 1983). Strategic management theory assumes that managers can actively intervene to lower corporate risk in a manner not available to shareholders. Using strategies to develop a competitive advantage, managers can reduce their company's risk by reducing the volatility of earning relative to that of the economy as a whole (Porter, 1985). In contrast, financial theory is based on the premise of passive management such that cash flows can be combined but not altered by managers. Under the assumption of perfect capital markets, risk pooling through unrelated diversification cannot improve firm value since individual investor can duplicate this from portfolio investments (Levy & Sarnat, 1970).

Transaction cost economics perspective. Economies of internal capital markets from the transaction cost paradigm can explain the benefit of unrelated diversification (Hill & Hoskisson, 1987; Williamson, 1975). Unrelated diversification can overcome external capital market failure (Teece, 1982; Williamson, 1975). They suggest that an external governance mechanism often suffers from two limitations that constrain its ability to efficiently allocate capitals between firms, and to discipline the managers of firms. The first limitation is that shareholders, in circumstances where ownership and control are separated, experience information disadvantages in their relationship with firm divisional[12] managers who allocate corporate capital. The second limitation is that shareholders experience control disadvantages in their relationships to manger when ownership and control are separated (Williamson, 1975). In contrast, an internal governance mechanism that has rich information, a strong performance monitoring system, and congruent reward and incentive schemes can overcome these limitations in the relationships with its divisions. In other words, using unrelated diversification, firms can achieve a more efficient allocation of capital resources between divisions by monitoring the divisions more effectively than the external capital market could if each division were an independent firm (Hill & Hoskisson, 1987).

Agency theory perspective. Strategic management view of diversification has an implicit assumption that companies pursue diversification to maximize the value of the firm. Alternatively, agency theory proposes that diversification may be motivated by managerial efforts to make personal gains rather than maximize the value of the firm.

[12] It includes divisions and subsidiaries.

There are two ways mangers can get benefit from diversification. First, firm size is highly correlated with diversification as well as with executive compensation (Tosi & Gomez-Mejia, 1989). Thus, diversification provides opportunities for managers to increase their compensation. Second, diversification can reduce managerial employment risks, such as job loss, loss of compensation, or loss of managerial reputation (Amihud & Lev, 1981). These risks are reduced with diversification because the firm becomes less vulnerable to the fluctuation of any one market, thereby limiting the influence from one market on corporate performance. Thus, diversification may be motivated by manager's own value maximization instead of maximizing firm value.

According to agency theory, there are internal governance mechanisms designed to control managerial discretion and incompetence. These include, but are not limited to, ownership structure, board of directors, and executive compensation schemes. When none of the internal governance devices are successful in controlling managerial discretion and incompetence, the company's performance is likely to increasingly diverge from its maximum potential and accordingly the value of the firm will drop. Under this circumstance, external governances such as the market for corporate control can alleviate management discretion and makes managers align with shareholders. Given the potential conflict of interests between shareholders and managers over the optimal amount of diversification, the preference of mangers will likely prevail if the internal and external governance mechanisms fail. Alternatively, if management discretion is properly controlled, firm diversification will approach the optimum level that aligns with firm value maximization. The ownership of institutional investors is included in the study as a proxy for internal governance mechanism. And debt is included as a proxy for external governance mechanism.

Summary of diversification. The strategic management perspective suggests that both related and unrelated diversification makes corporations show better accounting performance. The benefits from related diversification are defined by economies of scale, economies of scope, and market power. The benefits from unrelated diversification are defined by risk pooling, reduction of probability of bankruptcy. The perspective from transaction cost economics explains a benefit of unrelated diversification using economies of internal capital markets. Meanwhile, agency theory perspective suggests that diversified corporations can perform well only when top manager is monitored successfully either using internal or external monitoring mechanism.

Hypothesis 3a: Related diversification has both direct effect and indirect effect via debt and institutional investors on corporate accounting performance.

Hypothesis 3b: Unrelated diversification has both direct effect and indirect Effect via debt and institutional investors on corporate accounting performance.

Institutional Investors

The ownership concentration by institutional investors (INST) is one of the major trends in stock ownership over the past several decades. Institutional holding of U.S. corporate shares have grown from 12 percent of all stocks in 1949 to over 50 percent in many industries by the early 1990s (Mallette & Fowler, 1992). It has been assumed that institutional investors snatched corporate control from the hands of managers in the last quarter of the 20th century (Useem, 1993;1996).

Berle and Means (1932) first introduced the idea of "separation of ownership from control" in large companies. They maintained that it is hard for shareholder to exercise tight control over managers, because there are many individual and institutional investors, who share ownership of companies and each of them holds only a small percentage of the total outstanding equity. Moreover, it is not an easy task, and is some period of U.S. history it was illegal for shareholders to form groups in order to enhance their collective influence on managers. Under a weak disciplinary device such as the capital market with high dispersion of ownership, corporate managers may have strong control of corporation. However, corporate managers often waste or steal resources by managing companies in such a way to serve their own interests, rather than to serve the interests of shareholders (owner).

On the other hand, concentration in the hands of a few shareholders or in a given types of institutional investor carries with it an incentive to closely monitor managers (Jensen & Meckling, 1976). Institutional investors can provide governance when those with large ownership stakes are able to provide effective monitoring (Shleifer & Vishny, 1986). Acting as continuous monitors, concentrated shareholders can play an important role in preventing managerial decision to deviate from the interests of shareholders (Bethel & Liebeskind, 1993).

Researchers have found evidence to suggest that institutional investors support long-term managerial policies such as R&D expenditures (Baysinger, Kosnik, & Turk, 1991; Hill & Snell, 1988; Hill & Hansen, 1991) and new product development (David & Kochhar, 1996). There are several studies to support the view that the concentration of ownership by institutional investors is a constraining influence on diversification (Amihud & Lev, 1981; Hill & Snell, 1988; Hoskisson et al., 1994). Generally, prior studies have suggested a positive relationship between institutional investors and performance but did not reveal the causal relationship (Demsetz, 1983; McConnell & Servaes, 1990; Thomsen & Pedersen, 2000). There is a large empirical literature on the question of whether owner controlled or manager controlled companies performed better (Short, 1994). According to a survey conducted by Short (1994), a significant majority reported that owner controlled firms outperform manager controlled firms where the shareholdings are highly diversified. Agency theory (Jensen & Meckling, 1976) suggest that the concentration of ownership by institutional investors is expected to increase corporate accounting performance. Though I cannot disregard the possibility that higher accounting performance may attract institutional investors to invest.

Hypothesis 4: The corporation with high concentration of institutional investor ownership will outperform the corporation with lower concentration.

Debt

From the viewpoint of agency theorists, high levels of debt associated with high interest payments act to discipline managers to align with the goal of shareholders. As debt level becomes higher, management has less discretion in the allocation of the free cash flow of a company. The financial pressure from debt forces management to invest wisely and thus be more efficient, because possible bankruptcy from failing to satisfy debt obligation is a serious threat to managers not only in terms of the loss of their jobs and associated perquisites, but also in term of ruining its reputation (Jensen, 1986, 1988; Aghion, Dewatripont, & Rey, 1999). Thus agency theory posits that higher debt can increase corporate performance.

Financial market pressure from debt burden is also associated with increased productivity growth. Financial market pressure along with product market competition and shareholder control makes the role in generating improved productivity performances in companies possible (Nickell, Nicolitsas, & Dryden, 1997). Agency theory suggests that higher debt level might lead to higher accounting performance through increased pressure on the corporate manager. The higher the level of debt a company holds, the better the accounting performance of the company.

There is a possibility that research conducted in a different economic period may more strongly or weakly support agency theory, that is I would expect monitoring effect on managers of debt and institutional investors to be stronger in a period of recession. However, during the period of continuous economic growth in last seven years of 1990s, I would expect monitoring of managers as agents of owners to be weaker than in a period of declining.

Hypothesis 5: Financial pressure from high debt level will results in high return on assets.

R&D Intensity

According to transaction cost economics (Williamson, 1975; 1979; 1981), a firm can generate rents only when it has built up specific assets that distinguish it with other competitors. Specific assets can take the form of site, physical asset, dedicated assets, or human asset. When a firm with specific assets has an optimal organizational form based on interplay of technical efficiency and agency efficiency, it will generate rent that is synonymous with economic profit (Besanko, Dranove, & Shanley, 2000). R&D expenditures are major decision variables for managers who wish to build up firm specific assets. A firm will make investments in R&D only if the investments provided it with a unique position in the market from which to capture rents (Caves, 1982; Teece 1988). Firms in an industry can use different tangible or intangible assets, and pursue different strategies to improve their performance (Porter, 1979). Differences in profitability and accounting performance among firms may well reflect rents from firm specific assets accumulated from a superior management team or an effective R&D laboratory (Markides, 1995).

There are several studies that identified variables including R&D intensity and advertising as predictors of profitability (Ravenscraft, 1983; Scherer, 1980; and Shepherd, 1972). The effect of R&D intensity on firm profitability has generally been found to be positive (Scherer, 1980).

The association between R&D expenditure and diversification has been investigated to answer the question of why firms diversify. One group suggested that firms might improve the efficiency of R&D expenditure through diversification because of economics of scope (Gupta & Govindarajan, 1986; Hambrick & MacMillan, 1985; Porter, 1985). Other researchers suggested that highly diversified firms have control system that may lead division mangers to reduce long-term expenditures such as R&D. Thus there appears to be a negative relationship between diversification and R&D intensity (Baysinger & Hoskisson, 1989; Hoskisson & Hitt, 1988). However, organizational analysts have not looked at the effect of proliferation of subsidiary levels on performance. Largely because these analysts still measure diversification by counting divisions, not subsidiaries. Corporate performance in terms of market share is significantly increased by R&D intensity (Franco, 1989). I expect negative relationship between R&D and MOOH, because MOOH is a functional substitute for R&D. When corporations are growing rapidly they are more likely purchase than develop products and processes. The cost of purchasing product lines is less than developing their own product lines.

Hypothesis 6: R&D intensity is a cause of firm profitability (accounting performance) and it helps the firm build specific assets and thus increases its profitability.

Advertising Intensity

In transaction cost economics, along with R&D expenditure, advertisement expenditures are one of major strategic decision variables for managers to capture rents (Porter, 1979). Rent is generated from transaction-specific investment that would require the production process involving non-standardized inputs as found in differentiated products. This process is facilitated when consumer awareness distinguishes product characteristics from the advertisement (Comanor & Wilson, 1967). The positive relationship between advertising intensity and firm profitability is identified in many studies (Ravenscraft, 1983; Scherer, 1980; and Shepherd, 1972).

Advertising analysts view advertising either as a dynamic force operating as an engine for brand innovation and other types of change in the marketplace, or at least a defensive mean of protecting the status quo of brand awareness (Jones, 1990). Regardless of which perspective is followed, advertising is posited to increase profits of corporations. In his empirical study (Jones, 1995), he drew a conclusion that advertising is capable of a sharp immediate effect on sales increase that generally means profit increase. A successful brand that is identified by consumers is beneficial to firms in commanding a premium price, deriving above-average purchase frequency, and making advertising budget is more efficient (Jones, 1997).

Bettis (1981) found that the differentiation of firm on the basis of advertising and R&D is major source of performance advantage of related diversified corporations. He concluded that performance differences between related and unrelated diversified corporations are associated with advertising expenditures, accounting determined risk, research and development expenditures and capital intensity. For their analysis on the risk/return performance of diversified corporations, Bettis & Mahajan (1985) included advertising intensity as an indicator of product differentiation because of the monopoly power associated with product differentiation. Grossman (1996) tried to measure the level of long-term expenditures using proxy variables including advertising intensity.

Likewise, Franco (1989) and Grossman (1996) found that advertising expenditures are associated with long-term firm performance.

Hypothesis 7: Advertising intensity is a positive cause of corporate accounting Performance.

Summary

The variables chosen for this study are return on assets, size, multi-organizational ownership hierarchy, related diversification, unrelated diversification, institutional investors, debt, R&D intensity and advertising intensity. Rather than advocating a single perspective, my research is based on three perspectives; historical managerial theory, agency theory, and transaction cost economics. The finding of this research will shed light on the efficacy of each in explaining corporate accounting performance. The following chapter will introduce the tool used to unveil the causal relationship among the nine variables studied.

CHAPTER III

DIRECTED ACYCLIC GRAPHS

Directed Acyclic Graphs (DAGs) can be used to distinguish genuine from spurious causes in a set of data. Further they can be helpful in indicating what other variables are needed in a model, in order to measure one variable's effect on another. Finally, DAGs are useful in representing how one variable causes another via other variables. That is, the differentiation of direct cause and indirect cause becomes clear with DAG-type analysis.

Introduction

Theory may suggest a relationship among a set of variables. If we want to estimate or test this relationship, the way in which our data are obtained is important. When we have control over variables, in other words, when we perform a controlled experiment, we obtain unbiased estimates of the prior theoretical relationships. However, social scientists can not run experiments on human organization. Theory of social science usually requires the *ceteris paribus* condition that is not generally satisfied in observational data. Experimental methods work because they use randomization, random assignment of subjects to alternative treatments, to account for any additional variation associated with the unknown variables in a system (Campbell & Stanley, 1963).

The corporate data used in studies of organizational behavior are primarily observational and often secondary, not collected explicitly for the study but rather for some other primary purpose. We are not able to use experimental methods in the analysis of various decisions on strategy and structure.

The directed graph approach that we describe here is designed to aid researchers working with non-experimental data. The methods look to assign causal flows to a set of variables, which the problem and theory suggests should be related, even if we don't know exactly how.

Causal systems imply a set of asymmetries between causes and effects. In systems involving time, it is oftentimes the case that causes comes before the effect. So if variables X and Y measured at time t and t + k, $X_t \rightarrow Y_{t+k}$ is inconsistent with $Y_{t+k} \rightarrow X_t$. Other asymmetries in causal relationships exist. Several of these are discussed in Hausman (1998). For at least three variables asymmetries in "screening off" have been central in the development of directed acyclic graphs.

Consider the non-time sequence asymmetry in causal relations. For a causally sufficient set of three variables X, Y and Z, illustrate a causal fork, X causes Y and Z, as: $Y \leftarrow X \rightarrow Z$. Here the unconditional association between Y and Z is nonzero (as both Y and Z have a common cause in X), but the conditional association between Y and Z given knowledge of the common cause X, is zero: knowledge of a common cause screens off association between its joint effects.

The inverted causal fork that X and Z cause Y can be illustrated as $X \rightarrow Y \leftarrow Z$. Here the unconditional association between X and Z is zero, but the conditional association between X and Z given knowledge of the common effect Y is not zero: common effects do not screen off association between their joint causes. Finally consider the causal chain Y→ X →Z. The unconditional association between X and Z is non-zero; however given knowledge of Y, the association between X and Z is zero. So the middle variable in a causal chain screens off association between endpoints. These screening off phenomena are captured in the literature of directed graphs (Papineau, 1985).

Definition of Directed Acyclic Graph

A directed graph is a picture representing the causal flow among a set of variables. More formally, it is and ordered triple <**V, M, E**> where V is a non-empty set of variables, M is a non-empty set of symbols attached to the end of undirected edges, and E is a set of ordered pairs. Each members of E is called an edge. Variables connected by an edge are said to be adjacent. If we have X and Y in the set V, their relationship can be shown one of the following ways: undirected edge (X — Y), directed edge (X ⟶ Y), bi-directed edge (X ↔ Y), non-directed edge (X o—o Y), and partially directed edge (X o⟶ Y). There are several graphs associated with edges: (i) an undirected graph only with undirected edges; (ii) a directed graph only with directed edges; (iii) an inducing path graph contains both directed and bi-directed edges; (iv) a partially oriented inducing path graph contains directed, bi-directed, non-directed, and partially directed edges[13]. A directed acyclic graph (DAG) is a graph that contains no directed cycles and is able to represent causal relationships.

