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Market structure, compensation and incentives: An empirical analysis of CEO compensation

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MARKET STRUCTURE, COMPENSATION AND INCENTIVES:
AN EMPIRICAL ANALYSIS OF CEO COMPENSATION

A Dissertation

by

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ABSTRACT

Market Structure, Compensation and Incentives:

An Empirical Analysis of CEO Compensation. (August 1991)

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The incentive contracts written between owners and managers have long been studied by economists and compensation boards. Researchers have attempted to identify the relationship between compensation, profits and sales. These efforts have produced a plethora of results. Economists have found that the relationship between sales and compensation will be a function of the structure of the market in which firms are competing. This dissertation tests the robustness of linear estimates of incentives to changes in econometric specifications, and tests the restrictions imposed. Estimates of the terms of incentive contracts based on the market structure model of executive compensation are computed and reported. The results of this research indicate that CEO compensation contracts are dynamic, and the affects of sales on compensation differs significantly across firms. In addition, the results suggest that the affects of firm performance on CEO compensation also varies across firms.

DEDICATION

This dissertation is dedicated to my wife, Scarlet, whose love and support made getting through this process bearable, and to my parents, Colin and Wendy, whose unwavering confidence in my abilities made this undertaking seem reasonable, and whose belief in individualism and markets made economics a natural field of study for me.

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TABLE OF CONTENTS

TABLE OF CONTENTS-CONTINUED

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

When two parties to a contract have divergent goals, and the principal is unable to monitor perfectly the actions of the agent, a principal-agent problem exists. For example, an owner who is unable to observe cost and demand conditions will not be able to determine whether low realized profits in any given period are the result of an adverse cost or demand shock or shirking by the manager.

The relationship between a firm manager and owner is a classic example of the principal-agent problem. The conflict of incentives arises from the fact that while both the owner's and the manager's utility functions are increasing in income, the manager's utility function is a decreasing function of effort. Further, it is generally assumed that firm profits increase with increases in the manager's effort. Under these conditions, the manager will consider only the private costs and benefits of his decisions, and choose a level of effort that balances the increase in utility resulting from higher income, with the disutility resulting from increased effort. The particular form of the principal-agent problem outlined above has received considerable attention from researchers in several

This Dissertation follows the style and format of the American Economic Review.

fields.

The incentive contracts written between the owners and managers of a firm have important implications for the performance of the firm, the pricing and production decisions of managers, and therefore the efficiency of the market in which the firm is operating. Thus, a thorough understanding of the nature of incentive contracts and their affects on behavior is crucial to our understanding of firms and markets.

Much of the empirical research in the area of management compensation has sought to identify the role of sales in determining a manager's compensation. Baumol (1959, 1967) observed the positive correlation between compensation and firm sales and suggested that managers will be concerned with both profits and sales. Empirical researchers have often obtained contradictory estimates of the affect of sales on compensation. Some researchers have found a positive relationship between compensation and changes in sales, others have found that compensation is not related to changes in sales.

The purpose of this dissertation is to analyze the terms of executive compensation contracts. In performing this analysis, several questions arise. The questions addressed are:

(1) Why have empirical estimates of the terms of incentive contracts differed so dramatically?

(2) Are there systematic differences in the terms of incentive contracts across industries?

(3) What are the implications of oligopoly theory regarding the terms of compensation contracts?

The remainder of the dissertation is organized as follows. Chapter II reviews some relevant research in the principal-agent literature, and discusses previously reported estimates of the terms of compensation contracts. Chapter III describes the data and the data sources used in the empirical analysis presented in Chapters IV and VI. Chapter IV presents and compares estimates of the relationship between compensation, and profits and sales. The estimates presented in Chapter IV include estimates based on a cross-section model, and a model that pools individual firm data according to industry boundaries.

Chapter V discusses a model of optimal incentive structures based on oligopoly theory. Chapter VI describes how the model may be modified to more closely resemble real world markets, and presents estimates of the terms of compensation contracts based on the oligopoly model of compensation.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter classifies the literature investigating executive compensation into two groups: theoretical and empirical. Section I presents a summary of relevant theoretical investigations of the principal-agent and moral hazard problems, and hypotheses about the form of compensation contracts generated by those investigations. The discussion of the empirical literature is divided into two sections. Section II A summarizes previous empirical results that lend support to the profit maximization hypothesis. Section II B discusses results that suggest management compensation is related to sales.

Principal-Agent Theory

A risk-neutral firm owner prefers that the manager of the firm undertake any project with a positive expected rate of return, net of the cost of capital. However, in making decisions related to the operations of the firm the manager will consider only the private costs and benefits of his actions. These private costs and benefits include changes in income, the manager's level of effort, and possibly the response of fellow workers to his decisions. These considerations will result in a divergence between the objectives of the owners and those of the manager. Thus, owners will attempt to write incentive contracts that motivate managers to consider the effects of their decisions on the profits of the firm and the wealth of the owner, i.e., to realign the objectives of the manager with those of the owner.

Moral hazard describes a situation in which a risk-neutral principal contracts with a risk-averse agent over the distribution of a payoff of random size that is in part determined by an action, unobservable to the principal and costly to the agent, that is to be taken by the agent. The moral hazard problem is the result of the conflict of incentives that arises in this situation. Under the conditions outlined above, if the risk-neutral owner bears all of the risk associated with the random payoff, the risk-averse agent has no incentive to take the (costly) action that increases the expected payoff. Under these conditions, the principal is not able to identify the cause of an observed outcome. Specifically, if the principal is unable to monitor effectively the agent's actions, it will be impossible to distinguish between outcomes that are the result of choices made by the agent and outcomes that are the result of events beyond the agent's control. For example, an owner may be unable to determine when low realized profits in any given period are the result of an adverse cost or demand shock, or the result of shirking by the manager. The moral hazard problem increases the complexity of the contractual relationship between owners and managers.

The discussion will now outline some research in the area of the principal-agent problem, and research specific to the area of contracting in oligopolistic industries. Classical microeconomic theory predicts that managers will be compensated only for maximizing the profits of the firm. In a perfectly competitive market, the expected long run profits of any firm deviating from strict profit maximization will be negative. Negative expected long run profits suggest that the firm will eventually exit the industry. Thus, in a perfectly competitive market only firms that maximize profits will survive in the long run. Competition in the marketplace will force all firms not maximizing profits out of business. This implies that long run equilibrium in a competitive market will be characterized by compensation contracts that are functions only of profits.

Similarly, in the case of pure monopoly, an owner can do no better than compensate his manager for maximizing firm profits. However, if the firm is operating in a market where the number of firms is greater than one, but not large enough to ensure competitive conditions, or the firm is not a pure monopoly, there may be room for discretionary behavior by owners or managers. For example, a monopolist may be able to deter entry by producing a level of output greater than the usual monopoly output level, i.e., entry limit price. If the firm is able to maintain its' monopoly position, entry limit pricing may result in long run profits that are greater than the firm's profits with entry. Thus, an owner may reward the manager for sales and profits so as to maintain a monopoly position.

Similar considerations exist in oligopoly markets where firms are interdependent. For example, in the Stackelberg theory of oligopoly a leader firm is able to affect the output decisions of its' competitors by strategically choosing its' own production level. Assuming a linear demand function and constant marginal costs of production, the strategic selection of output can result in increased profits for the lead firm at the expense of the follower firm.

Jensen and Meckling (1976) have argued that imperfect monitoring and control of a manager's actions by the owner may result in managerial self indulgence. In the course of day to day decision making, the manager of a firm has significant discretion. Since the manager is not the sole residual claimant to the firms' profit stream, the private cost to the manager of a decision is less than the full cost. For example, the manager of a firm sacrifices only a small fraction of his own income when he indulges in the purchase of a computer, company car, or lavishly furnished office at the firm's expense. These purchases will result in increased costs and decreased profits for the firm, yet these expenditures will likely have a small impact on the manager's income. The owner will ultimately bear a significantly larger fraction of the costs of these decisions than the manager, since the necessary payments will be made primarily out of profits, and not out of the manager's compensation.

A natural extension of this analysis concerns the manager's selection from among alternative investment opportunities. When choosing investments to undertake, many factors will affect a manager's decisions. The owner will be concerned only with the expected net profit of the investment, while the manager may be concerned with other factors, such as the geographic location of a real estate investment. For example, a manager may prefer a less profitable investment in Florida to another more profitable investment in North Dakota. This line of analysis suggests that as monitoring becomes more difficult, managers will have increasing opportunities to indulge in their own preferences and increase their non-pecuniary income, while the owners of the firm will pay a disproportionately large fraction of the resulting costs.

Jensen (1988) extends the arguments made by Jensen and Meckling (1976) and suggests factors that will affect the manager's choices from among the set of alternative investment opportunities when monitoring is imperfect.

Jensen follows Baumol (1967) in noting the positive relationship between firm size and managerial compensation. Jensen then suggests that managers may choose to retain earnings and undertake investments designed to increase the size of the firm, rather than pay out those funds to the owners of the firm. While certain investments may not be in the profit maximizing interests of the owners, given the apparent positive relationship between firm size and executive compensation the manager will face incentives to make these investments. In this way, managerial discretion in decision making may well result in choices that suggest sales maximizing behavior.