Directed acyclic graphs are designs for representing conditional independence as implied by the recursive product decomposition:

$$\Pr(X_1, X_2, X_3, \ldots X_n) = \prod_{i=1}^{n} \Pr(X_i \mid Pa_i), \tag{3.1}$$

where Pr is the probability of variables X's and the symbol ⇈ refers the product operator. The symbol Pa_i refers to the realization of some subset of the variables that precede (come before in a causal sense). Pearl (1986) proposed d-separation as a graphical characterization of conditional independence based on the above equation[14]. If we formulate a directed acyclic graph in which the variables corresponding to are represented as the parents (direct cause) of X, then the independence implied by equation (1) can be read off the DAG using the criterion of d-separation.

D-Separation Criterion

Consider three disjoint sets of variables, X, Y, and Z, in a directed acyclic graph G. To decide whether X is independent of Y given Z, we need to test whether the variables in Z block all paths from variables in X to variables in Y. A path is a sequence of consecutive edges (of any directionality) in the graph, and blocking is to be interpreted as stopping the flow of information between variables that are connected by such paths. Formal definition of d-separation is as follows:

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[13] For more detailed description of edges and graphs see Spirtes et al. (2000).
[14] A proof of this proposition was provided by Verma and Pearl (1988).

A set Z is said to d-separate X from Y if and only if Z blocks every path from a variable in X to a variable in Y. And a path P is said to be d-separated (or blocked) by a set of variables Z if and only if 1. p contains a chain $i \rightarrow m \rightarrow j$ *or a fork* $i \leftarrow m \rightarrow j$ *such that the middle variable m is in Z, or 2. p contains an inverted fork (or collider)* $I \rightarrow m \leftarrow j$ *such that the middle node m is not in Z and such that no descendant of m is in Z* (Pearl, 2000: 16).

In other words, if information flow is characterized by condition 1 in the above definition then the middle variable m must be part of the "blocking" or conditioning set Z. However if information flow is characterized by condition 2 (above), them m cannot be conditioned on to block information flow.

PC Algorithm

The notion of d-separation has been applied in computer algorithms that search for causal structure in observational data. IC algorithm was developed by Verma and Pearl (1990), and PC algorithm was developed by Spirtes, and Glymour (1991). I briefly present elements of PC algorithm, since it is more general systematic way for building directed graphs and was further developed as an automated module to help build causal models (TETRADII)[15].

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[15] Structural equation model (SEM) is a system of linear equations and some statistical constraints. This is the multivariate procedure that, as defined by Ullman (1996), "allows examination of a set of relationships between one or more independent variables, either continuous or discrete, and one or more dependent variables, either continuous or discrete." Several softwares are available to get SEM. They are EQS, CALIS, LISREL, etc. The reason I am not using those or the reason I am cautious to use SEM is as follows. "Once again, SEM cannot test directionality in relationships. The directions of arrows in a structural equation model represent the researcher's hypotheses of causality within a system. The researcher's choice of variables and pathways represented will limit the structural equation model's

PC algorithm is an ordered set of commands that begins with a general unrestricted set of relationships among variables and proceeds step-wise to remove edges between variables and then direct causal flow. The algorithm is described in detail in Spirtes, Glymour, and Scheines (2000: 84). It begins with a complete undirected graph G on the vertex set X. The complete, undirected, graph shows an undirected edge between every variable of the system (every variable in X). Edges between variables are removed sequentially based on zero-order conditional independence relations, again on first order conditional independence relations, and so on. The conditioning variable(s) on removed edges between two variables is called the sepset of the variables whose edge has been removed (for vanishing zero order conditioning information the sepset is the empty set). Once all possible edges are removed based on conditional correlation tests, edges are directed. The notion of sepset is crucial for this purpose. Edges are directed by considering triples $X — Y — Z$, such that X and Y are connected as are Y and Z, but X and Z are not connected. Direct edges between triples: $X — Y — Z$ as $X \rightarrow Y \leftarrow Z$ if Y is not in the sepset of X and Z. If $X \rightarrow Y$, Y and Z are connected, X and Z are not connected, and there is no arrowhead at Y, then orient $Y — Z$ as $Y \rightarrow Z$. If there is a directed path from X to Y, and an edge between X and Y, then direct $X — Y$ as $X \rightarrow Y$.

In application of PC algorithm, Fisher's Z is used to test whether conditional correlations are significantly different from zero.

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ability to recreate the sample covariance and variance patterns that have been observed in nature". (Ricka Stoelting, http://online.sfsu.edu/~efc/classes/biol710/path/ SEMwebpage.htm)

$$Z(\rho(i, j \mid k)\, n) = 1/2\,(n - |k| - 3)^{1/2} \times \ln\{(|1 + r(i, j \mid k)|) \times (|1 - r(i, j \mid k)|)^{-1}\}, \quad (3.2)$$

where n is the number of observations used to estimate the correlations, $\rho(i, j|k)$ is the population correlation between series i and j conditional on series k (removing the influence of series k on each i and j), and $|k|$ is the number of variables in k (that we condition on). If i, j and k are normally distributed and $r(i, j|k)$ is the sample conditional correlation of i and j given k, then the distribution of $z(\rho(i,j|k)n) - z(r(i,j|k)n)$ is standard normal.

Limitation and Significance Level

Application of TETRAD II on observational data must be done with caution. In general, the correctness of the output of the model-building module in TETRAD II depends upon several factors (Scheines, Spirtes, Glymour, & Meek, 1994). First, one needs to have included in the set of observational data a causally sufficient set of variables. This means that there is no omitted variable that in fact causes any two of the included variables under study. If variable X causes both Y and Z and we leave X out of the analysis, then an apparent causal flow from Y to Z (or vice versa) may be due to the fact that X causes both Y and Z, so the causal flow identified as running from Y to Z would be spurious (Suppes, 1970).

Second, one needs to constrain himself/herself to causal flows that respect a causal Markov condition. That is to say, if X causes Y and Y causes Z, we can factor the underlying probability distribution on X, Y, and Z as $Pr(X,Y,Z)=Pr(X)Pr(Y|X)Pr(Z|Y)$. In words, we require the causal flows that we attempt to uncover to respect the genealogy condition that one need only condition on his/her parents in order to fully capture the probability distribution generating any variable. One need not condition on other genealogical relatives such as grandparents or uncles, aunts, or siblings.

Finally, the probability distribution we attempt to capture by directed graph, G, is faithful to G if X and Y are dependent if and only if there is an edge between X and Y. This last condition tells us that we cannot have cancellations of “deep underlying” parameters. When zero correlation is observed between two variables, it is because they are not related not because of cancellations of deeper “fundamental” causal parameters connecting two or more variables in the true system.

PC algorithm can commit either arrowhead commission error or edge commission error. Arrowhead commission error is to include an arrowhead where it does not belong. Edge commission error is to put an edge where it does not belong. Spirtes, Glymour, and Scheines (2000) have explored several versions of PC algorithm on simulated data with respect to errors on both edge inclusion and direction. And they conclude that in order for the method to converge to correct decisions with probability one, the significance level used in making decisions should decrease as the sample size increases, and the use of high significance levels (e.g. .2 at sample sizes less than 100, and .1 at sample sizes between 100 and 300) may improve performance at small sample sizes.

Regression Analysis: The Adjustment Problem

Given the directed graph, we can sometimes use regression analysis to measure the effect of X on Y. The directed graph will provide us guidelines on what variables we should condition on in a regression equation in order to measure the size of the effect of variable X on variable Y. When one is not careful, one can mis-specify a regression equation if he condition on (includes "blocking" variables) an improper set of variables. The "adjustment problem" by Pearl (2000) provides the answer for this fundamental problem. I introduce the procedure in detail since it is crucial when to decide whether a factor is to be included in order to measure the effect of a particular variable (ex. Diversification) on another variable (ex. corporate performance).

When we are applying the "adjustment problem" on the directed graph depicted in Figure 3.1, the procedure for factor selection is as follows:

Test if Z_7 and Z_9 are sufficient measurements to condition in order to measure the effect of X on Y.

Step 1: Z_7 and Z_9 should not be descendants of X.

Step 2: Delete all non-ancestors of {X,Y,Z}.

Step 3: Delete all arcs emanating from X.

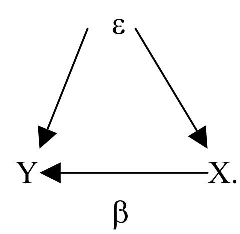
Step 4: Connect any two parents sharing a common child.

Step 5: Strip arrow-heads from all edges.

Step 6: Delete Z_7 and Z_9 from the graph.

Test : If X is disconnected from Y in the remaining graph, then $Z_7$and Z_9 are appropriate measurements to condition on. In other words, in order to measure the effect of X on Y correctly given Figure 3.1, Z_7 and Z_9 should be included in a regression equation.

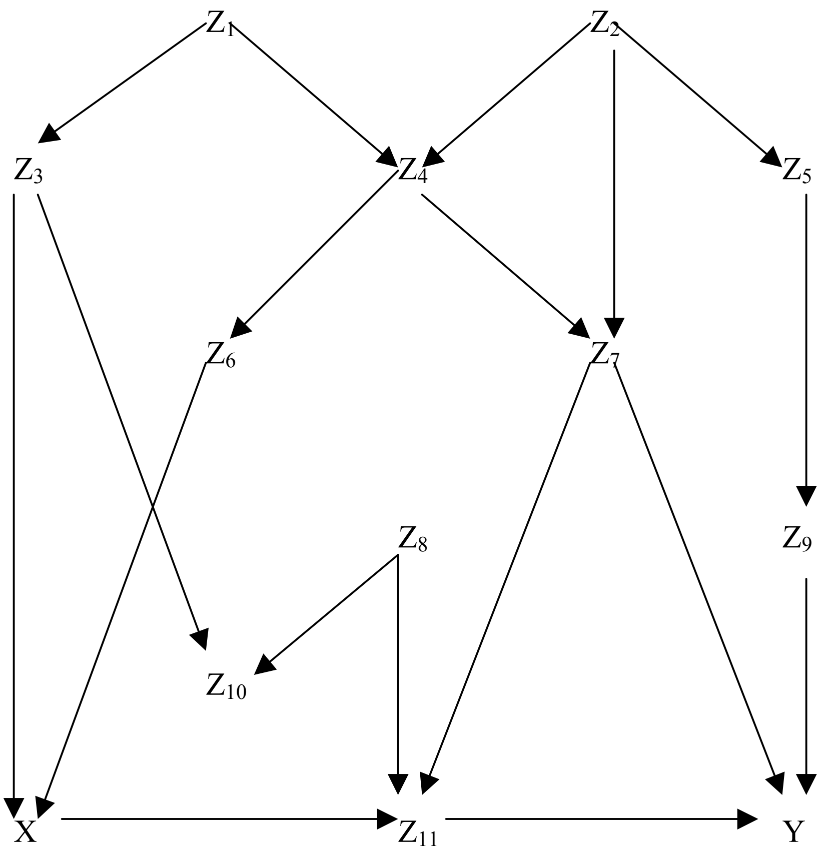
The essence of the "adjustment problem" is well understood in applied econometrics. We have a standard result: to measure the effect of X on Y using ordinary least squares regression, in a linear representation, $Y = X\beta + \varepsilon$, the variable X must not be correlated with ε. If there is an omitted variable (Z) that cause X and Y, it would show up in the above equation as one component of our error term ε. Its graphic representation would be



To measure β (the true effect of X on Y), we need to "block" the backdoor path $X \leftarrow \varepsilon \rightarrow Y$, by including the variable Z in the regression equation. So the proper regression would be $Y = X\beta_1 + Z\beta_2 + \varepsilon^*$, where ε^* is the residual not having Z as one of its components.

Figure 3.1

Causal Graph Illustrating the "Adjustment Problem" (Pearl, 2000)



CHAPTER IV

DATA AND METHODS

This chapter outlines the methods used to test hypotheses developed in Chapter II. A description of the sample, data source, and measurement follows in the first to third sections.

Sample

The sampling is from the 1999 Fortune 500 list (for the year 1998) that is ranked by revenue of corporation. The period under study is 1990-1998 when the economy of U.S. experienced steady growth after the recession of the early 1980's[16]. There are few studies covering this most recent past decade. Most studies of corporate performance have been conducted for the decade of the 1980's.

The rationale for tracking presently existing firms backward in time rather than forwards is that there is a larger volume of information and more electronic data base for the more recent time period (Armor & Teece, 1978). This analysis is performed on U.S. corporations except financial sectors, which survived from 1990 to 1998. Because I am not analyzing the risk of survival and because I want to ensure that the corporations selected remained in the sample through the 1990-1998 time frames, I have omitted all corporations, which did not survive throughout this period. I used the industry classifications from the Fortune instead of Standard Industrial Classification

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[16] I checked various measures provided from the Economic Cycle Research Institute. They are U.S. business cycle dates and U.S. growth rate cycle dates.

(SIC) to exclude some industries from my study. This process is necessary to maintain comparability and consistency with previous research on the relationships of interest[17]. In the Fortune, U.S. industry is grouped into 70 different industry sectors. Among them, I excluded industry sectors related to banking, insurance, and all diversified financial firms, and health care. They are commercial banks, diversified financials, insurance: life, health, insurance: P&C, health care, saving institutions, and securities. This yields 318 firms in my data set.

When counting the subsidiaries of parent corporations, foreign held entities of U.S. parent corporations were not included because they have different regulatory and business environments than domestic entities (Zey, 1996; 1998). The number of corporations in the sample is further limited by checking accessibility of relevant strategy, structure, and performance data. When I encountered a missing observation on a single variable for a corporation the following substitution methods provide the order in this I made missing data decision[18]. First, I used mean values of two contiguous years for a corporation. Second, when the first option was not available, the mean value of the time frame of the corporation was used. When neither of the two previous options was available, the industry average of the year was substituted. If none of these was

[17] Direct comparison with other studies might not be available, because many previous studies on corporate performance selected samples using two-digit Standard Industrial Classification (SIC) codes between 20 and 40. In my study, among final sample of 190 companies, 36 of them are indexed either before 20 or after 40 in terms of the two-digit SIC codes. Though broader coverage of industry sectors makes direct comparison with previous studies difficult, more generalized explanation of corporate performance covering various industries becomes possible. The access of all relevant strategy, structure, and performance data for financial sectors is much more problematic than the access for non-financial sectors.

[18] This process is necessary in order to perform regression analysis for longitudinal data. Due to incomplete reporting in R&D and advertising data, mean substitution for missing data were used (Hill, Hitt, & Hoskisson, 1992).

available, the observation was discarded. 128 firms are discarded because of missing data. Thus, the number of sample is 190 firms and the number of observation available for the analysis is 1710 (190*9) that is 190 companies for nine years. The size of the corporations in the final sample ranged from $3 billion to $178 billion in revenue in 1998.

Sources of Data[19]

The sources of data include Compustat, CompactD, Spectrum 3:13(f), SDC Platinum, America's Corporate Families: The Billion Dollar Directory, and Global Researcher. The data on financial variables (asset, debt, sales, dividend, revenue, etc.) and others (employee, R&D expense, advertisement expense) were collected from the annual data in Compustat, which records these data for each year. The data on ownership hierarchy (number of division, branch, subsidiary at each level) were collected from America's Corporate Families: The Billion Dollar Directory. The number of branches was added to the number of divisions to ensure the more stringent test of my model. The data on institutional investors ownership (percent shares held by institutional investors) were collected from either CompactD or Spectrum 3:13(f)[20]. The data on diversification (sales in each industry for a firm) were collected from the industry segment file from Compustat. The description of business and other supplementary information to trace the history and name changes of corporations were

[19] Most of the data for this study was collected while I was working for Corporate Strategy and Structure Project funded by Texas A&M University and by Zey. I'd like to thanks Mary Zey for allowing me to use the data.
[20] CompactD is electronic source of Spectrum 3:13(f) data.

collected from the Global Researcher. Table 4.1 summarizes the sources and measures of variables.