While the source of the discretionary behavior is similar to the model of Jensen and Meckling (1976), namely imperfect monitoring and control of the manager, Jensen makes specific predictions concerning how a manager will choose from among the available alternatives. Jensen predicts that managers will undertake investments that increase their own income, power, and prestige at the expense of owners.

Holmstrom (1979) considers the form of optimal contracts when perfect monitoring is prohibitively costly. In this model, the principal is not able to observe the agent's level of effort; however, the principal is able to observe a signal of the agent's effort. Holmstrom considers several information structures and finds that when the payoff is observed, but the realization of conditions that affect the payoff, such as costs, are not, optimal contracts will be a second-best solution. Holmstrom finds that when it is feasible the principal will make the compensation of the agent contingent on some mutually observable signal of the agent's level of effort. In the owner-manager contracting problem, appropriate signals of effort may include profits and sales. Holmstrom finds that optimal incentive contracts will result in the sharing of risk between the principal and the agent.

Holmstrom's analysis of the principal-agent problem has broad application. Holmstrom suggests that information other than the actual payoff, such as the information provided by cost accounting procedures, can increase the efficiency of risk-sharing contracts. The primary factor when choosing from among competing signals of effort is the degree of correlation between the signal and the agent's level of effort. The higher the degree of correlation, the greater will be the value of the signal.

Harris and Raviv (1979) analyze the effects of risk aversion and uncertainty on the principal-agent relationship and the resulting form of the optimal incentive contract. The authors find that when both the principal and the agent are risk neutral the optimal risk-sharing arrangement solves the moral hazard problem. Under the conditions of a risk sharing contract, the agent's payoff is dependent on both the realized value of exogenous random variables, such as demand and cost shocks, and the agents level of effort. Through the risk sharing contract, both the principal and the agent share the risk resulting from uncertainty about conditions that will affect the realized payoff.

Harris and Raviv also find that when there is no ex-post uncertainty regarding the relationship between the agent's action and the resulting payoff, "there are no gains to be derived from monitoring the agent's action when the agent is risk neutral"(p. 233). Thus, when there exists a one to one mapping between effort and outcomes, the principal need only observe outcomes to elicit optimal behavior from the agent. Again, the optimal risk sharing contract solves the moral hazard problem.

As described above, the moral hazard problem arises in the case of management compensation because of differences between the incentives of owners and managers. The goal of the owners of a firm is profit maximization. If profits are distributed to owners, the maximization of firm profits will also maximize the owners' income, or if profits are retained by the firm this will increase the value of the firm and the wealth of the owners. On the other hand, a manager will seek to maximize his utility, which is assumed to be increasing in income and decreasing in effort. Thus, owners will attempt to write incentive contracts that align the goals of managers with the goals of the owners. To summarize, when both managers and owners are risk neutral, risk sharing contracts solve the moral hazard problem by making the manager's compensation contingent on observed firm performance. Compensation contracts serve to realign the manager's incentives and solve the moral hazard problem. However, the question of how firm performance is to be measured, i.e., what the appropriate signal of firm performance is, remains unanswered.

The Empirical Literature

The following discussion describes how owners might choose to measure performance, and presents estimates of the affects of performance on compensation. While the theory of the principal-agent problem has received a great deal of attention in the literature, economists have often been frustrated in their attempts to analyze the problem empirically. For example, empirical research has often produced contradictory answers to the question of how owners structure incentive contracts written between themselves and their managers. Attempts to estimate the relationship between firm performance and managerial compensation empirically have generated wide ranging results.

Much of the empirical research in this area has been based on one of two competing hypotheses of firm behavior. The first of these hypotheses predicts that compensation contracts will be based solely on firm profits. The second of these is Baumol's (1957) sales maximization hypothesis. Baumol suggests that managers will face incentives that lead to the maximization of firm sales, or alternatively to increases in the rate of growth of firm sales. These hypotheses, as well as the results of empirical tests of each, are discussed in more detail below.

The Profit Maximization Hypothesis

Classical microeconomic theory predicts that CEO compensation will be structured to induce profit maximizing decisions by managers. Classical microeconomic theory does not consider strategic play by either managers or owners, nor does classical theory consider the costs of monitoring. Much of the research in this field has sought to identify the affects of each of these factors on incentive structures.

As discussed above, if owners are not able to perfectly monitor the managers effort, or when cost and demand shocks make monitoring more costly, then when writing compensation contracts owners will rely on a signal of a manager's effort.[1] The most common signal of effort proposed in the literature has been firm profits.

Numerous attempts have been made to estimate the relationship between the performance of a firm and the

[1]See for example the discussions of Holmstrom (1979) and Harris and Raviv (1979).

compensation of the chief executive. This research relies on various measures of firm profitability, often concentrating on the return earned by the owners of the firm's common stock or the accounting profits of the firm. Some research, such as Murphy's (1985), indicates that results obtained using either of these measures of performance do not differ qualitatively. However, the question of what the appropriate measure of firm performance is has yet to be fully resolved.

The measure of compensation most frequently used in empirical research is the sum of salary and bonus payments made to managers. Essentially, the sum of salary and bonus payments is a measure of the cash compensation paid to managers by firm owners. Other measures of compensation have included estimates of the return earned by managers resulting from stock ownership and/or the value of stock options offered to the manager. What follows is a survey of some of the research concerning firm profitability and its affect on compensation.

Jensen and Murphy (1990) analyze the relationship between firm performance and various measures of compensation. Measures of compensation used include the sum of salary and bonus, and the sum of salary, bonus, the value of restricted stock issued to the manager and fringe benefits.

The authors define the pay-performance sensitivity, b, to be "the dollar change in the CEOs wealth associated with a dollar change in the wealth of the shareholders"(p. 227). The authors claim that a higher degree of sensitivity implies that the compensation contract results in managerial incentives that are more closely aligned with the incentives of owners.

The authors identify and discuss certain data limitations. For example, proxy statements do not always specify when a bonus payment is made for performance during the year preceding the payment, or when the payment is part of a deferred compensation payment. The authors' results suggest that the firm's performance during each of the two years preceding the payment have a significant impact on the manager's compensation.

In their analysis of the effect of performance on compensation, the authors use two data sets. The first relies on data published by Forbes Magazine and includes salary and bonus payments for a sample of 2,214 CEOs. This sample covers the thirteen year period 1974-1986. The second data set is based on proxy statements and follows 154 CEOs over the period 1969-1983. This data set includes details of stock owned by CEOs, stock options granted during each period, deferred compensation, and fringe benefit payments.

The authors estimate that for every $1,000 increase in current period and lagged shareholder wealth, CEOs receive an increase in the current and the following year's salary and bonus of 2.2 cents. When measuring the change in total compensation, which includes the sum of salary and bonus payments, savings and thrift plans, and other benefits, the CEOs realized return from current and lagged performance is 3.3 cents for every $1,000 change in shareholder wealth. This translates into a present value of $0.30 per $1,000 change in shareholder wealth.[2]

While the authors report a positive relationship between performance and pay, they find that the affects of a $1,000 change in stockholder wealth on CEO compensation is asymmetric across firms. The authors divide their sample into small and large firms. Small firms are defined to be those falling into the bottom half of the sample when ranked by market value. Large firms are those in the top half of the ranked sample. When including the present value of changes in compensation and the value of stock options for managers of "small" firms, Jensen and Murphy estimate that CEOs receive a $0.90 cent change in compensation for every $1,000 change in stockholder wealth. In contrast, the authors estimate that managers of large firms receive increases in compensation of $0.40 per $1,000 increase in stockholder wealth. In addition, the authors find that the

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[2]In calculating present values, Jensen and Murphy assume that the CEO continues to receive the salary and bonus increment until the age of 70, and a real interest rate of 3%.

change in the value of the stock owned by a CEO of a small firm with median stock holdings is $4.90 for every $1,000 change in the value of outstanding common stock. The value of stock owned by managers of large firms with median stock holdings changes by $1.40 for every $1,000 change in the value of common stock. Thus, the total change in CEO wealth for every $1,000 change in stockholder wealth is estimated to be $3.25 over the entire sample, $1.85 for managers of large firms, and $8.05 for managers of small firms. According to these results, managers of relatively small firms have compensation more closely tied to firm performance than do managers of relatively large firms.

The authors contend that although they find a positive relationship between pay and performance, the strength of that relationship is not sufficient to solve the principal-agent problem. Furthermore, they cite evidence that suggests the affect of performance on pay has been declining since the 1930's. To explain this apparently small and declining degree of dependence of pay on performance, the authors argue that external forces not captured by the data may be imposing discipline on managers.

According to Jensen and Murphy, potential sources of discipline include competition in the product and managerial labor markets. The authors suggest that the threat of bankruptcy or takeover, and competition among managers may serve to discipline managers, decreasing the need for an internal solution to the principal-agent problem. The authors also consider the effects of political forces such as public sentiment, industry regulators, and the press on compensation payments. They argue that these forces may be imposing some form of implicit regulation in the market for managers.

In summary, Jensen and Murphy conclude that management compensation is dependent on firm performance. The authors estimate that on average CEO wealth will increase by $3.25 for every $1,000 increase in shareholder wealth. However, they argue that the degree of dependence of pay on performance is not sufficient to solve the principal-agent problem.

To analyze the relationship between profits and pay, Murphy (1985) gathered data covering the eighteen year period of 1964-1981. Murphy analyzes the relationship between firm performance and executive compensation for specific managers. Murphy's sample includes 461 executives and seventy two firms. Firms and their managers were included in the sample only if at least three executives appeared on the firm's proxy statements for a minimum of five years. The final data set includes 4,500 executive years of observations.

Murphy defines firm performance to be the rate of return realized by the firm's common stock owners. Murphy points out that managers typically hold large fractions of their wealth in the form of stock issued by the firm that they manage. Murphy also notes the apparent positive relationship between firm profits and stock price movements. In light of this, he contends that even if no direct link between firm performance and cash compensation is found, the manager's ownership interest implies that the wealth of managers is at least indirectly linked to firm performance.

Murphy contends that managerial compensation will depend on the ability of managers, the size of the firm in question, and past firm performance. Murphy asserts that if the effects of these variables on compensation are not constant across firms, results based on cross section data will suffer from an omitted variable bias. Murphy argues further that if these variables are constant across time for a given manager, then by analyzing time series data for specific executives the relationship between performance and pay can be assessed correctly. For these reasons, Murphy estimates the performance-pay relationship for specific executives using panel data.

The measures of compensation used by Murphy include salary, salary plus bonus, deferred compensation payments, the ex ante value of stock options, and total compensation. Total compensation is defined to be equal to the sum of the salary, bonus, deferred compensation, the ex ante value of stock options, and the value of fringe benefits and savings plans. Murphy ignores the effects of taxation on compensation and includes estimates of changes in income resulting from both promotion and firm performance.

The results obtained by Murphy indicate a positive relationship between the firm's stock price performance and managerial compensation. In contrast, simple cross section results indicate an inverse relationship between compensation and stock price performance. Murphy suggests that this inverse relationship is the result of differences in compensation due to variation in firm size. Murphy contends that many of the conflicting results reported by previous authors are due to the data set and estimation techniques employed, rather than indicative of incentives created by compensation contracts.

Murphy observes that owners of large firms are likely to pay their managers more than are owners of small firms, regardless of the relative performance of the firms. He argues that these differences in pay are the result of differences in the level of effort and human capital required to manage large firms as compared to small firms. According to Murphy, cross-section regressions fail to capture this relationship between scale and compensation; therefore, cross-section regressions will result in biased estimates of contract parameters.

Murphy finds that managers' salaries, bonuses, and deferred compensation payments are all positively and significantly affected by stock price performance. He argues that the variable with the greatest power to explain changes in salary plus bonus and total compensation is the return earned by the firm's common shareholders. Murphy also finds that bonuses and deferred compensation are more strongly affected by industry relative rates of return than by raw stock returns. Specifically, Murphy reports that a 10% raw stock return results in an increase in total compensation of 2.1%. Murphy finds that a 10% increase in the value of a firm's common stock will result in a .7% increase in salary, a 14% increase in bonus, and a 4.9% increase in deferred compensation. Finally, Murphy reports that the growth of firm sales is positively and significantly related to executive compensation, and estimates that a 10% increase in sales results in a 2% increase in compensation.

Thus, Murphy finds evidence to suggest that changes in the price of a firm's common stock is the best predictor of changes in executive compensation. Finally, Murphy finds some evidence of a positive relationship between the growth of firm sales and executive compensation.

Gibbons and Murphy (1989) develop a model to test the relative performance evaluation (RPE) hypothesis. Under the terms of a relative performance evaluation contract, a manager's compensation payment is dependent on the performance of the managed firm in comparison to the performance of other firms in the industry, or more generally, the performance of other firms in the economy. These contracts are designed to reduce changes in compensation resulting from changes in conditions that are beyond the manager's control.

The actual return earned by a firm's stockholders in any given period is a function of a host of variables ranging from changing consumer preferences to the weather, economic forecasts, and investor confidence. By including the information obtained by cross-firm comparisons, relative performance evaluation contracts are able to reduce the uncertainty inherent in a compensation contract. To the extent that performance is affected by industry wide shocks, this reliance on the firm's relative performance will result in a reduction in the risk associated with a performance contingent compensation payment; however, shocks that are firm specific will continue to affect measured performance and the manager's compensation.

To test for the presence of RPE contracts, the authors construct a panel data set including information pertaining to compensation and dismissal decisions for a group of 1,655 executives over the period of 1974-1986. The authors test for the presence of RPE contracts using only the cash component of the manager's compensation. They argue that cash payments are part of the contractual arrangement while factors such as stock ownership are not. By including only cash payments in the compensation measure, the authors claim these non-contractual components of the manager's compensation are filtered out.

In contrast to the results obtained by previous authors, such as Antle and Smith (1986), Gibbons and Murphy find empirical evidence to suggest that RPE compensation contracts play an important role in both compensation and dismissal policies. Much of the discrepancy between the current findings and previous research appears to be the result of econometric technique. The authors employ comparatively sophisticated panel data techniques to analyze a relatively large data set.

The authors find that CEOs are positively compensated for increases in shareholder wealth and find compensation to be adversely affected by performance that is poorer than the reference groups. For example, when both industry and firm stock returns are zero, the authors estimate managers receive pay increases of 5.6%, while they receive pay increases of 9.1% when their firm's return is 20% and the industry return is zero. In addition, the authors find the probability of dismissal to be inversely related to changes in shareholder wealth and positively related to poor relative performance.

The authors find evidence to suggest that at least a portion of CEO compensation, the cash component, is insulated from random market movements; however, a significant portion of the managers wealth remains vulnerable to market shocks. The value of a firm's common stock is directly related to stock price movements. Thus, the portion of the managers wealth and income that is dependent on the market price of the firms stock remains exposed to random stock price changes.

Baker, Jensen, and Murphy (1988) offer a review of incentive structures observed in the labor market. These structures include promotion based incentives, pay for performance, and piece rate pay. The authors argue that many observed compensation schemes have little to do with observed firm performance and these compensation schemes are unable to solve the principal-agent problem described above.

Classical microeconomic theory has little to say about many of the compensation arrangements observed in large organizations. Microeconomic theory predicts that, ceteris paribus, there will be a positive relationship between observed firm performance and increased levels of managerial effort; therefore, owners will structure incentive contracts so as to induce managers to supply this effort. The authors repeat a claim made by observers in the popular press, that there is little apparent use of pay for performance plans in U.S. corporations. The authors offer the following explanations for this apparent absence of pay for performance:

(1) Merit pay, i.e., pay for performance, induces people to focus on narrowly defined tasks, take few risks, and

introduce few innovations, which in turn negatively impacts the firm's long run profitability.

(2) Consideration of "horizontal equity" and imperfect performance measurement limit the usefulness of merit pay systems.

(3) Merit pay systems may be too effective. "Large monetary incentives generate unintended and sometimes counterproductive results because it is difficult to adequately specify exactly what people should do and therefore how their performance should be measured"(p 597).

Performance based compensation structures must identify the variables to which compensation is to be tied. Both objective and subjective systems have inherent problems. Bonuses tied to objective measures of performance result in systems that are difficult to change, since change is inevitably detrimental to some workers. Additionally, these systems may be harmful to the firm. For example, compensation tied to accounting profits may result in the sacrifice of long run profits for short run earnings, while compensation that is tied to piece-rate schedules may result in reduced quality.

Finally, specifying the variables to which compensation is to be tied is often difficult, if not impossible. For example, tieing pay to long run profits requires that a definition of "profits" (accounting, economic or relative) and the "long run" be specified. Attempts to specify quality or quantity variables in a contract will generate uncertainties of their own, particularly when a productive process is dependent on the performance of more than one worker or manager. When production occurs in a team environment, it is often difficult to monitor the actions and effort of each team member; therefore, incentives to shirk remain and the difficulties associated with performance based compensation increase.

The administration of subjective evaluations results in additional complications. Subjective evaluation systems often generate conflicts between supervisors and workers. In turn, supervisors are unlikely to exert the effort necessary to perform accurate evaluations, unless the supervisor's compensation is significantly affected by the accuracy of their evaluation of workers. This problem is also discussed in relation to CEO compensation.

CEO compensation is most often determined by the board's compensation committee. The members of this committee typically own a relatively insignificant percentage of the firm's outstanding stock. Since committee members receive little benefit from performing detailed evaluations of a CEO's performance, they are unlikely to invest high levels of effort in their evaluations of the CEO.

Baker, Jensen, and Murphy suggest that as firm owners have sought to avoid the apparent problems of merit pay systems they have turned to promotion based incentive programs. The authors contend that the strong positive affect of promotion on compensation is in fact a method by which owners are able to reward performance, while maintaining horizontal pay equity. The authors also point out that bonus based incentives are likely be more important in the higher levels of an organization, since the potential for promotion becomes more limited. For example, the CEO of a firm has limited promotion potential. The CEO has reached the top of the promotion ladder; therefore, empirical research is likely to find that performance contingent pay is a more important factor in top level than in lower level management positions.

Next, the authors describe market forces that appear to be creating new forms of performance contingent compensation. Their discussion of leveraged buyouts suggests that the post buyout structure of the firm has the effect of creating a strong direct relationship between the management teams wealth and firm performance. To support this claim, the authors point to the typically large fraction of the post buyout firm owned by the management team. In addition, examples of firm restructurings that have resulted in a closer alignment of owner-manager interests are discussed. Thus, the authors argue that while many firms appear to have compensation packages that are largely independent of performance, a return to performance based compensation has accompanied much of the leveraged buyout activity and corporate restructurings of the past several years.