Measurement

The measures were chosen to represent performance, size, ownership hierarchy, and various strategies of corporations in the study. This study analyzes the economic performance of the largest U.S. manufacturing corporations from 1990-1998. As I described in Chapter II, ROA was chosen to measure corporate accounting performance. The return on assets of the firm was calculated by dividing operating income before interest and taxes and after depreciation by total assets for each of the years 1990 to 1998. To control for industry effects[21] on accounting performance, I used a relative measure of firm ROA (ROA*). Each firm's ROA is adjusted by subtracting the dominant two-digit industry average ROA (Hitt et al, 1996; Hoskisson et al, 1993; Hoskisson et al., 1994)[22]. A relative firm ROA for i^{th} firm in j^{th} industry is thus calculated as follows:

$ROA_{ij}^* = ROA_i - M(j)$, where $M(j) = \sum_{i=1}^{N} ROA_{ij} / N$, i = 1, .., M, j = 1, .., 38, M<N and

M is the number of firms in j^{th} industry from my sample, N is the number of firms in j^{th}

[21] In the traditional structure/conduct/performance paradigm from industrial organization economists, corporate performance mainly depends on the industry effect from market structure (Bettis, 1981).
[22] The dominant two-digit industry represents the segment producing the majority of the firm's sales. Two-digit industries are based on Standard Industry Classification (SIC) codes. Hoskisson, Johnson, and Moesel (1993) indicate that the analysis using industry averages by primary SIC codes and the analysis using weighted industry averages by each SIC code showed similar results.

Table 4.1
Variables Used in the Analysis[a]

Category	Variable	Measure	Data source
Performance			
	Return on Assets (ROA)	The operating income after depreciation to assets ratio	Compustat, (I13-I14)/I6
	Return on Sales (ROS)	The operating income after depreciation to sales ratio	Compustat, (I13-I14)/I12
Structure			
	Corporate Size (SIZE)	Natural logarithm of total assets Natural logarithm of number of employees	Compustat, I6, I29
	Multi-Organizational Ownership Hierarchy (MOOH)	The number of the levels to reveal the hierarchy structure	America's Corporate Families
Strategy			
	Related Diversification (RD)	Extent a firm operates in number of different product lines within an industry	Compustat Business Segment
	Unrelated Diversification (UD)	Extent a firm operates in number of different industries	Compustat Business Segment
	Institutional Investors (INST)	End of the year % of total outstanding common voting shares owned by institutional investors	Compact D
	Financial Pressure (DEBT)	The ratio of total current liabilities to equity The ratio of long-term debt to equity	Compustat, (I5/I60, I9/I60)
	Research and Development Intensity (R&D)	The firm's R&D to sales ratio	Compustat, (I46/I12)
	Advertising Intensity (ADV)	The firm's advertising to sales ratio	Compustat, (I45/I12)

[a] This table provides the variables, and the sources of variables.

industry from Compustat . Also the relative firm return on sales (ROS*) was calculated in the same way to derive relative firm return on assets (ROA*). The inclusion of ROS* in the analysis allows me to check the consistency of the results from DAGs and the following regressions by changing the measure of corporate accounting performance.

Size is measured by both the natural logarithm of total assets (Armour & Teece, 1978; Baysinger & Hoskisson, 1989, Lubatkin, & Chatterjee, 1991) and the natural logarithm of number of employees (Hoskisson et al., 1993). As the case in accounting performance measure, multiple measures of size allow me to check the consistency of the analysis results.

Multi-organizational ownership hierarchy (MOOH) is defined as a vertical ownership structure in which an organization controls multiple numbers of legally separated organizations held at several levels[23]. MOOH measures the levels of ownership in form of subsidiaries. Suppose a parent company owns subsidiaries down to the second level, it is recorded as two levels below the corporate parent executive office .

Diversification is a primary corporate strategic focus. However, measuring diversification is not a clear and unambiguous task. Among the many measures of diversification, the entropy measure of diversification, originally developed by Jacquemin and Berry (1979), has been used by strategy researchers in response to the need for an objective measure that can addresses strategic differences (Hoskisson et al., 1993). Entropy measures address not only the number of categories, but also the

[23] First level subsidiary is owned and controlled by a parent company and second level subsidiary is owned and controlled by the first level subsidiary so on.

distribution of sales among the separate business categories. It has been accepted in the literature as the most objective way compared to categorical measures or simple SIC count measures (Hoskisson et al., 1993). In this frame, diversification can be divided into related (RD) and unrelated diversification (UD). The standard industrial classification (SIC) is used to define related and unrelated product groups. Products belonging to different four-digit SIC industries within the same two-digit industry group are treated as related. Products from different two-digit SIC industry group are treated as unrelated. Contrary to a simple SIC count measure, this measure addresses not only the number of categories, but also the distribution among the separate business categories. In other words, sales or revenues in entropy measure, weight firm's activities in each product group or industry group. The entropy components of diversification are defined as follows: Entropy measures= $\sum P_j \ln(1/P_j)$ where j is defined as the share segment j in the firm sales and $\ln(1/P_j)$ is the weight for each segment j that is the logarithm of the inverse of its sales. Related diversification (RD) is defined as the diversification arising out of operating in 4-digit segments within 2-digit industry group, with industry group sales defined as the sales in 2-digit industry. Unrelated diversification (UD) is defined as the diversification arising from operating between 2-digit industry groups, with total firms sales as the sales reference. Total diversification is formed by adding the two components of the entropy measures, related and unrelated diversification (Hoskisson et al., 1992). These three components are calculated for each firm for each year of the study.

R&D intensity is measured by the ratio of R&D expenses to sales, representing all costs incurred relating to development of new products or services. Advertising intensity is measured by the ratio of firm's advertisement to sales.

Ownership by institutional investors is the end of the year percent of total outstanding common voting shares owned by institutional investors. Debt (financial pressure) is measured by both the ratio of total current liabilities[24] to equity and the ratio of long-term debt[25] to equity. As the case in performance measure and size measure, multiple measures of debt allow me to check the consistency of the analysis result.

Analysis Method

The following analysis techniques were used. First, after data was summarized, I adjusted return ratios using industry average in order to remove an industry effect from the data. Second, I developed DAGs and tested which perspectives were applicable in explaining causal relationship among variables. Third, I measured the intensity o f relation among variables, applying some prior tests to choose appropriate estimation method. Fourth, based on the DAG, I estimated total effect and direct effect. Fifth, I compared the DAG model with the full model in several aspects.

A number of the studies have suggested that industry effects have the most impact on the profitability of diversified firms (Bettis & Hall, 1982; Chang & Thomas, 1989; Montgomery, 1985). To avoid misleading interpretations, the potential industry

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[24] This item represents debt and other liabilities due within one year and includes the current portion of long-term debt (Compustat).
[25] This item represents interest-bearing obligations due after the current year (Compustat).

effects on performance should be accounted for in research examining the diversification-performance relationship (Datta, Rajagopalan, & Rasheed, 1991; Hoskisson & Hitt, 1990; Ramanujam & Varadarajan, 1989). It becomes easier to compare the current study with selected previous studies when industry effects are controlled. Accordingly, the measure of accounting performance was adjusted by the industry average in order to remove any industry effects (Hoskisson et al, 1993; Keats & Hitt, 1988).

For size, debt, and accounting performance, multiple measures were developed to offer evidence of the stability of derived models from the DAG. From each DAG for different measures, the model generating weighted return was derived based on Markov Property that allows us to only conditional on parents (direct cause) (Pearl, 2000; Spirtes, Glymour, & Scheines, 2000).

The DAGs for different measures of size, leverage, and accounting performance were derived using TETRAD II and scored using model-fitness criteria, such as Akaike information criterion (AIC) and Schwartz criterion (SC). Both, Akaike information criterion (AIC) and Schwartz criterion (SC) penalize the loss of degrees of freedom that occurs when a model size is expanded (Green, 2000). AIC and SC are statistical loss functions which balance "fit" and "parsimony" in model specification. The goal is to select the model that minimizes the criterion. The formula of $AIC = \log (e'e/n) + 2K/n$,and the formula $SC = LOG (e'e/n) + K \log n/n$, where n is number of observations, K is number of parameters.

The correlation matrix being used as an input in the TETRAD II has nine variables including a profitability measure. This has repeated for two different profitability measures, i.e., return on asset, and return on sales. I expect to see some consistency across different measures of profitability, different measures of size, and different measures of debt.

Since the analysis is based on longitudinal data, there is a possibility of violating the classical assumptions of regression. Tests were conducted to check for cross-sectional heteroscedasticigy and cross-sectional correlation, respectively. Also an autoregressive process of order one (AR(1)) is adopted as a candidate for the residual process. Models based on this AR(1) error process were compared with models with no error autoregressive process to define autocorrelation. LM tests were conducted to check cross-sectional heteroscedasticity and Breusch-Pegan test was applied for cross-sectional correlation (Green, 2000).

Lagrangian Multiplier (LM) test was conducted to check cross-sectional heteroscedasticity. LM is calculated as: $T/2 \sum_{i=1}^{N} ((\sigma_{ii} / \sigma^2) - 1)^2$ where $\sigma_{ij} = 1/T \sum_{t=1}^{T} e_{it}\, e_{jt}$, $\sigma^2 = 1/N \sum_{i=1}^{N} \sigma_{ii}$, N is number of cross sectional units, and T is time period. The statistic of LM test has a chi-square distribution with N-1 degrees of freedom. The null hypothesis under the LM test is $\sigma_i = \sigma$.

The Breusch-Pegan (B-P) test is applied for cross-sectional correlation. B-P LM is calculated as $T \sum_{i=2}^{N} \sum_{j=1}^{i-1} r_{ij}^2$ where $r_{ij}^2 = \sigma_{ij}^2 / \sigma_{ij}\sigma_{jj}$, N is number of cross sectional units, and T is time period. The statistic of B-P LM test has asymptotic chi-square distribution with N(N-1)/2 degrees of freedom. The null hypothesis under the B-P test is $\sigma_{ij} = 0$ when $i \neq j$.

Based on these tests, appropriate estimation methods were chosen. Full models with different measures were estimated in order to access the stability of the model. A DAG model with hierarchy structure and a DAG model without hierarchy structure were estimated in order to evaluate the advisability of inclusion. For the variables that are not included in the DAG model from the Markov property as direct causes, the "adjustment problem" method (Pearl, 2000) was applied to measure the indirect effect on accounting performance (for them, indirect effect is same with total effect).

Finally, forecasting ability was compared between a full model and the DAG model using Root Mean Squared Error (RMSE). Root Mean Squared Error is $\sqrt{MSE}$ and MSE $= \frac{1}{190}\sum_{i=1}^{190}(WROA_i - \hat{WROA_i})^2$. This comparison was conducted on an out-of-sample period. The model with smaller RMSE has better predictive accuracy of forecasting.

It may be appropriate to use a formal test for judging which model is preferred in terms of forecasting performance. If knowledge of the first entails knowledge of the second, the first is said to encompass the second. The requirement of encompassing is that the competing model embodies no useful information absent in the preferred model. Encompassing is related to conventional misspecification analysis and composite forecasting (Hendry, 1995). Denote two forecast error series by e_{it}, $i = 1,2$, and the composite forecast error by ε_t, a white noise term, and write

$$e_{1t} = \lambda(e_{1t} - e_{2t}) + \varepsilon_t \qquad (4.1)$$

The null hypothesis is $\lambda = 0$. When the null is true, according to Chong and Hendry (1986), the first model encompasses the second in terms of forecasting performance. The actual test involves an ordinary least square regression e_{1t} on $(e_{1t} - e_{2t})$. A t-test of estimate of λ is used as our test for encompassing.

CHAPTER V

RESULTS

This chapter presents the results of the causal modeling effort, the theory of which is set forth in Chapter III. Descriptive statistics and correlations for the variables under analysis are presented in Table 5.1. Since MOOH has never been introduced in the empirical study, descriptive analysis of MOOH is conducted. Table 5.2 and Table 5.3 present the results from the descriptive analysis of MOOH. Table 5.4 through Table 5.7 present the results of application of TETRADII to alternative data sets. Alternative measures of accounting performance, debt, and size are applied to find directed acyclic graphs (DAGs) using TETRADII. The results of regression analyses suggested by the DAG results are provided in Tables 5.8 through 5.16.

Association of Variables

Table 5.1 provides descriptive statistics and correlations among the variables used in the study. The correlation between multi-organizational ownership hierarchy (MOOH) and relative return on assets (ROA*) provides *prima facie* evidence that changes in ownership hierarchy (vertical financial ownership) are related to corporate accounting performance. The correlation between MOOH and diversification (DR, DU) as well as the correlation between MOOH and SIZE show strong relationships as well. The variables that have strong relationship with ROA* in terms of correlation are unrelated diversification (DU), R&D intensity (R&D), advertisement (ADV), and

MOOH. In order to find out whether these four variables are direct causes of ROA* and to reveal the causal relationships among other variables, TETRADII is applied. The results follow.

Descriptive Analysis of MOOH

Table 5.2 presents the change in corporate entities of the 1999 Fortune 500 largest U.S. firms, 1980, 1990, and 1998. It shows that the majority of units held by the parent company are in the form of subsidiaries by the 1990s. The data from 1980 to 1998 show that many industrial corporations no longer held their entities as divisions but as subsidiaries. Further, the data show that the levels of subsidiarization increased from 1980 to 1998. In other words, multi-organizational ownership hierarchies have become deeper.

The mean numbers of divisions per corporation has declined from 8.9 to 7.3 in 1980s and from 7.3 to 4.5 in 1990s. As the data shows, these changes are more significant in 1990s than 1980s. In contrast, the mean number of domestic subsidiaries owned by US firms has drastically increased from 1.5 to 14.9 in 1980s and from 14.9 to 32.8 in 1990s. The mean number of levels of subsidiaries tells a similar story. It increased from .49 to 1.6 in 1980s and from 1.6 to 2.5 in 1990s. Paired t-tests are used to determine the statistical difference of means. All of these changes are significant at the 5% level, except the change of number of divisions between 1980 and 1989[26].

[26]Analysis of all years from 1980 to 1998 offers similar results. Since the trends explained above are consistent over this period, only the summary covering three data points is reported.

Table 5.1
Means, Standard Deviations (S.D.), and Correlations of Variables[a]

Variables	Means	S.D.	Correlations[b]								
			RD	UD	R&D	ADV	MOOH	DEBT	SIZE	INST	ROA*
RD	0.147	0.263	1.000								
UD	0.367	0.456	0.086	1.000							
R&D	0.038	0.041	0.018	-0.220	1.000						
ADV	0.036	0.040	0.003	0.002	0.020	1.000					
MOOH	2.132	1.433	0.212	0.309	-0.157	-0.020	1.000				
DEBT	0.645	2.212	0.027	0.062	-0.028	0.005	0.139	1.000			
SIZE	8.470	1.307	0.209	0.243	0.004	0.059	0.547	0.122	1.000		
INST	57.437	17.958	0.118	0.038	0.005	-0.041	0.005	0.057	0.040	1.000	
ROA*	0.073	0.088	-0.041	-0.200	0.363	0.205	-0.200	-0.076	-0.091	0.020	1.000

[a] Source: Compustat, CompactD, Spectrum 3:13(f), SDC Platinum, and America's Corporate Families and Global Researcher.
[b] N=1710. Definitions of variables are listed in Table 4.1. DEBT is measured by total current liabilities. SIZE is measured by total assets.

Table 5.2
Change in Corporate Entities of the 1999 Fortune 500 Largest U.S. Firms, in 1980, 1990, and 1998[a]

	Mean	Difference of Mean	SE	T-ratio	2-tailed Significance
Divisions					
1998	4.5				
		2.8	1.0	2.85	.005
1989	7.3				
		1.5	1.1	1.42	.155
1980	8.9				
Subsidiaries					
1998	32.8				
		17.9	2.4	7.51	.000
1989	14.9				
		13.4	1.1	12.40	.000
1980	1.5				
Levels of Subsidiaries					
1998	2.53				
		0.94	0.08	10.74	.000
1989	1.59				
		1.10	0.07	16.94	.000
1980	0.49				

[a] Source: America's Corporate Families: the Billion Dollar Directory. 1980, 1989, 1990. Parsippany, NJ: Dun & Bradstreet Inc. Each three years present the information of the subheading. Second column is the mean of subheading in each year. Third column is the mean difference between two years. Fourth column is the standard deviation of the mean difference. Fifth, and last column is for testing the null hypothesis: there is no mean difference between two years.