Finally, the authors note the apparent positive relationship between firm size and executive compensation. The authors report the findings of Murphy (1985) and the compensation-sales elasticities reported by *The Conference Board* (1985) of approximately .3, indicating that sales and the growth of sales are important determinants of executive compensation. The authors go on to argue that these results are supportive of Baumol's (1959) sales maximization hypothesis.

As is evident from the results presented above, attempts to estimate the relationship between profits and compensation have often revealed that variation in firm profits alone is incapable of explaining all of the observed variation in compensation. Apparently, other factors also affect compensation payments. The factor most often considered in this context is sales. The following section presents results of research designed to estimate the relationship between sales and compensation.

The Revenue Maximization Hypothesis

Classical microeconomic theory implies that managers will be compensated only for increasing the profits of a firm, i.e., for increasing shareholder wealth. However, much of the research in the area of compensation has been stimulated by what is known as the Baumol hypothesis.

The Baumol hypothesis concerns the objectives of managers and owners. The two objectives discussed by Baumol are the maximization of profits and sales. In the original version of the model, Baumol (1959) argues that firm managers and owners are concerned with both the profits and sales of the firm. Baumol contends that conditions in credit markets, and the perception of the firm held by customers, distributors, and employees improve as the size of the firm increases. Baumol argues that these factors create incentives for both managers and owners to maximize the size of the firm, i.e., sales. In a revised version of the model, Baumol (1967) observed that "maximization of the rate of growth of sales revenue seems a somewhat better approximation to the goals of many management groups in large firms"(p. 96).

When analyzing compensation empirically, researchers have often controlled for the scale of the firm and concentrated on the rate of growth of sales in an attempt to identify the hypothesized positive relationship between sales growth rates and compensation. Permitting the intercept to vary across firms is intended to capture the relationship between the size of the firm and the level of effort and human capital required to effectively manage it. In this way, scale may be used as a proxy for the scope and complexity of the manager's position. Baumol argues that there is a positive relationship between sales growth and compensation that is independent of scale effects. If the nature of the relationship between sales growth and compensation is constant across firms, this technique will facilitate unbiased estimation of regression coefficients by allowing the intercept to vary across firms.

Other researchers have suggested that once a firm has achieved some minimum level of profitability, the manager is free to indulge in activities that maximize his utility, rather than the utility of the firm's owner.[3] Given the observed positive relationship between scale and compensation, this is often interpreted to imply that managers will strive to maximize the size of the firm, since this will lead to increased income, prestige, and power. These researchers suggest that managers face incentives to maximize sales that are independent of the incentives created by the manager's compensation contract.

In response to the suggestions of Baumol and others, empirical researchers have sought to analyze the relationship between sales and compensation. The specific form of the hypothesis to be tested varies from author to author. A brief review of some empirical research designed to investigate the relationship between sales and compensation follows.

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[3] See for example, the work of Jensen (1988), and Jensen and Meckling (1976).

Lewellen and Huntsman (1970) used cross section data when testing the original version of Baumol's revenue maximization hypothesis. The authors collected data at three year intervals from 1942-63. The data set includes representatives of industries as heterogeneous as dairy products, steel, and aviation. The data set includes a total of fifty manufacturing firms. Essentially, the data set is comprised of a series of cross-section samples. The authors use this data to run cross-section regressions for each sample period.

The authors report results from a total of four different regression runs. In the first specification, the independent variables used include reported after tax accounting profits and the dollar value of sales. In the second specification, the list of independent variables includes the market value of outstanding common stock and the dollar value of sales. Each of these equations was run against two different measures of managerial compensation. The first measure of compensation includes only cash compensation payments, salary plus bonus. The second compensation measure includes the sum of salary and bonus and a measure of the value of deferred compensation. To correct for the problem of heteroskedasticity of the residuals, all variables in each of the four regressions were deflated by the firms' asset value.

Each of these regression equations was estimated for eight time periods. In all but two cases (of thirty two total regressions), the estimated coefficients for the profit measures were statistically significant; however, the authors report that the sales coefficient is not statistically different from zero in any of the estimated regressions. Thus, the authors find no evidence to support the hypothesis that managers are paid to maximize firm sales.

In effect, the estimation procedure used by Lewellen and Huntsman treats each firm identically and ignores the potential gain in information available through the use of panel data. Since the regressions rely on data for a single year and the sample crosses industry boundaries, the regressions are not able to take advantage of potentially important firm and industry specific regularities in compensation structures. If any firm or industry specific variables are present, such as an unusually productive manager or a large or small number of competitors, the results of the regression will suffer from an omitted variable bias.

Additionally, as noted by Kuh (1963), "cross-sections typically will reflect long run adjustments whereas annual time series will tend to reflect shorter run reactions"(p. 182). This argument rests on the assumption that, on average, firms are operating in equilibrium. Given this observation, it is not surprising that cross-section estimation of contract parameters suggests that these contracts are functions only of profits. Given their results, the Lewellen and Huntsman reject the simple form of the Baumol hypothesis; however, the results must be considered to be conditional given the nature of the data and econometric methods used.

McGuire, Chiu, and Elbing (1962) also test Baumol's revenue maximization hypothesis. The authors construct a panel data set covering the seven year period of 1953-1959. The data collected includes executive compensation, sales, and profits for forty five of the largest industrial firms in the U.S. Again, the data set includes firms from a variety of industries. Although the authors recognize a potential bias resulting from the inclusion of only the largest firms in the U.S., they claim that a "careful analysis of the figures does not reveal such a bias."

The compensation data includes only the CEO position. When the CEO was granted stock as part of the compensation package, the authors computed the market value of the stock using the closing stock price on December 31 of the year in which the stock was granted. Independent variables used in the regressions include sales revenues and accounting profits. The authors find that executive incomes are most strongly affected by sales and argue that the direction of causation appears to run from sales to income. The authors concede that there may be additional variables affecting executive incomes, reporting that "the tests employed do not completely rule out the possibility of a valid relationship between profits and executive incomes too"(p. 760). Thus, the authors of this study find evidence to support Baumol's sales maximization hypothesis.

Winn and Shoenhair (1988) observe that some earlier work has failed to separate the effects of the scale firm operations from the effects of the growth rate of sales. In this article, the authors analyze the effects of scale and growth rates of both profits and sales on management compensation. The data set includes more than 200 manufacturing firms and covers the period from 1968-1981.

The data used is gathered from the Compustat tapes and Forbes Magazine's annual survey of CEO compensation. To test the effects of measured growth rates the authors break the data set into three equal time periods, each covering five years (1968-73, 1972-77, 1976-81). There are 241, 222 and 213 firms in each of the respective samples.

The authors do not attempt to measure non-pecuniary incentives such as power and prestige. The authors concentrate on the incentives created by the board through the compensation contract. Therefore, the analysis focuses on cash payments, and ignores the effects of stock ownership. The authors argue that their results, which indicate boards create dis-incentives for revenue growth, may actually be interpreted as supportive of Baumol's hypothesis. The authors contend that the board will penalize managers for sales growth only if managers face external incentives associated with revenue growth.

The authors point out that salaries of newly hired CEOs are not likely to be affected by the performance of the firm prior to their hiring. For this reason, the study treats firms with newly hired CEOs as a control group. While this may be a valid assumption when considering CEOs hired from outside the firm, it is not clear that past performance will not affect the compensation payment for a manager who has been promoted from within the firm. Therefore, some managers in the control group may have compensation affected by past performance.

The reported coefficient estimates indicate that for firms with veteran CEOs, compensation is positively related to the growth rate of profits. Estimates of the effects of the profit growth rate on compensation are significantly greater than the effects of changes in profits reported by Jensen and Murphy (1990). The authors also find that prior firm performance has no significant influence on the compensation of newly hired CEOs. The results obtained by Winn and Shoenhair suggest that managers are rewarded for profits, and penalized for increases in the growth rate of sales.

Lackman and Craycraft (1974) use data gathered from firms in the corrugated specialties industry to compare market outcomes with those predicted by several oligopoly theories. The models tested include an unconstrained revenue maximization model, revenue maximization subject to a minimum profit constraint, and a joint profit maximization model.

In this paper, the authors estimate demand and cost conditions and predict the output, price, and profits for each firm using each of the three models outlined above. The authors then compare the predicted outcomes with the observed results of each firm. The authors use interview data to estimate the demand facing each firm in the industry and reported cost data for individual firms to estimate a cost curve for each firm in the sample.

The results indicate the model that best fits the data for the industry is Baumol's constrained revenue maximization model. Using this model, Baumol argues that after achieving some minimum profit level managers are free to maximize the firm's revenues. While this model does not perfectly predict the results observed in the market, the authors find that this model performs better in predicting the behavior of the firms than either of the other models tested.

This research is the only existing published work that examines the effects of industry specific characteristics on management behavior. The results are industry specific and rely on a relatively small sample; however, the authors find support for Baumol's model. There is only an indirect link between the work of Lackman and Craycraft and research in the area of executive compensation. The authors do not analyze the incentives created by the compensation contract; therefore, the only link between this work and executive compensation will be the result of the effects scale on compensation payments.

As in the review of research testing the profit maximization hypothesis, research activity analyzing the sales maximization hypothesis has produced contradictory estimates of compensation contract parameters. Thus, the question concerning the form of incentives created by compensation contracts remains unanswered.

Summary

The results discussed above differ dramatically from paper to paper. Murphy has participated in published research with no less than three related, yet distinctly different, results. Jensen and Murphy (1990) find a weak link between performance, however measured, and compensation, arguing that the degree of dependence is insufficient to solve the moral hazard problem, and turn to external forces to explain the result. Gibbons and Murphy (1989) find that managers are compensated according to their firm's relative performance. Baker, Jensen and Murphy (1988) argue that the revenue maximization model best explains changes in compensation, as predicted by Baumol (1959, 1967). Finally, Murphy (1985) finds that stock price movements are the best predictor of compensation. Other authors have also been stymied in their efforts to find agreement about the terms of compensation. Lewellen and Huntsman (1970) find that profits influence compensation payments, while sales have no impact on payments. Winn and Shoenhair (1988) report that CEO compensation is positively related to scale and profit growth rates, and negatively related to sales growth rates.

The results reported by Murphy (1985), Lewellen and Huntsman (1970), and Winn and Shoenhair (1988) may all be interpreted to provide support for the predictions of classical microeconomic theory, and the predictions of the principal-agent literature. Microeconomic theory predicts that managers will be paid for increasing the wealth of owners, i.e., profits. The principal-agent literature predicts that compensation payments will be functions of observable signals of effort. Combining each of these predictions suggests that compensation payments will be contingent on an indicator of the manager's effort that is related to the wealth of the owner. Stock price movements fit the bill.

Support for at least three theories of compensation may be found in the work reviewed above:

(1) Baumol's sales maximization hypothesis.

(2) The predictions of the principal-agent literature.

(3) The relative performance evaluation hypothesis.

The challenge for both theorists and empiricists is to identify the cause of the discrepancies in the reported estimates of contract parameters, and to develop a model that is able to explain and predict how executive compensation is determined.

Finally, given the empirical nature of much of this research a discussion of the data is appropriate. The data sources used most often by researchers in this field are the Forbes 500s and the Compustat tapes. The data sets used typically include a relatively small number of firms and/or time periods. Because of the data sources relied upon, firms included in the samples are among the largest in the industry studied, if not among the largest in the U.S. economy; therefore, the data sets often contain a possible selection bias.

As noted by Murphy, large firms are likely to pay higher than average salaries for reasons other than the maximization of sales revenue. While many authors realize the selection bias inherent in data sets that contain only large firms, very few authors address this issue directly. Therefore, it is unclear whether the diversity of the results reported by these authors is a result of differences in the underlying structure of executive compensation or a result of differences in the characteristics of industries represented in the data sets used to estimate incentive structures.

CHAPTER III

DATA SOURCES AND SUMMARY STATISTICS

Sound empirical research requires as a prerequisite a minimum of three characteristics. The first of these is a well defined theory underlying the hypotheses to be tested. The second is a reliable data set that is sufficiently large and rich to permit testing of the hypotheses resulting from the theory. Finally, the econometric methods employed must be able to overcome the statistical problems inherent in the data. The purpose of this chapter is to describe the data that is used in Chapters IV and VI to estimate terms of CEO compensation contracts, and to identify the sources from which the data was obtained.

Data Sources and Description

The primary data sources for this project are the Forbes 500s, published annually by Forbes Magazine, and the annual Forbes compensation surveys. For approximately twenty years, Forbes has been gathering compensation and financial data from the largest U.S. corporations. The Forbes 500s contain listings of the 500 largest firms in the United States, ranked according to sales, asset value, profits, and market value. While each of the four 500s is based on separate criteria, there is considerable overlap in each of the rankings.

In addition to the financial data contained in the 500s, Forbes publishes an annual survey of executive compensation. The compensation survey includes compensation payments made to the CEO of each firm included in one or more of the Forbes 500s. The sources used by Forbes include annual financial reports and proxy statements filed with the Securities and Exchange Commission by each firm. The data reported includes accounting profits, costs, asset value, cash flow, and sales.

In addition to the large quantity of data available through Forbes, the use of the Forbes data facilitates comparison of results presented in later sections with the results of prior research in this area. Several other authors have relied on the Forbes data in their research; therefore, a direct comparison of results will be possible.

The figures included in the sample are the accounting profits, sales, costs, cash flow, asset value, and compensation data for each firm. Since the financial data are the same as those included in the firm's annual reports to shareholders, the reported figures will include distortions resulting from differences in the accounting methods chosen by different firms, tax structures, the effects of inflation, and other issues not directly under the firms' control.

A brief description of the data contained in the sample follows. Profit is the excess of revenues over expenses.

Net cash flow is the difference between the cash generated by the firm and the cash used in the operation of the firm. Sales are the dollar revenues resulting from the sale of goods and services. Asset value represents the historical cost of acquiring the assets owned by the firm, less depreciation.

The compensation figures reported by Forbes are referred to as salary plus bonus over the period 1979-1989. From 1971-1978 this figure is called total compensation. While the term used by Forbes to refer to the sum of salary and bonus payments changed between the two periods, the definition of these two terms is consistent, with one exception. During several years, Forbes included deferred compensation payments in the salary plus bonus figure. While this change occurred during the sample period, analysis of the data does not reveal significant differences in the reported figures from year to year.

In the majority of the years included in the sample, the salary plus bonus figure includes all forms of cash compensation paid to the CEO during the sample year, independent of when the compensation award was specified. This data was originally reported to the SEC in corporate proxy statements. The reported figure includes all salary, bonuses, commissions, directors fees, and during most years, deferred compensation payments made during the sample year. In effect, salary plus bonus represents the sum of all forms of cash payments made by the firm to the CEO during the previous year with the exception of stock dividend payments. Since the compensation figure includes deferred compensation, during any given year the reported compensation figure may include cash payments made as a result of firm performance during prior years.

All of the data included in the sample are reported in nominal dollars. The Consumer Price Index is used to convert the nominal data to 1983 constant dollars.

There are two omissions from the compensation figures. Each of these omissions is discussed below.[4] The first of these is non-cash compensation.

Compensation could properly be defined to include all fringe benefits, such as the use of a company car, recreation facilities, and payments for things such as health insurance and retirement fund contributions. These forms of non-cash payments can add significantly to the real income of corporate executives. Since factors add to both the executive's income and the cost to the firm of employing the CEO, including the value of these payments in the measure of executive compensation would more accurately capture the true value of the compensation package; however, difficulties arise when attempting to place a value on these forms of compensation. Often when it is possible to place

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[4]Formally, it is therefore assumed that optimal contracts are separable into alternate components.

a market value on the good or service, it is virtually impossible to determine how much of the good or service a particular executive or his family consumed.

Secondly, the reported compensation figure ignores the effects of stock ownership on a manager's behavior and incentive. For many executives, stock issued by the managed firm and owned by themselves or by family members represents a significant portion of their family's wealth; therefore, changes in stock prices will impact wealth. Also, the value of stock options depends on the stock price fixed by the option offer, and the future market price of the company's stock. Since the price of a firm's stock is in part dependent on the performance of the firm, the value of the stock option will be dependent on firm performance. In addition, the terms and conditions of stock options vary dramatically between firms, and for a given firm or manager the terms of option offers often change from year to year. Because of these differences, even when it is possible to identify when an option is granted to a CEO and identify the number of shares involved, it is not always possible to accurately estimate the value of the option. Because of the dependence of the value of a stock option on stock price performance, the expected effect of a particular investment or executive decision on stock prices will affect the behavior of CEOs. These factors will result in incentives not captured by the data.

While it is difficult to place a value on the stock owned by managers, Forbes reports that the median value of the sum of fringe benefits and stock gains for managers included in their 1988 sample was $203,000. Forbes reports that in 1988 the median salary plus bonus earned by CEOs was $682,000. While it is evident that stock ownership and fringe benefits are an important aspect of compensation, the salary plus bonus measure is by far the largest component of compensation for a CEO with median earnings. So far as an executive's cash compensation is determined by firm performance, the data included in the sample is sufficient to estimate incentives created by compensation contracts.

To be included in the sample a firm must appear in one or more of Forbes annual surveys throughout the sample period, and the compensation earned by the CEO must be included in Forbes compensation survey. The sample covers the period 1970-1988, inclusive. There is a one year lag between publication dates and the reported financial data for each firm. Thus, for each firm in the sample a nineteen year time series has been gathered.

During the nineteen year period covered by the sample, several firms underwent name changes. Wherever possible these name changes did not result in the firm being dropped from the sample. The final sample includes 234 firms in fifty industries, for a total of 4,446 firm years of observations.

Industries are defined according to four digit Standard Industrial Classification (SIC) codes. Firms were classified as being in a particular industry according to their SIC classification as of 1984. While firms occasionally change their primary line of business, which results in a change in their SIC classification, this is a relatively rare occurrence and for the purposes of this study those changes have been ignored. The number of firms in each industry ranges from two to twenty.

By using the four digit SIC codes to define industries, the data set risks separating competing firms, and grouping together firms that in reality are not competitors. Perhaps the most obvious example of this is the separation of state and federally chartered banks, SIC numbers 6022 and 6025. Although these considerations suggest that SIC codes will not provide a perfect method for establishing industry classifications, these codes are often used for making such distinctions, and provide the best available means for doing so. A complete listing of firms included in the final sample, and the industries to which they were assigned, may be found in Appendix 1.[5]

Statistical Summary

In the statistical description that follows, all

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[5]Appendix 1 also includes the industry numbers (1-50) used to identify industries throughout the remainder of the dissertation.

nominal data have been converted to constant dollars using the Consumer Price Index with 1983 as the base year. The CPI may be found in the *Survey of Current Business* published by the U.S. Department of Commerce.