Table 5.3 provides more detailed description of how the ownership hierarchy of U.S. industrial firms has changed in 1990s. U.S. large industrial corporations hold subsidiaries down to eight levels. Mean values of the number of subsidiaries at each level are presented in column 4. The average number of subsidiaries in each level between 1990 and 1998 increases consistently for all the levels from 1990 to 1998.

In Table 5.3 column 6, the number of parent corporations at each level at each maximum level is recorded. Among 190 parent companies in the study, the number of parent companies that do not own subsidiaries at all changes from 31 in 1990 to 8 in 1998.

Results of DAGs

Following the suggestion from Spirtes et al., (2000), I set a 5% significance level as a maximum level for edge removal. An edge must be significantly different from zero at the 5% level or at the lower level to remain in the causal structure. The direction of causal flows is determined using the sepset conditions[27] programmed in TETRAD II, which follows the rule that a common cause screens off association between its effects, while a common effect doesn't screen off association between its possible causes.

Using simulation with respect to errors on both edge inclusion (yes or no) and direction (arrow heading), Spirtes et al., (2000) conclude that in order for the method to

[27] It is explained in PC algorithm in Chapter III.

Table 5.3
The Change in Multi-Organizational Ownership Hierarchy[a]

Year	Level of Ownership Hierarchy	Number of Parent Companies owned each level	Mean value of number of subsidiaries	Lowest Level of Ownership Hierarchy	Number of Parent Companies
1998				Level 0	8
	Level 1	182	15.2	Level 1	45
	Level 2	137	12.6	Level 2	62
	Level 3	74	10.5	Level 3	49
	Level 4	26	10.2	Level 4	15
	Level 5	11	19.6	Level 5	4
	Level 6	7	10.0	Level 6	5
	Level 7	2	3.0	Level 7	1
	Level 8	1	1.0	Level 8	1
1997				Level 0	11
	Level 1	179	14.9	Level 1	53
	Level 2	126	14.9	Level 2	54
	Level 3	72	11.5	Level 3	45
	Level 4	27	9.7	Level 4	12
	Level 5	15	14.9	Level 5	9
	Level 6	6	12	Level 6	3
	Level 7	3	2.7	Level 7	2
	Level 8	1	1.0	Level 8	1
1991				Level 0	31
	Level 1	159	15.0	Level 1	45
	Level 2	114	11.1	Level 2	56
	Level 3	58	6.6	Level 3	40
	Level 4	18	7.3	Level 4	12
	Level 5	6	4.5	Level 5	1
	Level 6	5	9.8	Level 6	2
	Level 7	3	1.3	Level 7	3
	Level 8	0	0	Level 8	0
1990				Level 0	31
	Level 1	159	13.9	Level 1	45
	Level 2	114	9.1	Level 2	63
	Level 3	51	6.7	Level 3	36
	Level 4	15	5.5	Level 4	8
	Level 5	7	2.6	Level 5	3
	Level 6	4	2.8	Level 6	2
	Level 7	2	1	Level 7	2
	Level 8	0	0	Level 8	0

[a] Source: America’s Corporate Families: the Billion Dollar Directory. 1990-1998. Parsippany, NJ: Dun & Bradstreet Inc.

converge to correct decisions on edge inclusion and direction with probability 1, the significance level used in making decisions should decrease as the sample size increases. For example, Spirtes et al. (2000) suggest setting the significance level at 10% when the sample size is 100 to 300 and at 5% or smaller for larger samples. The sample size in my study is 1710; that is, 190 corporations for nine years. Based on the suggestion from Spirtes et al., (2000), I set a 5% significance level as the maximum level for deciding edge direction in the DAG analysis. I did consider alternative significance levels to see how robust resulting DAGs were to the different levels.

Further, multiple measures of size, leverage, and accounting performance were used to check the robustness of DAG representations to variable definitions. Total assets (SIZE1) and the number of employees (SIZE2) were used as alternative measure of firm size. Total current liabilities (DEBT1) and long-term debt (DEBT2) were used as measures of financial pressure from external financing. Accounting performance was measured by either the relative return on assets (ROA*) or the relative return on sales (ROS*). Since MOOH ,the measure of ownership hierarchy structure, has never been used in the literature, the DAG without MOOH was derived for comparison with the result of DAG with MOOH.

For each combination of different measures of size, debt, and accounting performance, I compared the DAG results from different significance levels (5%, and 10%). Spirtes, et al. (1994) recommended that users test for stability of the output under small variations of the significance level when applying TETRAD II. For the models that used ROA* as the measure of corporate accounting performance, most of edges were not directed at 1% significance level. Since the 5% significance level was the lowest level indicating causal directions and Spirtes, et al. (2000) suggested 5% or lower significance level for large samples, 5% significance level DAGs were chosen for finding a causal model of corporate accounting performance. The results from 5% significance level and 10% significance level were compared to see the stability of outputs from TETRADII. All the comparisons consistently indicated that the causal directions from the chosen level (5%) were stable. I did not impose any restriction based on prior hypotheses[28] in order to decide causal relationship.

The results of DAGs are reported in four tables. Table 5.4 reports the result with ROA* used as the measure of accounting performance. Table 5.5 reports the result when the measure of ownership hierarchy (MOOH) is not included in deriving the DAG. Table 5.6 reports the result when ROS* is used as the measure of accounting performance instead of ROA*. Each table presents the results for two different significance levels.

Table 5.4 presents four models with different measures of size and debt. The first model used SIZE1 as the measure of size and DEBT1 as the measure of debt. The second model used SIZE1 as the measure of size and DEBT2 as the measure of debt. The third model used SIZE2 as the measure of size and DEBT1 as the measure of debt. The fourth model used SIZE2 as the measure of size and DEBT1 as the measure of debt. In all four models, there were few changes in the edges and the directions of

[28] TETRADII allows the researchers to supply information on timing; e.g. variable1 occurs before variable2, which prevents causal flows from variable2 to variable1 as the output of the model. Such prior knowledge was never used in this effort.

causal flows, comparing two different significance levels. There were more changes in the edges and directions of causal flows at different significance levels when SIZE2 was used (third and fourth model) than when used SIZE1 was used (first and second model). DEBT1 (first and third model) showed more causal relationship with other variables than DEBT2 (second and fourth model) did. The edges and directions of causal flows were stable with respect to changes in the measure of debt (between first and second model, between third and fourth model).

Table 5.5 presents two models with different measures of debt. MOOH was not included in deriving causal relationship in these two models. The first model used DEBT1 as a measure of debt and the second model used DEBT2 as a measure of debt. Here, there were few changes in the edges and the directions of causal flows, at the different significance levels. As the case presented in Table 5.4, DEBT1 in the first model showed more relationships with another variables, than DEBT2 in the second model. The edges and directed causal flows were relatively unstable with respect to change in the measure of debt. The models with MOOH in Table 5.4 were more stable than the models without MOOH in Table 5.5, when changing the measure of debt.

The Table 5.6 presents the models when ROS* was used as the measure of corporate accounting performance. The first model used DEBT1 as the measure of debt and the second model used DEBT2 as the measure of debt. In the two models, there were few changes in the edges and the directions of causal flows at different significance levels. As is case in Table 5.4 and Table 5.5, DEBT1 in the first model

Table 5.4
DAG Result When ROA* is Used[a]

Variables: ROA*, SIZE1, MOOH, RD, UD, INST, DEBT1, R&D, ADV
Sample Size:1710

Significance level = 0.050			Significance level = 0.100		
RD	→	MOOH	RD	→	MOOH
SIZE1	→	RD	SIZE1	→	RD
RD	→	INST	RD	→	INST
R&D	→	UD	R&D	→	UD
MOOH	→	UD	MOOH	→	UD
SIZE1	→	UD	SIZE1	→	UD
UD	→	ROA*	UD	→	ROA*
R&D	→	MOOH	R&D	→	MOOH
R&D	→	ROA*	R&D	→	ROA*
ADV	→	SIZE1	ADV	→	SIZE1
ADV	→	ROA*	ADV	→	INST
MOOH	→	DEBT1	ADV	→	ROA*
SIZE1	→	MOOH	MOOH	→	DEBT1
MOOH	→	ROA*	SIZE1	→	MOOH
SIZE1	→	DEBT1	MOOH	→	ROA*
DEBT1	→	INST	SIZE1	→	DEBT1
ROA*	→	DEBT1	DEBT1	→	INST
			ROA*	→	DEBT1

Variables: ROA*, SIZE1, MOOH, RD, UD, INST, DEBT2, R&D, ADV

Significance level = 0.050			Significance level = 0.100		
RD	→	MOOH	RD	→	MOOH
SIZE1	→	RD	SIZE1	→	RD
RD	→	INST	RD	→	INST
R&D	→	UD	R&D	→	UD
MOOH	→	UD	MOOH	→	UD
SIZE1	→	UD	SIZE1	→	UD
UD	→	ROA*	UD	→	ROA*
R&D	→	MOOH	R&D	→	MOOH
R&D	→	ROA*	R&D	→	ROA*
ADV	→	SIZE1	ADV	→	SIZE1
ADV	→	ROA*	ADV	→	INST
SIZE1	→	MOOH	ADV	→	ROA*
MOOH	→	ROA*	MOOH	→	DEBT2
DEBT2			SIZE1	→	MOOH
			MOOH	→	ROA*

Table 5.4 Continued

Variables: ROA*, SIZE2, MOOH, RD, UD, INST, DEBT1, R&D, ADV

Significance level = 0.050			Significance level = 0.100		
MOOH	→	RD	RD	→	MOOH
SIZE2	→	RE	RD	→	SIZE2
RD	→	INST	RD	→	INST
UD	—	R&D	UD	—	R&D
UD	—	MOOH	MOOH	→	UD
UD	—	SIZE2	UD	→	SIZE2
ROA*	→	UD	UD	→	ROA*
R&D	→	ROA*	R&D	→	MOOH
ADV	—	SIZE2	R&D	→	ROA*
ADV	→	ROA*	ADV	→	SIZE2
MOOH	→	DEBT1	INST	→	ADV
MOOH	—	SIZE2	ADV	→	ROA*
ROA*	→	MOOH	MOOH	→	DEBT1
INST	→	DEBT1	MOOH	→	SIZE2
ROA*	→	SIZE2	MOOH	→	WRPA
			DEBT1	→	INST
			DEBT1	→	ROA*
			ROA*	→	SIZE2

Variables: ROA*, SIZE2, MOOH, RD, UD, INST, DEBT2, R&D, ADV

Significance level = 0.050			Significance level = 0.100		
MOOH	→	RD	MOOH	→	RD
SIZE2	→	RD	SIZE2	→	RD
RD	→	INST	RD	→	INST
UD	—	R&D	UD	—	R&D
UD	—	MOOH	UD	—	MOOH
UD	—	SIZE2	UD	→	SIZE2
ROA*	→	UD	UD	→	ROA*
R&D	→	ROA*	R&D	—	MOOH
ADV	—	SIZE2	R&D	→	ROA*
ADV	→	ROA*	ADV	→	SIZE2
MOOH	—	SIZE2	ADV	→	INST
ROA*	→	MOOH	ADV	→	ROA*
ROA*	→	SIZE2	MOOH	→	DEBT2
DEBT2			MOOH	→	SIZE2
			ROA*	→	MOOH
			ROA*	→	SIZE2

[a] Interpretation of symbols: A→B: A is a cause of B, A —B: A is related with B, but the causal relationship is indecisive. Where, ROS* is weighted return on assets, SIZE1 is total assets, SIZE2 is the number of employees, RD is related diversification, UD is unrelated diversification, INST is institutional investors, DEBT1 is current liabilities total, DEBT2 is long term debt, R&D is research and development intensity, and ADV is advertisement intensity.

Table 5.5
DAG Result without MOOH[a]

Variables: ROA*, SIZE1, RD, UD, INST, DEBT1, R&D, ADV
Sample Size: 1710

Significance level = 0.050			Significance level = 0.100		
SIZE1	→	RD	SIZE1	→	RD
INST	→	RD	INST	→	RD
R&D	→	UD	R&D	→	UD
SIZE1	→	UD	SIZE1	→	UD
UD	→	ROA*	UD	→	ROA*
R&D	→	ROA*	R&D	→	ROA*
SIZE1	→	ADV	SIZE1	→	ADV
ROA*	→	ADV	ADV	→	INST
SIZE1	→	DEBT1	ROA*	→	ADV
DEBT1	→	INST	SIZE1	→	DEBT1
ROA*	→	DEBT1	INST	→	DEBT1
			ROA*	→	DEBT1

Variables: ROA*, SIZE1, RD, UD, INST, DEBT2, R&D, ADV

Significance level = 0.050			Significance level = 0.100		
RD	—	SIZE1	SIZE1	→	RD
RD	—	INST	INST	→	RD
R&D	→	UD	R&D	→	UD
SIZE1	→	UD	SIZE1	→	UD
UD	→	ROA*	UD	→	ROA*
R&D	→	ROA*	R&D	→	ROA*
SIZE1	→	ADV	SIZE1	→	ADV
ROA*	→	ADV	ADV	→	INST
DEBT2	—	SIZE1	ROA*	→	ADV
			DEBT2	—	SIZE1

[a] Interpretation of symbols: A→B: A is a cause of B, A —B: A is related with B, but the causal relationship is indecisive. Where, ROS* is weighted return on assets, SIZE1 is total assets, RD is related diversification, UD is unrelated diversification, INST is institutional investors, DEBT1 is current liabilities total, DEBT2 is long term debt, R&D is research and development intensity, and ADV is advertisement intensity.

Table 5.6
DAG Result When ROS* is Used[a]

Variables: ROS*, SIZE1, MOOH, RD, UD, INST, DEBT1, R&D, ADV
Sample Size: 1710

Significance level = 0.050			Significance level = 0.100		
RD	→	MOOH	RD	→	MOOH
SIZE1	→	RD	SIZE1	→	RD
RD	→	INST	RD	→	INST
R&D	→	UD	R&D	→	UD
MOOH	→	UD	MOOH	→	UD
SIZE1	→	UD	SIZE1	→	UD
MOOH	→	R&D	MOOH	→	R&D
ROS*	→	R&D	ROS*	→	R&D
ADV	—	ROS*	INST	→	ADV
MOOH	→	DEBT1	ROS*	→	ADV
SIZE1	→	MOOH	MOOH	→	DEBT1
SIZE1	→	DEBT1	SIZE1	→	MOOH
DEBT1	→	INST	SIZE1	→	DEBT1
ROS*	→	SIZE1	DEBT1	→	INST
			ROS*	→	SIZE1

Variables: ROS*, SIZE1, MOOH, RD, UD, INST, DEBT2, R&D, ADV

Significance level = 0.050			Significance level = 0.100		
RD	→	MOOH	RD	→	MOOH
SIZE1	→	RD	SIZE1	→	RD
RD	→	INST	RD	→	INST
R&D	→	UD	R&D	→	UD
MOOH	→	UD	MOOH	→	UD
SIZE1	→	UD	SIZE1	→	UD
MOOH	→	R&D	MOOH	→	R&D
ROS*	→	R&D	ROS*	→	R&D
ADV	—	ROS*	INST	→	AD
SIZE1	→	MOOH	ROS*	→	ADV
ROS*	→	SIZE1	MOOH	→	DEBT2
DEBT2			SIZE1	→	MOOH
			ROS*	→	SIZE1

[a] Interpretation of symbols: A→B: A is a cause of B, A — B: A is related with B, but the causal relationship is indecisive. Where, ROS* is weighted return on assets, SIZE1 is total assets, MOOH is multi-organizational ownership hierarchy, RD is related diversification, UD is unrelated diversification, INST is institutional investors, DEBT1 is current liabilities total, DEBT2 is long term debt, R&D is research and development intensity, and ADV is advertisement intensity.

showed more causal relationships with another variables than DEBT2. The edges and directions of causal flows were stable with respect to changes in the measure of debt.