The mean annual cash compensation for all CEOs included in the sample is $579,429. The standard deviation of compensation for the entire sample is $307,114. These figures alone suggest significant differences exist between the level of compensation across firms. Among the industries included in the sample the Motor Vehicle industry, SIC 3711, pays executives the highest cash compensation, with an average annual payment of $1,051,540. In contrast, the chief executives of firms in the Electric and Other Service industry, SIC 4931, receive the lowest annual average income, $273,969. Figure 1 shows the distribution of compensation payments for the entire data set. Figures 2 and 3 show the mean compensation by industry, and the standard deviation of mean compensation payments for each industry.

One explanation of the variance in compensation across firms and industries relies on differences in the scale of operations between firms. To continue the example begun above, firms in the Motor Vehicle industry earn average annual revenues of almost forty billion dollars, while firms in the Electric and Other Service industry earn average annual revenues of only two million dollars. It is argued

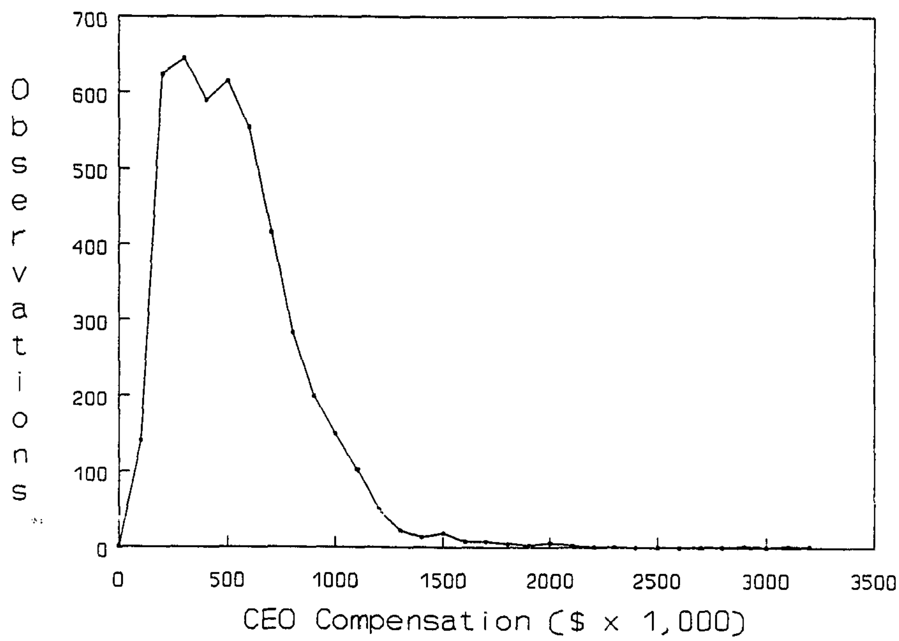
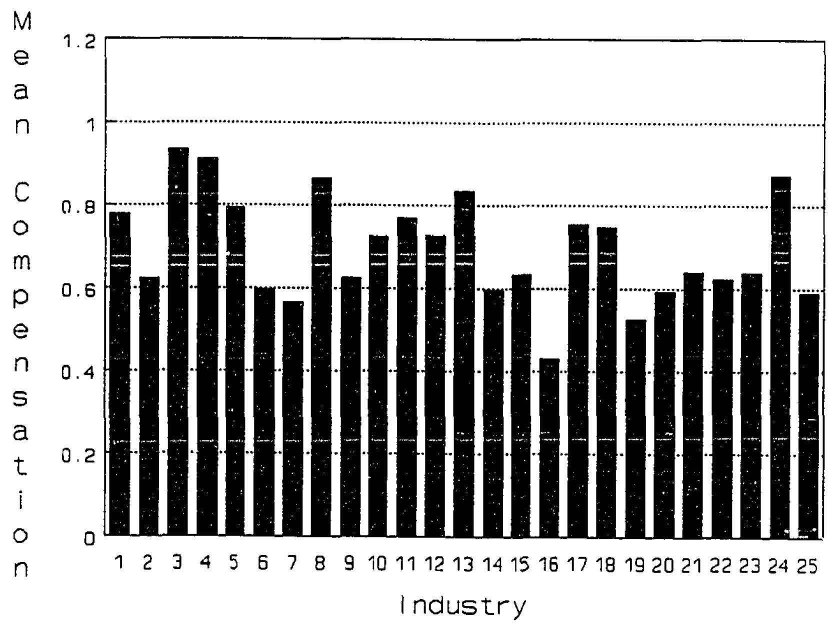


Figure 1. Sample Distribution of CEO Compensation



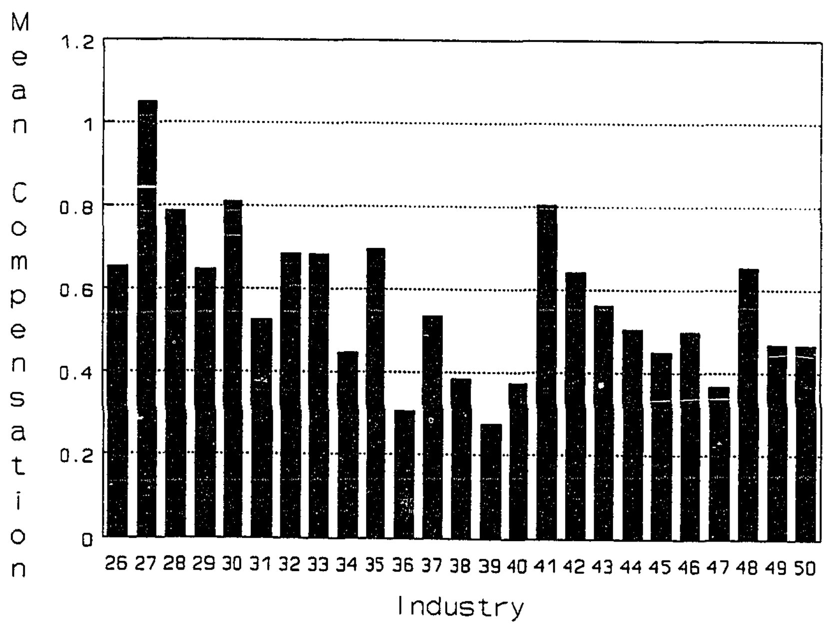


Figure 2. Mean CEO Compensation in Millions of Dollars by Industry

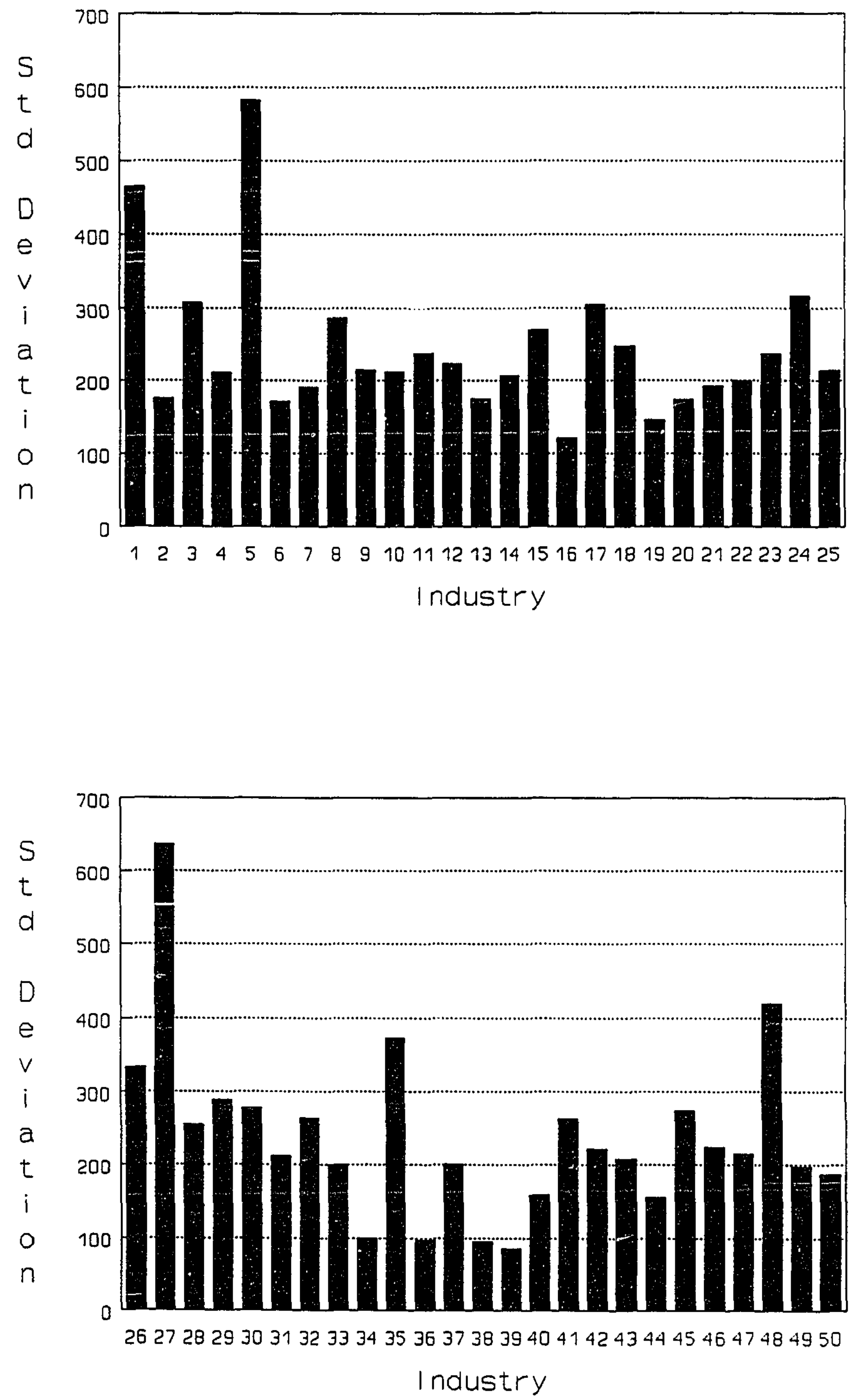


Figure 3. Standard Deviation of CEO Compensation in Thousands of Dollars by Industry

that as the scale of operations increases the responsibilities of the manager, and the difficulties associated with managing the firm increase. While it is possible that managers may gain utility from managing a larger enterprise, there are at least two reasons to expect compensation to be positively related to firm size. A brief discussion of each of these follows.

First, larger firms are more difficult to control, have more complex corporate structures, and almost by definition, have larger capital bases than their smaller counterparts.[6] Thus, managers of larger firms may be expected to exert greater effort and experience higher levels of stress than their counterparts in smaller firms. If these conditions result in greater disutility for managers, then to attract qualified personnel larger firms must offer higher levels of compensation, ceteris paribus, than smaller firms.

Secondly, larger firms often operate in more than one market. The result being that the manager of a diversified firm must be familiar with several markets; therefor, managers of diversified firm managers must invest in larger amounts of human capital than managers of specialized firms. The compensation received by managers of large firms may constitute a normal return to this investment in human capital.

[6]A number of the firms in the sample appear not because of their large capital bases, but because they have large profit, sales or market values.

These scale effects are likely to affect estimates of the terms of incentive contracts. Even if firms within an industry all create dis-incentives for sales, when the terms of contracts are estimated using cross-section data it is not possible to distinguish between the fixed payment, and performance contingent components of compensation. Cross-section data effectively forces all firms' compensation schedules to share a common intercept. If there is a positive relationship between scale and pay, then cross-section analysis may well result in a positive estimated relationship between sales and compensation, whatever the actual terms of compensation may be. Some evidence of the relationship between scale and compensation may be found Appendix 2, which reports mean CEO compensation, profits and sales for each industry included in the sample.

Figure 4 shows the relationship between sales and compensation for three hypothetical firms. Firm A is a small firm, firm B is intermediate sized, and firm C is a large firm. As illustrated by the clustering of data points, the manager of each of these hypothetical firms is penalized for increases in sales. However, when each of the firms is forced to share a common intercept, as in a cross-section regression, the sales coefficient will be positive, indicating that compensation is an increasing function of sales. This bias may be avoided through the use of panel data, since estimation of firm specific intercepts, and slope coefficients is possible. In addition, panel data will facilitate estimation of the affects of firm and industry specific characteristics on the performance contingent component of compensation.

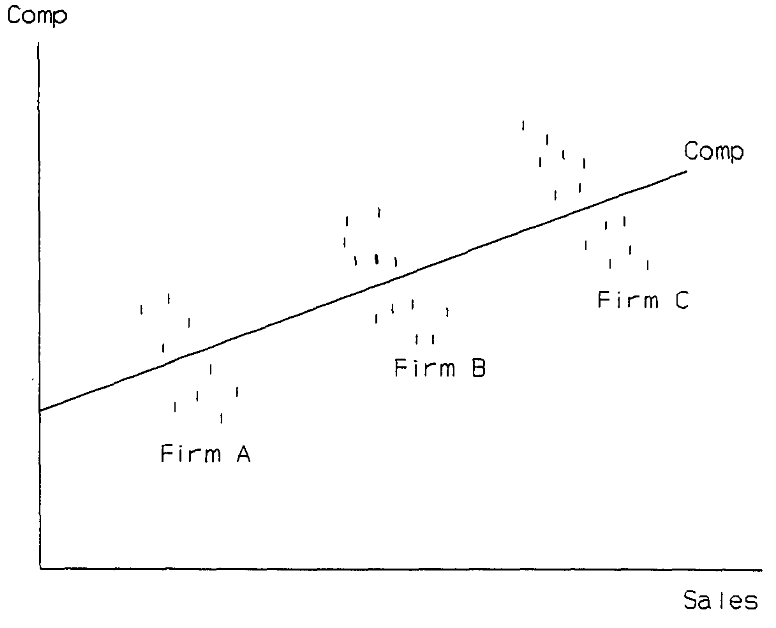


Figure 4. Sales and Compensation

Comparison with Earlier Work

Much of the early econometric work in the area of executive compensation relied on relatively small samples and often used only cross-section data. Advances in econometric methods have led to increased use of panel data sets and sophisticated econometric techniques in many areas of research, including executive compensation. The data set compiled for this research is sufficiently large to allow it to be divided into industry groupings, while retaining sufficient degrees of freedom to permit the use of panel data techniques.

With one exception, noted in Chapter II, all of the research to date has relied on data that has grouped firms without regard to industry participation. Industrial organization theory finds that equilibrium conditions differ dramatically depending on whether firms compete in prices or in quantities, with changes in the number of firms competing in the industry, and with differences in information structures. In light of these results, it is likely that the terms of compensation contracts will vary with industry structure.

The data gathered for this research will facilitate testing for differences in incentive structures both within and across industries. To date, no author has tested the assumption of homogeneity of incentive contracts. The analysis of Chapter IV will with begin with cross-section estimation. Cross-section regressions will include all firms in the sample and will be run for each of the nineteen years in the sample. If the relationship between sales, profits and compensation is constant there will be little difference between the coefficient estimates across time. Next, firm specific regressions will be run by industry, restricting the intercept and the profit and sales coefficients to be constant over time for each firm. This will facilitate cross firm comparisons of compensation contracts. Next, regressions restricting sales and profit coefficients to be constant over time and for all firms within an industry will be run. These results will be used to test the restrictions imposed.

The goal of this analysis is the identification of the factors underlying the diverse results outlined in Chapter II. Chapter VI will concentrate on testing the oligopoly theory of incentives. This model predicts that compensation will be a function of a firm's market and the variance of production costs. The data gathered will facilitate estimation of the affects of each of these variables on compensation payments.

CHAPTER IV

ESTIMATES OF INCENTIVES
BASED ON ALTERNATE LINEAR SPECIFICATIONS

This chapter begins the empirical analysis of compensation and seeks to identify the causes underlying the diversity of results outlined in Chapter II. The results of econometric modelling depend on two main factors. First is the data set, discussed in the previous chapter. The second factor is the econometric model itself. Researchers in the field of compensation have relied on a variety of econometric techniques, ranging from the cross-section analysis of Lewellen and Huntsman (1970), to the error components technique employed by Murphy (1985). This chapter will estimate incentives based on a cross-section model, and Zellner's (1962) seemingly unrelated regression model. The results of these models will be compared with the results outlined in Chapter II.

In estimating the factors affecting compensation, authors have almost universally included firm profits and sales in the regression equation. This research has largely been motivated by the work of Baumol (1959, 1967), and the work done in the area of the principal-agent problem by Holmstrom (1979), Jensen and Meckling (1975), Harris and Raviv (1979) and others, reviewed in Chapter II. The principal-agent literature suggests that owners will make compensation contingent on some observable signal of effort.

Throughout this research, firm performance has been interpreted to mean having an impact on firm profits, or the value of the firm. Therefore, empirical researchers have included some measure of profit as an independent variable in their estimates of incentives. In addition, the work of Baumol (1959, 1967) suggests that sales will have an affect on firm performance. Therefore, sales data have also been included in much of the empirical research to date.

Econometric modelling of incentives has proceeded under the assumptions that the relationship between firm performance and compensation is linear, and that all owners write similar incentive contracts with their managers. Whether estimates have been obtained using cross-section or panel data, authors have at best allowed the intercept of the compensation equation to vary across managers, and with one exception, slope coefficients have been assumed to be equal for all managers, or each management position.[7] These restrictions have been implicit in the models behind the results reported to date, yet no author has sought to test the restriction that slope coefficients are equal across firms.

The following analysis maintains the assumption of

[7]Jensen and Murphy (1990) divided their data into two groups, one group including the largest firms, the other including the smallest firms in their sample. The authors found that the effects of performance on compensation differ according to firm size.

linearity. While the linearity restriction will not be tested, several of the restrictions implicit in the work of authors reviewed above will be tested explicitly below. The restrictions to be tested include those imposing homogeneity of slope coefficients across firms and industries. In addition, coefficient estimates based on cross-section analysis for each of nineteen years will be computed so that the qualitative effects of time specific factors may be illustrated.