The goal of the study is to find a causal model linking accounting performance with size, diversification, ownership hierarchy, and other strategies. Hence, the comparison of the results of DAGs is focused on alternative specifications of the accounting performance. A summary of DAG results and model selection criteria are presented in Table 5.7. The first four rows in Table 5.7 are from Table 5.4. The next two rows in Table 5.7 are from Table 5.5.[29] The suggested representations on accounting performance from each model are scored using Akaike information criterion (AIC) and Schwartz criterion (SC) in Table 5.7. These scores are given in the last column of Table 5.7. The suggested model generating ROA* with SIZE1 has UD, R&D, ADV, and MOOH. The model generating ROA* with SIZE2 has R&D, and ADV as right hand side regressors.

The change of the measures of debt did not change the result of DAG in terms of suggested model generating the accounting measures of performance. However, the change in the measures of size resulted in the change of suggested model generating ROA*. It is not surprising that the derived models with MOOH and without MOOH were different. The AIC and SC metrics favor the models in which MOOH was a right-hand-side variable (-5.0721 is less than –5.0161, for example). MOOH is recognized as one of the key variables in deciding the structure of corporations and its role in

[29] The DAG analyses with ROS* (Table 5.4) did not result in a specification of corporate accounting performance.

Table 5.7
Summary of DAG Results and Model Selection Criteria, AIC and SC, from Regression[a]

Measures	Suggested Model	Goodness-of-Fit Measures	
W/ MOOH ROA*, SIZE1, DEBT1	ROA*=f(UD, R&D, ADV, MOOH)	AIC SC	-5.0721 -5.0572
W/ MOOH ROA*, SIZE1, DEBT2	ROA*=f(UD, R&D, ADV, MOOH)	AIC SC	-5.0721 -5.0572
W/ MOOH ROA*, SIZE2, DEBT1	ROA*=f(R&D, ADV)	AIC SC	-5.0393 -5.0323
W/ MOOH ROA*, SIZE2, DEBT2	ROA*=f(R&D, ADV)	AIC SC	-5.0393 -5.0323
W/O MOOH ROA*, SIZE1, DEBT1	ROA*=f(UD, R&D)	AIC SC	-5.0161 -5.0091
W/O MOOH ROA*, SIZE1, DEBT2	ROA*=f(UD, R&D)	AIC SC	-5.0161 -5.0091

[a] ROA* is weighted return on assets, SIZE1 is total asset, SIZE2 is the number of employees, DEBT1 is current liabilities total, and DEBT2 is long-term debt. W/ MOOH means inclusion of MOOH in the DAG analysis. W/O MOOH means exclusion of MOOH in the DAG analysis. AIC is Akaike information criterion and SC is Schwartz criterion. Where AIC = log ($\mathbf{e'e}/n$) + $2K/n$ and SC = LOG ($\mathbf{e'e}/n$) + K log n/n ,where n is number of observations, K is number of parameters.
Note: AIC and SC are statistical loss functions which balance “fit” and “parsimony” in model specification. The goal is to select the model that minimizes the criterion. The selection criteria can be compared across alternative models for the same “dependent” variables.

generating accounting performance is significant when corporation changes its size. Failure to include this variable will show incorrect causal flows.

Since the change in the measure of size, and inclusion or exclusion of MOOH resulted in suggesting different models representing ROA*, goodness-of-fit measures are applied as the criteria to decide final model. Both, Akaike information criterion (AIC) and Schwartz criterion (SC) penalize the loss of degrees of freedom that occurs when a model is expanded. Both measures are improved (decreased in numeric size) as R^2 increases, but everything else held constant, degrade as the model size increases. The Schwartz criterion, with its heavier penalty for degree of freedom lost, will lean toward a simpler model (Green, 2000). According to AIC and SC, the one from DAG using ROA* with MOOH and SIZE1 is the model to choose. The decision based on AIC and SC got support from the analyses in Tables 5.4 - 5.6. I found that relatively there were more changes in the edges and directions of causal flows in different significance levels when SIZE2 was used than SIZE1 was used from Table 5.4. I also found that the models with MOOH in Table 5.4 were more stable than the models without MOOH in Table 5.3, when changing the measure of debt. The analyses from Tables 5.4 –5.6 imply that the consistency of causal graphs can be improved by including MOOH or using SIZE1 instead of SIZE2.

However, result with DEBT1 and result with DEBT2 from DAGS using ROA* with MOOH and SIZE1 were not distinguishable, since they had the same magnitude in terms of AIC and SC. Comparing the result of DAG in both cases from Table 5.4, these two were the same with the exception of causal flows related to debt. The choice between the two did not change the determination of the DAG model generating ROA*. Both DAGs resulted in UD, R&D, ADV, and MOOH were right-hand-side regressors to estimate ROA*. However, when it came to the adjustment problem[30] in measuring the individual total effect of variables that was not included in the model generating ROA*, it was sensitive to the choice between the two. Rather than having debt isolated by choosing the DAG with DEBT2, it was appropriate to choose the DAG with DEBT1 and measured the interaction of debt with another variables.

Based on the decision made above, Figure 5.1 provides the suggested causal flows from DAG generating ROA* with MOOH. Without imposing any prior restrictions on causal flows, the DAG shows that the majority of corporate structure and strategy variables are either direct or indirect causes of corporate accounting performance. Further, the results generally support the structure → strategy → performance paradigm discussed in Chapter II. The ovals in dotted lines in Figure 5.1 enclose measures associated with each of the above paradigm categories: structure, strategy, and performance. The two structure variables SIZE and MOOH have three arrows from strategy variables flowing in to them (RD→MOOH, ADV→SIZE, and R&D→ MOOH). SIZE and MOOH direct five arrows to strategy variables (SIZE→RD, SIZE →DEBT, SIZE→UD, MOOH→DEBT, MOOH→ UD).

There is only one arrow from a structure variable (MOOH) to the performance variable (ROA*). Generally structural information finds its influence on performance by passing through the strategy variables. The DAG has ADV, MOOH, UD, and R&D as direct

[30] The device designed to avoid Simpson's Paradox (Pearl, 2000).

causes of accounting performance when it was measured as ROA*. The effect of RD, and SIZE are transferred to ROA* via the former four factors. The DAG shows that the effect of SIZE on ROA* flows through MOOH and UD. The variables R&D, MOOH and SIZE are the causes of UD. The variables RD, R&D and SIZE are the causes of MOOH. DEBT is indicated as the common effect of SIZE, MOOH, and ROA*, rather than a cause of ROA*. INST is indicated as the common effect of DEBT and RD.

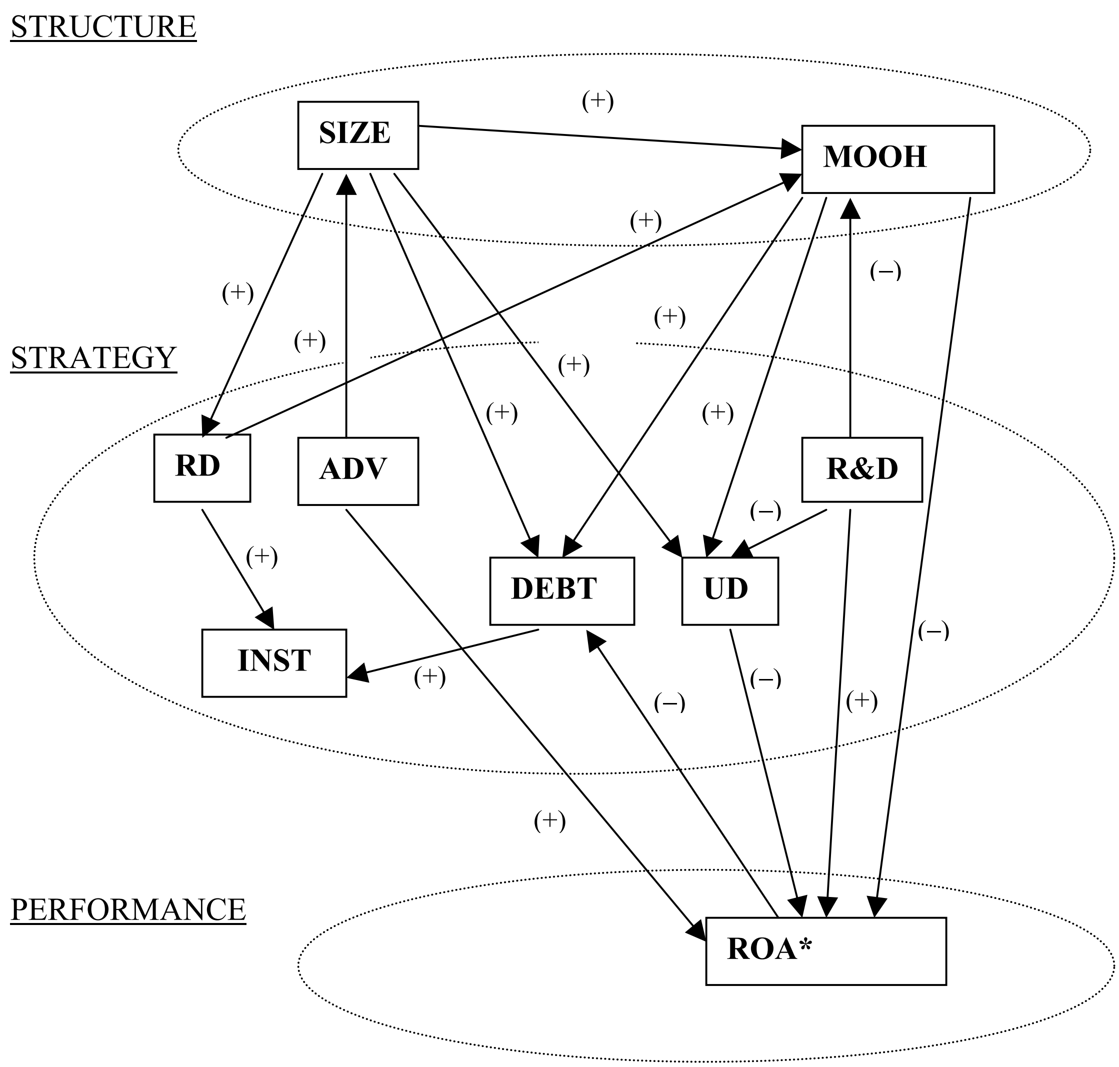
Results of Regression Analyses

In this section I present results on regression models. The purpose in this section is to compare the DAG-suggested models based on Figure 5.1 with a Full model –where all variables are included as regressors in an equation for accounting performance (ROA*).

The DAG showed how the nine variables under study are causally related. In other words, a causal model on these nine variables is the DAG presented in Figure 5.1. In order to measure the strength of relationship and to compare the DAG model with the Full model that included all the variables, regression analysis was applied. Since the analysis is done using longitudinal data, caution is required in order not to violate classical assumptions of regression. Estimation was based on the result of various preliminary tests. Table 5.8 shows the results of the tests. In order to check the stability of the estimation method chosen from tests, tests were repeated for different measures

Figure 5.1

Suggested Causal Flows from the DAG with Ownership Hierarchy[a]



[a] Definitions of variables are provided at Table 4.1.

Table 5.8
Test for Cross-Sectional Heteroskedasticity and Cross-Sectional Correlation[a]

Models	Null Hypotheses	Tests	P Value	Result of Tests
DAG Model				
W/ MOOH	$\sigma_i = \sigma$	LM=342.34	P=0.00	Reject H_0
SIZE1	$\sigma_{ij} = 0$	B-P LM=17820	P=0.90	Don't reject H_0
W/ MOOH	$\sigma_i = \sigma$	LM=341.11	P=0.00	Reject H_0
SIZE2	$\sigma_{ij} = 0$	B-P LM=17759	P=0.76	Don't reject H_0
W/O MOOH	$\sigma_i = \sigma$	LM=288.73	P=0.00	Reject H_0
	$\sigma_{ij} = 0$	B-P LM=17847	P=0.71	Don't reject H_0
Full Model				
SIZE1, DEBT1	$\sigma_i = \sigma$	LM=341.11	P=0.00	Reject H_0
	$\sigma_{ij} = 0$	B-P LM=17759	P=0.85	Don't reject H_0
SIZE1, DEBT2	$\sigma_i = \sigma$	LM=337.53	P=0.00	Reject H_0
	$\sigma_{ij} = 0$	B-P LM=17750	P=0.86	Don't reject H_0
SIZE2, DEBT1	$\sigma_i = \sigma$	LM=340.17	P=0.00	Reject H_0
	$\sigma_{ij} = 0$	B-P LM=17795	P=0.80	Don't reject H_0
SIZE2, DEBT2	$\sigma_i = \sigma$	LM=336.48	P=0.00	Reject H_0
	$\sigma_{ij} = 0$	B-P LM=17792	P=0.80	Don't reject H_0

[a] Model of each row is as follows from the top to bottom: ROA*=f(UD, R&D, ADV, MOOH), ROA*=f(RD,ADV), ROA*=f(UD, R&D), ROA*=f(RD,UD,R&D,ADV,MOOH,DEBT1,SIZE1,INST), ROA*=f(RD,UD,R&D,ADV,MOOH,DEBT2,SIZE1,INST), ROA*=f(RD,UD,R&D,ADV,MOOH,DEBT1,SIZE2,INST), ROA*=f(RD,UD,R&D,ADV,MOOH,DEBT2,SIZE2,INST).

LM is calculated as $T/2 \sum_{i=1}^{N} \left((\sigma_{ii} / \sigma^2) - 1 \right)^2$ where $\sigma_{ij} = 1/T \sum_{t=1}^{T} e_{it}\, e_{jt}$ and $\sigma^2 = 1/N \sum_{i=1}^{N} \sigma_{ii}$ and it has a chi-square distribution with N-1 degrees of freedom.

B-P LM is calculated as $T \sum_{i=2}^{N} \sum_{j=1}^{i-1} r_{ij}^2$ where $r_{ij}^2 = \sigma_{ij}^2 / \sigma_{ij}\sigma_{jj}$ and it has asymptotic chi-square distribution with N(N-1)/2 degrees of freedom. In LM and B-P LM, N is number of cross sectional units and T is time period.

of the variables. The general model to represent the i^{th} observation on ROA* suggested by Figure 5.1 is given as equation 5.1.

$$ROA^*_{it} = A_0 + A_1(MOOH)_{it} + A_2(R\&D)_{it} + A_3(UD) + A_4(ADV)_{it} + \varepsilon_{it} \qquad (5.1)$$

Where A_i, i = 0,1,2,3,4 are unknown parameters to be estimated and ε_i is a residual or error term. The classical assumption on ε_i are that ε_{it} is not correlated with ε_{jt} for $i \neq j$ and other ε_i has a constant variance. Representing the variance of ε_i as σ_i and covariance of ε_i and ε_j as σ_{ij}, we test for $\sigma_i = \sigma$ and $\sigma_{ij} = 0$, $i \neq j$ in the estimation of equation 5.1. First, one tests for the hypothesis of homoskedasticity, and second, one tests for a diagonal covariance matrix (that is, no cross-sectional correlation).

Two tests were conducted to check cross-sectional heteroscedasticity and cross-sectional correlation, respectively. Also results of estimations including a correction for first-order autocorrelation of residuals (AR(1)) were compared with results without the AR(1) correction to see if autocorrelation is a serious problem. The Lagrangian Multiplier (LM) test was conducted for cross-sectional heteroscedasticity. The null hypothesis of LM test is error covariance is constant, i.e., $\sigma_i = \sigma$. In Table 5.6, the hypothesis was rejected in all seven models. The test result indicated that the estimation method should incorporate the remedy of cross-sectional heteroscedasticity. The Breusch-Pegan (B-P) test was conducted for cross-sectional correlation (that is, a test for a diagonal covariance matrix). The null hypothesis for the Breusch-Pegan test is $\sigma_{ij} = 0$ when $i \neq j$. It was not rejected in all seven models. For each model, the estimation with AR(1) correction and without AR(1) were conducted and carefully compared. Their results didn't show any differences. So pooled cross-section time-series estimation, allowing cross-sectional heteroscedasticity was adopted as the estimation method. The estimations of model were achieved by using SHAZAM. In order to measure the forecasting ability of models in the next section, the data on 1998 was reserved and the data from 1990 to 1997 was used in the model estimation.

Four tables are provided for showing the result of estimation. Table 5.9 shows the regression result from the Full model when MOOH was not included. In order to see the stability of model, multiple measures of size, debt were used. For example, the estimation model at second column is ROA*=f(RD, UD, R&D, ADV, DEBT1, SIZE1, INST). The regression results were consistent across different measures in terms of sign and significance level. Most of coefficients are significant except the one for RD. The coefficients of UD, R&D, ADV are significantly different from zero at 5% significance level in all four cases. The coefficients of R&D and ADV have positive sign. The coefficient of UD has negative sign. The coefficient of SIZE is negative and significantly different from zero at 5% level for all cases. The coefficient of DEBT is negative and significantly different from zero at 5% level for two cases. The coefficient of INST is positive and significantly different from zero at 5% significance level for all four cases. Table 5.10 shows the regression result from the Full model, which has all variables as the causes of ROA*. In order to examine the stability of model, multiple measures of size, and debt were used. For example, the estimation model at second column is ROA*=f(RD, UD, R&D, ADV, MOOH,DEBT1, SIZE1, INST).

Table 5.9
Pooled Cross-Section Time Series Allowing Cross–Sectional Heteroskedasticity for the Full Model without MOOH[a]

Dependent variable =ROA*	Full Model where ROA* = f (All w/o MOOH)			
N = 1520	SIZE1, DEBT1	SIZE1, DEBT2	SIZE2, DEBT1	SIZE2, DEBT2
Variables				
CONSTANT	.0474***	.05153***	.0877***	.0901***
RD	-.0095	-.0094	-.0082	-.0083
UD	-.0205***	-.0212***	-.0201***	-.0209***
R&D	.7412***	.7448***	.7345***	.7365***
ADV	.5176***	.5140***	.5199***	.5155***
MOOH				
DEBT	-.0028***	-.0007	-.0029***	-.0007
SIZE	-.0029*	-.0035***	-.0064***	-.0066***
INST	.0002*	.0002*	.0002*	.0002*
F-value	87.92***	86.25***	90.69***	88.77***
Buse R-Square	.288	.284	.295	.290
AIC	-5.0629	-5.0602	-5.0695	-5.0664
SC	-5.0385	-5.0356	-5.0449	-5.0419
RMSE	.08171	.08173	.08216	.08225

***p<.005, ** p<.01, *p<.05.

[a] This table presents the results of four estimations on ROA*. All variables are included as regressors except MOOH. Each column is different by the measure of size, and debt. AIC and SC are criteria of "goodness-of-fit". AIC is Akaike information criterion and SC is Schwartz criterion. AIC = $\log(\mathbf{e'e}/n) + 2K/n$ and SC = $\mathrm{LOG}(\mathbf{e'e}/n) + K \log n/n$,where n is number of observations, K is number of parameters. RMSE is measuring forecasting power. Buse R-square is calculated as $1 - e'\Omega^{-1}e / (Y\text{-}DY)'\,\Omega^{-1}\,(Y\text{-}DY)$ with $D = jj'\Omega^{-1} / j'\Omega^{-1}j$ where j is an N×1 vectors of ones, Ω is a known positive definite symmetric matrix that allows for a general error covariance structure. Unlike the usual R-square, the Buse R-square is not guaranteed to be a non-decreasing function of the number of explanatory variables.

Table 5.10
Pooled Cross-Section Time Series Allowing Cross–Sectional Heteroskedasticity for the Full Model with MOOH[a]

Dependent variable =ROA*	Full Model where ROA* = f (All)			
N = 1520	SIZE1, DEBT1	SIZE1, DEBT2	SIZE2, DEBT1	SIZE2, DEBT2
Variable				
CONSTANT	.0338***	.0369***	.0759***	.0769***
RD	-.0075	-.0073	-.0058	-.0057
UD	-.0182***	-.0186***	-.0177***	-.0182***
R&D	.7182***	.7196***	.7269***	.7269***
ADV	.5091***	.5058***	.5149***	.5109***
MOOH	-.0056***	-.0058***	-.0042***	-.0045***
DEBT	-.0025***	-.0005	-.0025***	-.0005
SIZE	.0001	-.0002	-.0043***	-.0044***
INST	.0002*	.0002*	.0002*	.0002*
F-Value	80.56***	79.35***	81.78***	80.43***
Buse R-Square	.29	.29	.30	.30
AIC	-5.0682	-5.0658	-5.0726	-5.0702
SC	-5.0402	-5.0378	-5.0446	-5.0421
RMSE	.08143	.08138	.08149	.08149

***p<.005, ** p<.01, *p<.05.

[a] This table presents the results of four estimations on ROA*. All variables are included as regressors. Each column is different by the measure of size, and debt. AIC and SC are criteria of "goodness-of-fit". AIC is Akaike information criterion and SC is Schwartz criterion. AIC = log ($\mathbf{e'e}/n$) + $2K/n$ and SC = LOG ($\mathbf{e'e}/n$) + K log n/n ,where n is number of observations, K is number of parameters.
RMSE is measuring forecasting power. Buse R-square is calculated as $1 - e'\Omega^{-1}e / (Y-DY)' \Omega^{-1} (Y-DY)$ with $D = jj'\Omega^{-1} / j'\Omega^{-1}j$ where j is an N×1 vectors of ones, Ω is a known positive definite symmetric matrix that allows for a general error covariance structure. Unlike the usual R-square, the Buse R-square is not guaranteed to be a non-decreasing function of the number of explanatory variables.

The regression results were consistent across different measures in terms of sign and significance level. Most of coefficients are significant except the one for RD. The coefficients of UD, R&D, ADV, and MOOH are significantly different from zero in 5% significance level in all four cases. The coefficients of UD and MOOH have negative sign and the coefficient of R&D and ADV have positive sign. The coefficient of DEBT is negative and significantly different from zero at 5% level in two cases. The coefficient of SIZE is negative and significantly different from zero at 5% level in two cases. The coefficient of INST is positive and significantly different from zero at 5% level in three cases.

Table 5.11 shows the regression result from DAG model, which used the variables only if they were shown to directly cause ROA* from DAG. The derived model generating accounting performance based on DAG has DU, R&D, ADV, and MOOH as right hand side regressors. Referring back to Figure 5.1, one can see no "unblocked" backdoor path between one of these variables and ROA*. The derived model generating accounting performance based on the DAG when MOOH is not included has DU and R&D as right hand side regressors. In both models, the coefficients of the regressors are all significantly different from zero at a 5% significance level. DU and R&D in the DAG model without MOOH have the same signs as those in the MOOH included DAG models. The right hand side regressors in the DAG models have the same signs as those in the Full models that are presented in Table 5.10. In order to facilitate the comparison between the Full model and the DAG model, the estimated coefficients, standard errors and several criteria of model selection

Table 5.11
Pooled Cross-Section Time Series Allowing Cross–Sectional Heteroskedasticity for the DAG Model[a]

Dependent variable =ROA*	DAG Model with MOOH ROA*=f (DU,R&D,ADV,MOOH)	DAG Model without MOOH ROA*=f (DU, R&D)
N = 1520		
Variables		
CONSTANT	.0460***	.0508***
RD		
UD	-.0187***	-.0228***
R&D	.7223***	.7558***
ADV	.5006***	
MOOH	-.0063***	
DEBT1		
SIZE1		
INST		
F-Value	155.59***	200.24***
Buse R-Square	.29	.21
AIC	-5.0721	-5.0161
SC	-5.0572	-5.0093
RMSE	.08137	.8459

***p<.005, ** p<.01, *p<.05.

[a] This table presents the results of two models on ROA*. AIC and SC are criteria of "goodness-of-fit". AIC is Akaike information criterion and SC is Schwartz criterion. AIC = log ($\mathbf{e'e}/n$) + $2K/n$ and SC = LOG ($\mathbf{e'e}/n$) + K log n/n ,where n is number of observations, K is number of parameters.
RMSE is measuring forecasting power. Buse R-square is calculated as $1 – e'\Omega^{-1}e$ / $(Y\text{-}DY)'\ \Omega^{-1}\ (Y\text{-}DY)$ with $D = jj'\Omega^{-1}/\ j'\Omega^{-1}j$ where j is an N×1 vectors of ones, Ω is a known positive definite symmetric matrix that allows for a general error covariance structure. Unlike the usual R-square, the Buse R-square is not guaranteed to be a non-decreasing function of the number of explanatory variables.

are given in usual regression format. Since the model with MOOH, ROA*, SIZE1, DEBT1 was chosen as the most plausible model from Table 5.7, a comparison is focused on the Full model with SIZE1 and DEBT1. Equation 5.2 presents the Full model with SIZE1 and DEBT1 in Table 5.10 and equation 5.3 presents the DAG model with MOOH.

$$\begin{aligned} ROA^* = \; & \underset{(.0123)}{.0338} - \underset{(.0062)}{.0075}\,(RD) - \underset{(.0037)}{.0182}\,(UD) + \underset{(.0427)}{.7182}\,(R\&D) + \underset{(.0375)}{.5091}\,(ADV) \\ & - \underset{(.0014)}{.0056}\,(MOOH) - \underset{(.0008)}{.0025}\,(DEBT1) + \underset{(.0015)}{.0001}\,(SIZE1) + \underset{(.0001)}{.0002}\,(INST), \end{aligned} \quad (5.2)$$

Where F-Value=80.56, Buse R^2 = .29, AIC=-5.068, SC=-5.040.

$$ROA^* = \underset{(.004)}{.046} - \underset{(.0038)}{.0187}\,(UD) + \underset{(.0422)}{.7223}\,(R\&D) + \underset{(.0376)}{.5006}\,(ADV) - \underset{(.0012)}{.0063}\,(MOOH), \quad (5.3)$$

Where F-Value= 155.59, Buse R^2 =.29, AIC=-5.072, SC=-5.057.

The F-value is higher in the DAG model (equation 5.3) compared with the Full models (equation 5.2). The information measures, AIC and SC, both indicate that the DAG model is superior to the Full models. The signs and significance levels of four variables in the DAG model are same as the signs and significance levels of them in the Full model. They are all significantly different from zero at 5% level in both models. The coefficients of ADV and R&D have positive signs, suggesting that in general U.S. large industrial corporations could generate more returns by investing on research and development, and advertisement in 1990s. The coefficient of UD is negative, suggesting that in general U.S. large industrial corporations did not benefit from expanding their businesses to different industries in 1990s. The coefficient associated with MOOH is negative, suggesting that, in general, U.S. large industrial corporations, that expanded their subsidiary ownership hierarchy vertically, reduced accounting profits by doing so.

In the equation 5.2, DEBT and INST are significantly different from zero at 5% level, suggesting their role in generating ROA*. However, the results of DAG suggest that DEBT and INST are both effect rather than a cause of ROA* and thus they should not be included in the model representing ROA*. Among DAG models, AIC and SC indicate that the DAG model with MOOH is superior to the DAG model without MOOH.

Table 5.12 shows the models for RD and SIZE that are not included in the DAG model for generating ROA*. But they are indirectly related with ROA* and theory tells us that they are factors affecting accounting performance of industrial corporations. According to the result from the DAG, DR, SIZE have no direct effect on ROA*. They affect ROA* via other variables. In order to correctly measure the effect of DR to ROA*, and SIZE to ROA*, the adjustment problem suggested by Pearl (2000) was considered. This procedure allows us to define other variables that should be included to measure the effect of one variable to ROA*. The adjustment problem process suggested that the model for RD needed to include SIZE and the model for SIZE needed to include ADV. The estimated coefficients, standard errors, and R^2 are given in usual regression format. In these two equations, the interpretation of coefficient should be focused on RD in equation 5.4, and SIZE in equation 5.5.

Table 5.12
Estimation of Indirect Effect Using Adjustment Problem[a]

Dependent variable =ROA*	DAG Models based on "adjustment problem"	
N = 1520	RD	SIZE
Variable		
CONSTANT	.0940***	.0808***
RD	-.0005	
UD		
R&D		
ADV		.5262***
MOOH		
DEBT1		
SIZE1	-.0031*	-.0038***
INST		
Buse R-Square	0.01	0.11
F-value	2.315**	83.78***
AIC	-4.8549	-4.8970
SC	-4.8479	-4.89

***p<.005, ** p<.01, *p<.05, $^{+}$p<.10

[a] This table presents the results two estimations. Second column presents the result on measuring the effect of RD to ROA*. Third column presents the result on measuring the effect of SIZE to ROA*. AIC and SC are criteria of "goodness-of-fit". AIC is Akaike information criterion and SC is Schwartz criterion. AIC = log ($\mathbf{e'e}/n$) + $2K/n$ and SC = LOG ($\mathbf{e'e}/n$) + K log n/n ,where n is number of observations, K is number of parameters.

$$ROA^* = .094 - .0005\,(RD) - .0031\,(SIZE) \quad ; \text{Buse } R^2 = .01 \qquad (5.4)$$
$$\quad\;\; (.0127) \quad (.0071) \qquad\quad (.0015)$$

The Buse R^2 is low, and the coefficient of RD is negative but not significantly different from zero, suggesting that in general RD did not have a significant influence on ROA* in 1990s. The Full model with SIZE1 and DEBT1 from Table 5.10 provided the same interpretation on RD.

$$ROA^* = .0808 - .0038\,(SIZE) + .5262\,(ADV) \quad ; \text{Buse } R^2 = .11 \qquad (5.5)$$
$$\quad\;\; (.0116) \quad (.0013) \qquad\quad (.0417)$$

The coefficient of SIZE is negative and significantly different from zero at 5% significance level, suggesting that in general U.S. large industrial corporations got harm rather than benefit on their returns from expanding their size in 1990s. This interpretation aligns with the one about UD from equation 5.3. It is no surprising that SIZE and UD have a same impact on ROA*. In the Full model with SIZE1 and DEBT1, the coefficient of SIZE1 is positive and not significantly from zero. This is the an example of making a wrong conclusion when one does not select the model appropriately, suggesting that researchers need to have a guidance from DAG when selecting the variables in the model.

Forecasting Power

Comparisons of forecasting ability of the Full models with the DAG models, and the DAG model with MOOH and without MOOH were studies using 1998 data.

The model parameters were fit on 1990-1997 data. Out-of-sample forecasts over the period of 1998 were made for the Full model, the DAG model with MOOH and the DAG model without MOOH. Based on parameter values fit over data 1990-1997 for the Full model, the DAG model with MOOH and the DAG model without MOOH, actual 1998 values for the right- hand side variables were used to forecast 1998 values for ROA*. As criteria of "goodness", Root Mean Squared Error (RMSE) is used and the result of test is provided in Table 5.7 – 5.9. Root Mean Squared Error is $\sqrt{MSE}$ and MSE = $\frac{1}{190}\sum_{i=1}^{190}(ROA*_i - \hat{ROA}*_i)^2$. In terms of RMSE, the DAG model is superior to the Full models. When comparing the DAG model with MOOH with the DAG model without MOOH, RMSE clearly shows that the DAG model with MOOH is superior in forecasting.

It may be appropriate to use a formal test for judging which model is preferred in terms of forecasting performance. Based on the forecast encompassing described in Chapter IV, test is conducted and the results of the test are presented in Table 5.13 in probability form. The null hypothesis (λ=0) is that the forecast of accounting performance from the model in the column encompasses the forecast from the model in the row. For example, the entry .85 in the second line is the p-value that indicates forecasting accounting performance from the Full model with MOOH encompassing the forecasts from the Full model without MOOH at 0.1 significance level. The value of λ, .85, was estimated as follows: The coefficients from the Full model with MOOH, that is estimated in period: 1990-1997, is used to forecast ROA* in 1998 and forecast error, e_{1t}, is recorded. Same forecasting procedure for 1998 is made using the Full model without MOOH and forecast error e_{2t} is recorded. Then estimate the following equation: $e_{1t} = \lambda(e_{1t} - e_{2t}) + \varepsilon_t$ where ε_t is a white noise term as the composite forecast error. When the null hypothesis is true, the first forecast encompasses the second. Same procedure to acquire .85 are made except defining the forecast error from the Full model without MOOH as e_{1t} and the forecast error from the full model with MOOH as e_{2t} instead. Then the value of λ, .22, are derived. It indicates that the Full model without MOOH encompasses the Full model with MOOH. Based on the implication from the two λs, .85 and .22, finally I conclude that the Full model with MOOH and the Full model without MOOH perform equally in forecasting.

For the DAG model w/o MOOH, all other three models outperform or encompass the DAG model w/o MOOH in forecasting. The tests between the DAG model w/ MOOH and the Full model w/ MOOH showed that neither of them encompasses the other in forecasting ROA* in 1998. The tests between the DAG model w/ MOOH and the Full model w/o MOOH showed that neither of them encompasses the other in forecasting ROA* in 1998.

Table 5.13
Forecast Encompassing Test[a]

	Full w/ MOOH	Full w/o MOOH	DAG w/ MOOH	DAG w/o MOOH
Full w/ MOOH		0.22 $\lambda = 0$	0.20 $\lambda = 0$	0.00 $\lambda \neq 0$
Full w/o MOOH	0.85 $\lambda = 0$		0.46 $\lambda = 0$	0.00 $\lambda \neq 0$
DAG w/ MOOH	0.61 $\lambda = 0$	0.40 $\lambda = 0$		0.00 $\lambda \neq 0$
DAG w/o MOOH	0.94 $\lambda = 0$	0.78 $\lambda = 0$	0.94 $\lambda = 0$	

[a] First entry in one cell is the p-value of the null hypothesis that a model (in a column) encompasses another model (in a row) and second entry in one cell is the followed conclusion. For example, the first entry in the second row is 0.85, and then full model with MOOH encompasses the full model without MOOH in forecasting ROA* at a 0.10 significance level. λ is estimated from the equation : $e_{1t} = \lambda(e_{1t} - e_{2t}) + \varepsilon_t$ where e_{it} is two forecast error series and ε_t is composite forecast error.

Re-estimation Using Full Years

Finally the regressions from the Tables 5.10 – 5.12 are repeated by including 1998 to the sample period. Tables 5.14 – 5.16 present the result of regressions. And they are compared with the regressions that have sample period from 1990 to 1997. In terms of sign, magnitude, and significance level the results from the regression covering 1990 to 1998 are similar to the results from the regression covering 1990 to 1997. This is same for all three tables.

Summary

In this chapter I presented empirical results on the causal representation of accounting performance in terms of structure and strategy variables from individual firm data over the years 1990-1998. Results from TETRADII show a DAG structure that supports the structure → strategy → performance paradigm, as most causal flows identified at alternative level of significance are consistent with this flow. Regression analysis, comparing a full model with the DAG model is offered as further evidence of the DAG-model validity. Here statistical loss functions AIC and SC, support the DAG specifications over the Full models. Finally out of sample forecast of 1998 data from the models fit over 1990-1997 data, support the DAG-based models.

Table 5.14
Full Model Estimation for the Full Sample Period[a]

Dependent variable =ROA*	Full Model where ROA* = f (All)			
N = 1710	SIZE1, DEBT1	SIZE1, DEBT2	SIZE2, DEBT1	SIZE2, DEBT2
Variable				
CONSTANT	.0537***	.0543***	.0915***	.0899***
RD	-.0051	-.0047	-.0038	-.0036
UD	-.0177***	-.0181***	-.0175***	-.0178***
R&D	.7102***	.7119***	.7129***	.7141***
ADV	.4913***	.4881***	.4998***	.4965***
MOOH	-.0041***	-.0044***	-.0033***	-.0037***
DEBT	-.0021**	-.0007	-.0021***	-.0007
SIZE	.0016	-.0017	-.0052***	-.0049***
INST	.0001	.0001	.0001	.0008
F-value	75.89***	75.25***	78.16***	77.27***
Buse R-Square	.26	.26	.27	.27
AIC	-5.0635	-5.0612	-5.0666	-5.0643
SC	-5.0381	-5.0357	-5.0412	-5.0388

***p<.005, ** p<.01, *p<.05.

[a] This table presents the results of four estimations on ROA*. All variables are included as regressors. Each column is different by the measure of size, and debt. AIC and SC are criteria of "goodness-of-fit". AIC is Akaike information criterion and SC is Schwartz criterion. AIC = log (**e'e**/*n*) + 2*K*/*n* and SC = LOG (**e'e**/*n*) + *K* log *n*/*n* ,where *n* is number of observations, *K* is number of parameters.
Buse R-square is calculated as $1 - e'\Omega^{-1}e / (Y\text{-}DY)' \Omega^{-1} (Y\text{-}DY)$ with $D = jj'\Omega^{-1}/ j'\Omega^{-1}j$ where j is an N×1 vectors of ones, Ω is a known positive definite symmetric matrix that allows for a general error covariance structure. Unlike the usual R-square, the Buse R-square is not guaranteed to be a non-decreasing function of the number of explanatory variables.

Table 5.15
DAG Model Estimation for the Full Sample Period[a]

Dependent variable =ROA*	DAG Model with MOOH ROA*=f (DU,R&D,ADV,MOOH)	DAG Model without MOOH ROA*=f (DU, R&D)
N = 1710		
Variable		
CONSTANT	.0472***	.0532***
RD		
UD	-.0186***	-.0226***
R&D	.7093***	.7339***
ADV	.4859***	
MOOH	-.0055***	
DEBT1		
SIZE1		
INST		
F-value	141.52***	194.07***
Buse R-Square	.26	.19
AIC	-5.0659	-5.0184
SC	-5.0532	-5.0021

***p<.005, ** p<.01, *p<.05.

[a] This table presents the results of two models on ROA*. AIC and SC are criteria of "goodness-of-fit". AIC is Akaike information criterion and SC is Schwartz criterion. AIC = log ($\mathbf{e'e}/n$) + $2K/n$ and SC = LOG ($\mathbf{e'e}/n$) + K log n/n ,where n is number of observations, K is number of parameters. Buse R-square is calculated as $1 - e'\Omega^{-1}e$ / $(Y\text{-}DY)'\ \Omega^{-1}\ (Y\text{-}DY)$ with $D = jj'\Omega^{-1} / j'\Omega^{-1}j$ where j is an N×1 vectors of ones, Ω is a known positive definite symmetric matrix that allows for a general error covariance structure. Unlike the usual R-square, the Buse R-square is not guaranteed to be a non-decreasing function of the number of explanatory variables.

Table 5.16
Indirect Effect Estimation for the Full Sample Period[a]

Dependent variable =ROA*	DAG Model based on adjustment problem	
N = 1710 Variable	RD	SIZE
CONSTANT	.1064***	.0949***
RD	-.0006	
UD		
R&D		
ADV		.5122***
MOOH		
DEBT1		
SIZE1	-.0044*	-.0052***
INST		
F-value	5.516***	77.14***
AIC	-4.8550	-4.9001
SC	-4.8486	-4.8938

***p<.005, ** p<.01, *p<.05, $^{+}$p<.10

[a] This table presents the results of two estimations. Second column presents the result on measuring the effect of RD to ROA*. Third column presents the result on measuring the effect of SIZE to ROA*. AIC and SC are criteria of "goodness-of-fit". AIC is Akaike information criterion and SC is Schwartz criterion. AIC = log ($\mathbf{e'e}/n$) + $2K/n$ and SC = LOG ($\mathbf{e'e}/n$) + K log n/n ,where n is number of observations, K is number of parameters. Buse R-square is calculated as $1 - e'\Omega^{-1}e$ / (Y-DY)' Ω^{-1} (Y-DY) with $D = jj'\Omega^{-1}/ j'\Omega^{-1}j$ where j is an N×1 vectors of ones, Ω is a known positive definite symmetric matrix that allows for a general error covariance structure. Unlike the usual R-square, the Buse R-square is not guaranteed to be a non-decreasing function of the number of explanatory variables.

CHAPTER VI

DISCUSSION AND CONCLUSION

This chapter integrates the results reported in Chapter V with the theory outlined in Chapter II. The section below briefly reviews the research objectives and discusses the overall findings. The following section is organized by discussion of the DAG results and discussion of the regression results. Directions for future study, limitation of the study, and concluding remarks follow.

Summary of Objectives and General Discussion of Results

The objectives of this study are to define through the directed acyclic graphs the causal ordering of various strategy, structure and performance variables, to construct a causal model of corporate performance measured as return on assets, to define the relationship between the effect of multi-organizational ownership hierarchy on corporate performance, and to investigate existing predominant theories of corporate performance and their support by way of empirical analysis.

Results from the causal modeling show a DAG structure that supports the structure → strategy → performance paradigm, as most causal flows identified at alternative levels of significance are consistent with this flow. While the DAG does suggest feedback, as there are causal flows from strategy variables to structural variables, the preponderance the evidence favors the structure → strategy → performance causal chain.

Regression analysis and statistical loss functions are applied to the causal models suggested by the DAG results. Here again, the evidence favors the structure → strategy → performance model. These results are re-confirmed in tests of forecasting ability.

Discussion of DAG Results

Based on prior literature, I identified nine variables and classified each with respect to its role as a structure, strategy, or performance metric. The performance measure I focused on was relative return on assets (ROA*). Structural variables were identified as firm size (SIZE) as measured by total assets and multi-organizational ownership hierarchy (MOOH) as measured by levels of ownership in forms of subsidiary. There are six variables identified as strategy variables. They are related diversification (RD) and unrelated diversification (UD) measure by an entropy measure based on SIC codes, ownership concentration by institutional investors (INST), corporate debt (DEBT) measured by current liabilities total, and R&D intensity (R&D) and advertising intensity (ADV) measured by expenses.

Figure 5.1 provides the suggested causal flows from the DAG analysis generating ROA* with MOOH. Without imposing any prior restrictions on causal flows, the DAG shows that the majority of corporate structure and strategies are either direct or indirect causes of corporate accounting performance. Further the results generally support the structure → strategy → performance paradigm discussed in Chapter II. The DAG has ADV, MOOH, UD, and R&D as direct causes of accounting performance when it was measured as ROA*. The effect of RD, and SIZE are transferred to ROA* via the former four factors. The DAG shows that the effect of SIZE on ROA* flows through MOOH and UD. The variables R&D, MOOH and SIZE are the causes of UD. The variables RD, R&D and SIZE are the causes of MOOH. The variable DEBT is indicated as the common effect of SIZE, MOOH, and ROA*, rather than a cause of ROA*. INST is indicated as the common effect of DEBT and RD. Multi-organization ownership hierarchy (MOOH) is identified as a direct cause of ROA* and also as a mediator to transfer the effects from SIZE, RD, and R&D to ROA*.

Comparison of the DAG Model with the Full Model

I used regression analysis to contrast the model suggested by the DAG analysis with a full model of the variable, relative returns on assets (ROA*). The result of the regression of the Full model (Table 5.8) suggested that ownership concentration by institutional investors (INST) and financial pressure from debt (DEBT) played an important role in representing the accounting performance (ROA*) of U.S. large industrial corporations. Meanwhile the result of DAG analysis (Figure 5.1) suggests that INST and DEBT are effects rather than causes of corporate accounting performance. In terms of the DAG model, the variable DEBT is an ancestor rather than a descendant of ROA*, suggesting that DEBT should not be included in a model to represent ROA*. To include DEBT in the model results in suggesting that DEBT has a negative effect on ROA*, perhaps not supporting the agency theory, which proposes that debt burden acts in such a way to improve corporate performance by putting the pressure on top managers. The inclusion of DEBT in the model reduced lowered the ability of the model forecasting ROA*. Including INST in the Full model along with DEBT resulted in a positive and significant coefficient, suggesting that INST affects ROA* in the positive way, (supporting the agency theory). This is one of the example that researcher can get a wrong implication from the analysis without guidance from DAG.

The SIZE from the Full model has positive sign and insignificant. Meanwhile the estimation of effect from SIZE to ROA* at the DAG model using the "adjustment problem" has negative sign and significant. An implication from the DAG model about SIZE is that in general, most of U.S. large manufacturing, industrial corporations reached the optimal level of size before the period of 1990-1997 and any attempt to make them any bigger was harmful in 1990-1997.

Comparison of the DAG model with the Full model was conducted using goodness-of –fit measures (AIC, SC). These two measures consistently suggested that the DAG model does fit better to the data than the Full model, even though the Full model has more regressors. Out-of-sample forecasts over the period of 1998 were made for both models and compared. The criteria of goodness (RMSE) indicated that the DAG model performs better than the Full model in forecasting.

Repeating the estimation for full years including 1998 tested the stability of the DAG model. In terms of signs, magnitudes, and significance levels the results from the regression covering 1990 to 1998 were similar to the results from the regression covering 1990 to 1997. This suggests that the model generated from the DAG analysis is relatively stable in different time periods (though it was not conducted over non-overlapping data).

Direct and Indirect Causes of Corporate Performance

The application of DAG in the study concluded that research and development intensity (R&D), advertising intensity (ADV), unrelated diversification (UD), and ownership hierarchy structure (MOOH) are directed causes of corporate accounting performance (ROA*). It is further concluded that indirect causes of corporate accounting performance are corporate size (SIZE) and related diversification (RD). Following regression analysis it is demonstrated that R&D and ADV affect ROA* positively, and UD and MOOH affect ROA* negatively. The effect from SIZE on ROA* is negative. The effect of RD on ROA* is negative but not significant.

The positive influence from R&D and ADV on ROA* has been identified in several studies (Ravenscraft, 1983; Scherer, 1980; and Shepherd, 1972). Jones (1995) supports that ADV in a positive influence on ROA*. It supports the idea of how firms generate rents based on the transaction cost economics. Based on the result of the study, I conclude that R&D and advertisement played an important role in accumulating firm specific assets in U.S. large manufacturing firms in 1990s. This helped them generate large accounting profits.

According to a traditional strategic management perspective, unrelated diversification is beneficial to firms in terms of risk pooling, reduced probability of bankruptcy, and economies of internal capital markets (Perry, 1998; Hill & Hoskisson, 1987). Meanwhile unrelated diversification can be motivated by managerial efforts to make personal gains, which may result in the firm deviating from maximizing the value of its assets (an agency theory perspective). Further, the preference of managers may prevail if the internal governance mechanism fails. The measure of the internal governance mechanism used in this study is institutional investors (INST), the external governance mechanism is measured as financial pressure from debt (DEBT). The two variables do not show up as direct causes of ROA*. I interpret this as an indication that INST and DEBT failed to monitor the managers in 1990s as internal and external control mechanism. The negative effect of UD on ROA* from the regression analysis support the idea from agency theory that governance mechanism failure will lead managers to pursue their own goals. It also provides an explanation of why several large firm in U.S. failed while pursuing unrelated expansion in late 1990s.

This study suggests that expansion of multi-organizational ownership hierarchy (MOOH) is not beneficial in terms of accounting performance. As MOOH becomes deeper, the control of corporate capital structure becomes more difficult. When control of capital structure passes through increasing levels of hierarchy, the risk of loss of control increases. Meanwhile, if an ultimate parent company makes its multi-organization ownership hierarchy deeper, it can generate more free capital that would otherwise be used in acquiring the holdings. Accordingly, there may be an optimal level of MOOH for each industry or for each corporation. The result of regression analysis indicates that on average large U.S. industrial and manufacturing corporations have already reached optimal level of MOOH. Further increase in levels of MOOH hurt rather than helps their accounting performance.

Hypotheses and Supported Theories

The hypotheses of R&D, ADV, MOOH, and SIZE on the relationship with ROA* are supported by this study. The hypotheses of UD, RD, DEBT, and INST on relationship with ROA* are not supported by this study. In Chapter II, I proposed nine hypotheses in order to define the relationships among variables.

Size is hypothesized that it does not have a direct effect on corporate performance; rather size has either an indirect effect or a mediator effect on performance. From the DAG analysis, size shows its role as an indirect cause and as a mediator. Multi-organization ownership hierarchy is hypothesized that the proliferation of the ownership hierarchy is directly related to performance, because as the hierarchy is extended the executive officer loses control over lower level. Thus I expect MOOH to reduce accounting performance. DAG analysis and regression analysis indicate that MOOH affects ROA* negatively.

I hypothesized that unrelated diversification and related diversification have both direct effect, and indirect effect via debt and institutional investors on corporate accounting performance. Only UD is indicated as a direct cause of ROA*, affecting it negatively. Several previous studies have attempted to compare the performance between related diversifier with unrelated diversifier. They often conclude that related diversifier performed better than unrelated diversifier. In this study these two ratios were derived from one corporation in order to catch each strategy's effect on one firm's performance. The results of the DAG analysis in my study are consistent, as it implies U.S. large industrial corporations did not capture benefits from economies of scale, economies of scope, and vertical economies over the 1990's: SIZE affects ROA* negatively, MOOH affects ROA* negatively, UD affects ROA* negatively. The DAG analysis shows a difference between RD and UD. RD has no effect on performance and UD has negative effect on performance.

It is hypothesized in Chapter II that corporations with a high ownership concentration by institutional investors will outperform corporations with lower ownership concentration . The DAG results INST is not a cause of ROA*. Quite to the contrary, variable INST is affected by ROA* through DEBT (corporations showing good accounting performance appear to be able to attract more institutional investors).

It is hypothesized that financial pressure from high debt level results in high return on assets based on agency theory. The result from DAG and the associated regression analysis indicates that ROA* affects Debt negatively. This result aligns with the proposition that the management of firms desire flexibility and freedom from excessive restrictions often associated with debt covenants (Barton & Gordon, 1987; 1988). A corporation with a high earnings rate (ROA*) will maintain relatively low debt levels, perhaps because of its ability to finance itself from internally generated funds.

It is possible that research conducted in a different economic period may reverse the finding with respect to institutional investors and debt, and their support in agency theory. I expect monitoring effects on managers of debt and institutional investors to be stronger in a period of recession. However, during the period of continuous economic growth of the last seven years of 1990s, I expect monitoring of managers as agents of owners to be weaker than in a period of declining returns.

In this study, debt was measured by total current liability rather than long- term debt, since I posited that managers would get more pressure of bankruptcy from the change in total current liability than the change in long-term debt. Then it is reasonable to see that ROA* (corporate return) is associated with DEBT (total current liability total) in a way that increase of ROA* reduces DEBT.

I hypothesized that R&D intensity increases corporate profitability (accounting performance). The DAG and regression results show that R&D is a direct cause of ROA*, affecting it positively (Ravenscraft, 1983; Scherer, 1980; and Shepherd, 1972).

Finally, I hypothesized that advertising intensity will increase corporate profitability. The DAG and regression results show that ADV is a direct cause of ROA*, affecting it positively (Ravenscraft, 1983; Scherer, 1980; and Shepherd, 1972).

Other causal flows have been uncovered and deserve out attention as well. To facilitate discussions, I use the arrow (→) and a (+) or (−) sign to indicate the directions and sign associated with the causal effect.

SIZE (+)→ MOOH: Some theorists posit size as the major predictor of certain structural configurations (Pugh et al, 1969; Blau, 1970). Increase size may strain the managerial span of control, resulting in increased hierarchical levels and increasingly decentralized authority (Blau, 1970).

SIZE (+)→ RD, SIZE (+)→ UD: Size is correlated with both diversification strategy and structure in a way that it mediates strategy and structure (Grinyer & Yasai-Ardekani, 1981). Keats and Hitt (1988) include size as the mediator between the strategy and structure in their causal model on corporate performance. They view size having an indirect effect on performance via diversification and structure.

R&D (-)→ MOOH: I expect negative relationship between R&D and MOOH, because MOOH is a functional substitute for R&D. When corporations are growing rapidly, they are more likely to purchase than develop products and processes. The cost of purchasing a product line is less than developing their own product lines.

ADV (+)→ SIZE: Both transaction cost economist (Williamson, 1975; 1979) and advertising analyst (Jones, 1990; 1995; 1997) maintain advertisement helps firms to generate more returns. It is plausible that a firm experiencing higher returns from the investment on advertisement will be larger (in the study, corporate size is measured by total assets).

R&D (-)→UD: There appears to be a negative relationship between diversification and R&D intensity (Baysinger & Hoskisson, 1989; Hoskisson & Hitt, 1988). They viewed that diversified firms have control system that may lead managers in lower level to reduce long-term expenditures such as R&D.

RD (+)→INST: Previous studies found that related diversifiers performed better that unrelated diversifiers (Palepu, 1985; Rumelt, 1986; Varadarajan & Ramanujam, 1987). Further expansion of firm to related area with its core business would attract more institutional investors to invest.

SIZE (+)→ DEBT: The capital structure of firms varies with firm size (Bhaduri, 2002). Large firms tend to be more diversified (that is, SIZE is positively related with UD and RD) and hence, less liable to financial distress. The cost associated with financial distress decreases with firm size (Ang, Chua, & McConnell, 1982; Warner, 1977). Accordingly, one would expect large firms to be more leveraged.

Limitation of the Study and Directions for Future Study

The application of the directed graph algorithm in observational data made the assumption that the data set is a causally sufficient set of variables (that there are no omitted causes for any two or more of the variables in the study). Though I have studied more variables than previous studies, it may be that I have not studied a causal sufficient set of variables. Thus, caution is needed in application.

In order to analyze dynamic causal flows, it will be necessary to treat the same variable in different years as different variables. I did not offer such a model, but suggest that such work is worthy of study.

The partial overlap of the data period weakened the reliability of the test of the stability of the model. In order to have a formal test to check the stability of the model, it is suggested to use a new data set covering new period rather than using partially overlapping data.

Finally, there is a measurement issue on hierarchy structure (vertical financial ownership). Inclusion of a measure of horizontal as well as vertical expansion of ownership hierarchy may improve future work in this area.

Concluding Remarks

Results from causal modeling using directed acyclic graphs supports the structure → strategy → performance paradigm as predominant relational model. This model can help researchers who study manager's strategic decisions and offer professional advice to corporate managers. As theorists, Chamberlain (1968), Hammond (1990), and Pitt (1980) suggested that corporate structure leads strategy. Critical knowledge and decision making capabilities in large firms are dispersed throughout the firm rather than concentrated in top mangers. A firm's structure determines how lower-level decision makers come together to contribute their information to corporate strategic decisions from top manager. Accordingly an analysis of corporate structure is required in order to analyze how corporate strategic decisions are made and thus how they influence corporate performance. A consultant might offer informed suggestions on based on a prior suggestions of corporate organizational structure. That is to say, by way of DAG identified here, he/she should study a firm's structure in order to make informed decisions on the firm's strategies.

The study shows that most corporate strategies and characteristics that have been the focus of the research in corporate management are either direct or indirect causes of corporate accounting performance. Here I introduced the directed graph algorithm to study causality in the field of corporate management. Using several statistical criteria, I showed that the DAG model outperformed the Full model in fitting the data and forecasting. I illustrated several cases where researcher may obtain biased results without the aid of the DAG. A new variable, capturing corporate governance structure, multi-organizational ownership hierarchy, is defined and measured. I show that it is one of the direct causes of corporate profitability, along with unrelated diversification, investment on R&D, and investment on advertisement.

My study suggests that, in general good corporate performance in 1990s defined as net returns on assets, was mainly achieved by internal expansion through investment in R&D and advertisement, rather than external expansion of firms through unrelated diversification, related diversification, and expansion in multi-organizational ownership hierarchy. My study shows that investment in R&D and investment in advertisement both lead to better performance in terms of ROA. Further, my study shows that investment in advertisement leads to additional external expansion such as multi-organizational ownership hierarchy and unrelated diversification, and higher debt level. In contrast, my study shows that investment in R&D leads less external expansion through multi-organizational ownership hierarchy and unrelated diversification, and thus leads to lower debt level. High debt and aggressive external expansion are believed to be primary reasons of many of the largest corporate failures in the last few years. Corporate regulators may control the higher risk of corporate failure coming from debt and external expansion by devising mechanisms that encourage more internal innovation such as R&D and discourage more expansion by way of additional advertisement.

The result from a DAG analysis comes with certain assumptions that one must keep in mind. Causal paths identified in this study (Figure 5.1) may vanish if other variables are added to my (assumed) causally sufficient set. This conclusion puts us on weak ground with respect to edges that remain. However, the decisions on removed edges remain unchanged if we add other variables to our causally sufficient set. Yet, I am confident that this trial of finding casual relations among corporate performance, strategy, and structure variables is beneficial to the study in corporate management. This study provides a guide on how we can enhance our analyses of corporate performance. After all, A modeling exercise is an effort to simplify the world, which we want to analyze, without breaking its core nature. This study provides evidence on relationships among a set of variables which have been the focus of theoretical and empirical research on corporate performance. Observations on the variables were non-experimental. Thus, a prior rejection of a given set of variables or the prior assignment of causal flow may inappropriately mask the underlying causal flows that are present in the data.

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APPENDIX A

U.S. ULTIMATE PARENT COMPANIES USED IN THE STUDY

(n = 190)

ID	Name	Industry	SIC
1	General Motors	M6	3711
3	Exxon Mobil	P1	1311
4	Ford Motor	M6	3711
5	General Electric	E1	3641
8	AT&T	T1	4813
9	Philip Morris	T4	2111
10	Boeing	A2	3721
12	SBC Communications	T1	4813
13	Hewlett-Packard	C5	3571
14	Kroger	F1	5411
20	Compaq Computer	C5	3571
23	Procter & Gamble	S5	2841
28	Texaco	P1	1311
33	Bell Atlantic	T1	4813
34	Merck	P2	2834
35	Chevron	P1	1311
37	Motorola	N1	3674
39	Intel	S4	3674
42	E.I. du Pont de Nemours	C1	2819
43	Johnson & Johnson	P2	2844
45	Time Warner	E4	7812
52	Lockheed Martin	A2	3761
55	GTE	T1	4813
56	Dell Computer	C5	3571
57	United Technologies	A2	3724
58	BellSouth	T1	4813
61	International Paper	F4	2621
66	Walt Disney	E4	7812
76	PepsiCo	B1	2086
77	AMR	A3	4512
79	Sara Lee	C7	2251
82	Raytheon	A2	3663
83	Coca-Cola	B1	2086
84	Microsoft	C6	7372
85	Caterpillar	I1	3531
87	Xerox	C5	3861
89	Dow Chemical	C1	2821
94	UAL	A3	4512
103	TRW	M6	3714

U.S. ULTIMATE PARENT COMPANIES USED IN THE STUDY

ID	Name	Industry	SIC
106	Alcoa	M4	3353
107	Pfizer	P2	2834
108	Johnson Controls	M6	3822
115	Halliburton	E3	1629
116	Delta Air Lines	A3	4512
118	Coca-Cola Enterprises	B1	2086
121	Emerson Electric	E1	3824
123	Winn-Dixie Stores	F1	5411
124	Eastman Kodak	S2	3861
126	Phillips Petroleum	P1	2911
129	American Home Products	P2	2834
131	Dana	M6	3714
134	US West	T1	4813
135	Abbott Laboratories	P2	2834
136	Atlantic Richfield	P1	2911
138	Kimberly-Clark	F4	2676
139	Warner-Lambert	P2	2834
140	Goodyear Tire & Rubber	R2	3011
143	Lear	M6	3714
145	Weyerhaeuser	F4	2621
146	Cisco Systems	N1	3577
149	Deere	I1	3523
150	Sun Microsystems	C5	3571
151	Anheuser-Busch	B1	2081
152	Gap	S6	5651
154	Textron	A2	3721
161	Farmland Industries	F2	2013
164	Whirlpool	E1	3634
166	Office Depot	S6	5943
167	Monsanto	F2	2824
170	Eli Lilly	P2	2834
172	Gillette	M3	3421
174	Manpower	T2	7363
180	Texas Instruments	S4	3674
181	Illinois Tool Works	M3	3565
183	H.J. Heinz	C7	2033
185	Schering-Plough	P2	2834
187	Colgate-Palmolive	S5	2844
189	Paccar	M6	3713
190	Northrop Grumman	A2	3721
191	General Dynamics	A2	3731

U.S. ULTIMATE PARENT COMPANIES USED IN THE STUDY

ID	Name	Industry	SIC
192	Staples	S6	5943
196	TJX	S6	5651
203	Gateway	C5	3571
207	Bestfoods	F2	2034
208	US Airways Group	A3	4512
210	Ingersoll-Rand	I1	3562
211	Sunoco	P1	2911
213	Eaton	E1	3625
214	Solectron	S4	3672
227	PPG Industries	C1	2851
228	Crown Cork & Seal	M3	3411
235	Occidental Petroleum	M5	1311
236	Unisys	C3	3571
237	CBS	E4	4833
242	American Standard	I1	3585
243	Baxter International	M2	5047
244	Pharmacia & Upjohn	P2	2834
245	Ashland	C1	2911
246	Fort James	F4	2676
250	Kellogg	C7	2043
252	Boise Cascade	F4	5112
256	Seagate Technology	C4	3572
260	EMC	C4	3572
261	SCI Systems	S4	3672
262	Cummins Engine	I1	3519
264	Federal-Mogul	M6	3714
269	Campbell Soup	C7	2032
271	Newell Rubbermaid	M3	3951
275	Masco	M3	3432
279	General Mills	C7	2043
283	NCR	C5	3571
285	Apple Computer	C5	3571
292	Union Carbide	C1	2821
293	Owens-Illinois	B2	3221
294	3Com	N1	3577
295	ServiceMaster	D2	8741
297	VF	A4	2325
298	Automatic Data Processing	C3	8721
300	B.F. Goodrich	A2	2821
305	Mattel	T5	3942
308	Cendant	D2	7299

U.S. ULTIMATE PARENT COMPANIES USED IN THE STUDY

ID	Name	Industry	SIC
309	Ryder System	T7	7513
310	Rohm & Haas	C1	2821
312	Avon Products	S5	2844
321	Fortune Brands	M3	3432
322	Dole Food	C7	2033
324	Air Products & Chemicals	C1	2813
326	Sherwin-Williams	C1	5231
330	Quantum	C4	3572
333	Litton Industries	E1	3812
334	Corning	N1	3827
335	Reynolds Metals	M4	3334
336	InaCom	W3	5045
337	America Online	C3	7375
339	Southwest Airlines	A3	4512
341	Quaker Oats	C7	2043
342	Ralston Purina	C7	2047
346	Venator	S6	5661
347	Praxair	C1	2813
349	PPL	U1	4911
354	Pitney Bowes	C5	3579
356	Black & Decker	I1	3634
361	Meritor Automotive	M6	5013
363	Dover	I1	3559
365	Engelhard	C1	3399
368	Maytag	E1	3633
369	Thermo Electron	S2	3826
372	AK Steel Holding	M4	3312
373	Brunswick	T6	3732
375	Flowers Industries	C7	2051
376	Hasbro	T5	3944
381	Medtronic	M2	3845
382	Tandy	W3	5731
383	Nash Finch	W4	5141
384	LTV	M4	3312
385	AutoZone	S6	5531
386	FMC	C1	3533
399	Clorox	S5	2842
400	Adams Resources & Energy	E2	5172
401	McGraw-Hill	P4	2721
403	Hershey Foods	C7	2066
406	Este Lauder	S5	2844

U.S. ULTIMATE PARENT COMPANIES USED IN THE STUDY

ID	Name	Industry	SIC
407	Foster Wheeler	E3	1629
408	Cablevision Systems	T1	4841
409	Qualcomm	N1	3663
412	Bethlehem Steel	M4	3312
418	Cooper Industries	E1	3646
421	Kaufman & Broad Home	E3	1531
422	Autoliv	M6	3714
423	Mead	F4	5111
426	Leggett & Platt	F5	2515
427	Harris	A2	3812
429	Avery Dennison	C1	2672
430	Micron Technology	S4	3674
435	Longs Drug Stores	F1	5912
437	USG	B2	3275
438	Ball	M3	3411
441	U.S. Industries	M3	3432
442	Fleetwood Enterprises	M6	3716
444	Allegheny Technologies	M4	3312
451	Becton Dickinson	M2	3841
463	Amgen	P2	2834
472	Hercules	C1	2869
474	Knight-Ridder	P4	2711
476	Tribune	P4	2711
478	Danaher	M3	3423
482	Ace Hardware	W2	5072
485	Interim Services	T2	7363
493	Phelps Dodge	M4	3331
494	Arvin Industries	M6	3714

Note: The column “ID” is from the ranks in 1999 based on the revenue. The column “Industry” is based on the industry category from Fortune 500.

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