Cross-Section Analysis

When independent variables are subject to shocks, the affects of the shocks will have an impact on coefficient estimates. For example, if cost and demand conditions fluctuate randomly, then in any period that a shock occurs estimates of contract coefficients will include the affects of the terms of contracts, and the influence of the shock. Under these conditions, cross-section regressions will not be able to separate the influence of the shock from the terms of contracts. Figure 5 illustrates how coefficient estimates might be affected if one industry, industry A, experiences an adverse cost shock, while other industries are unaffected. Only if all owners create identical incentives for their managers, and market shocks do not distort the perceived relationship between performance and pay will cross-section analysis reveal an accurate picture of incentive structures.

Combined, these considerations provide strong arguments against the use of cross-section methods to estimate terms of incentive contracts. However, a significant fraction of the empirical literature in this field has relied on cross-section analysis. This section reports coefficient estimates based on cross-section analysis, so that the results using the data described above may be compared with those reported by previous authors.

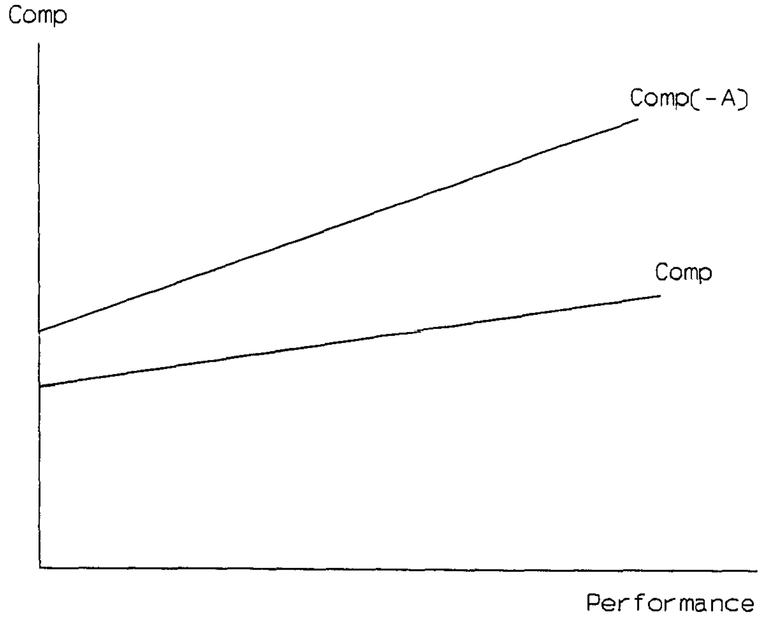


Figure 5. Shocks and Compensation

Assuming compensation is a linear function of profits and sales, the manager's compensation contract may be written as in Equation 4.1:

$$\Psi_{it}=\beta_{0t}+\beta_{1t}\Pi_{it}+\beta_{2t}S_{it}+\mu_{it},\ for\ i=1,\ldots,N. \qquad \textbf{(4.1)}$$

In this specification, Ψ_{it} represents the compensation payment made to the manager of firm i in period t. π_{it} and S_{it} represent the profits and sales of firm i earned in period t respectively, μ_{it} represents a random disturbance. This specification is similar to that used by previous authors. Given this model, the test of the significance of profits and sales in determining a manager's compensation is reduced to a test of the significance of β_{1t} and β_{2t}.

Cross-section analysis presents some statistical problems, two appear to be present here. The first of these problems is heteroskedasticity, the second is multicollinearity. Each is discussed below.

In order for OLS estimates to be BLUE, the variance of the residuals must be constant for all observations. One problem encountered in cross-section analysis is non-constant variance of the residual across cross-sectional units. In this case, differences in the error variance appear to be the result of differences in the scale of operations across firms. When the error variance is heteroskedastic, OLS coefficient estimates will be unbiased and consistent; however, they will not be efficient. Since the coefficient estimates are not efficient, standard hypothesis testing techniques are invalid.

To test for the presence of heteroskedasticity, a simple cross-section OLS regression was run on the model represented by Equation 4.1. Profits and sales are each measured in millions of dollars, and compensation is measured as dollars received by a CEO. Since there is no need to control for inflation in a cross-section model, nominal data are used. Given this specification, the White test (1980) rejected the null hypothesis of homoskedasticity in ten of nineteen periods. The disturbance terms of the regression equations appear to be positively related to the scale of the firm. By weighting each observation in the regression equation by a scale-related variable this heteroskedasticity can be avoided, assuming the variance of the deflator is proportionate to the variance of the residuals. The book value of assets is a widely accepted measure of firm size and was chosen as the deflator here. Equation 4.2 presents this specification of the model.

$$\frac{\Psi_{it}}{A_{it}} = \beta_{0t}\frac{1}{A_{it}} + \beta_{1t}\frac{\pi_{it}}{A_{it}} + \beta_{2t}\frac{S_{it}}{A_{it}} + \frac{\mu_{it}}{A_{it}} \qquad (4.2)$$

A_{it} represents the book value of each firms' assets in period t. With this specification, the estimated compensation equation is linearly homogeneous in assets, and assuming the variance of the residuals is homoskedastic, the usual hypothesis tests are valid.

To show the residuals of Equation 4.2 will be hcmoskedastic, assume the variance of the residuals from Equation 4.1 are proportionate to asset value. Given this, the variance of the residuals μ_i will be heteroskedastic with variance σ_i^2. Let $\varepsilon_i=\mu_i/A_i$ be the residuals from the correctly specified model, given by Equation 4.2. To show $Var(\mu_i)=\sigma^2A_i^2$, assume that ε_i satisfies the Gauss-Markov assumptions: $E(\varepsilon_i)=0$ and $Var(\varepsilon_i)=\sigma^2$. These assumptions imply: $Var(\varepsilon_i)=Var(\mu_i/A_i)=Var(\mu_i)/A_i^2$; therefore, $\sigma^2A_i^2=Var(\mu_i)$.

There are three reasons for choosing asset value as the deflator. The first concerns the interpretation of the resulting regression equation and coefficient estimates. As described by Modigliani and Miller (1966), when all variables are deflated by asset value, the equation models a process by which managers are compensated according to the profits and sales earned per dollar of assets; therefore, the regression models a manager who is maximizing profits and sales, subject to available capital.

Secondly, results of preliminary regressions revealed large standard errors of coefficient estimates. Large standard errors may indicate a high degree of multicollinearity between independent variables. It is reasonable to expect that much of the multicollinearity between profits and sales is again related to firm size. Using a scale related variable to deflate the dependent and independent variables has the fringe benefit of reducing the effects of this multicollinearity.

Finally, the results reported by Lewellen and Huntsman (1970) rely on a model where all variables are deflated by assets. By following the precedent set by Lewellen and Huntsman, it will be possible to directly compare the results reported below with those reported previously.

The results of the regressions for each of the nineteen years are reported in Table 1. After deflating by asset value, the White test indicates heteroskedasticity remains a problem in four of the nineteen years in the sample. The regression estimates for the periods, still indicated by the White test to have heteroskedastic error variances, are reported for qualitative purposes only, since the reported t-statistics and confidence intervals are invalid. The following discussion refers only to those years in which heteroskedasticity does not appear to be a significant problem.

Given the model described above, the interpretation of the estimated coefficients is as follows: a one million dollar increase (decrease) in the associated explanatory variable, profits or sales, will result in an increase (decrease) in executive compensation equal to the value of the estimated coefficient. For example, the estimated value of β_1 in 1970 is 858.56. This estimate indicates that a one million dollar increase in firm profits will result in an increase in the CEO's compensation of $858.56.

The first noteworthy characteristic of the parameter

Table 1-Cross-Section Estimates of Contract Coefficients Based on a Linear Model

Year	$\beta_0 * 10^3$	β_1	β_2	R^2
1970[1]	87.30 (16.06)	858.66 (5.52)	5.25 (0.44)	0.80
1971	82.86 (19.88)	1342.68 (10.04)	12.84 (2.18)	0.87
1972	95.75 (15.29)	936.64 (6.91)	43.11 (4.72)	0.86
1973	111.74 (15.61)	1281.37 (7.88)	25.47 (2.60)	0.86
1974	150.51 (19.16)	1215.26 (8.21)	5.27 (0.64)	0.88
1975[1]	154.96 (16.33)	205.92 (3.10)	49.51 (6.03)	0.85
1976	182.07 (16.13)	1413.86 (8.47)	5.05 (0.56)	0.86
1977[1]	222.02 (17.36)	1064.05 (6.31)	3.80 (0.39)	0.83
1978[1]	230.79 (29.77)	304.37 (6.01)	10.59 (3.51)	0.89
1979	253.02 (23.64)	544.76 (5.52)	17.42 (3.35)	0.90
1980	286.81 (21.44)	435.53 (4.09)	24.47 (3.79)	0.89
1981	366.69 (22.10)	538.09 (4.27)	10.09 (1.52)	0.89
1982	375.77 (19.30)	163.00 (1.85)	24.57 (3.60)	0.84
1983	476.45 (23.79)	274.24 (2.57)	17.21 (2.46)	0.89
1984	489.51 (24.29)	294.63 (2.87)	28.04 (4.25)	0.90
1985	466.76 (20.94)	313.97 (3.06)	37.60 (5.68)	0.89
1986	541.66 (24.05)	245.10 (3.47)	31.63 (5.14)	0.90
1987	593.80 (22.50)	465.85 (5.16)	17.71 (2.62)	0.90
1988	690.84 (20.67)	634.46 (5.50)	11.05 (1.27)	0.88

Notes: 1 indicates the White test rejects null hypothesis of homoskedasticity at the 95% level of confidence. t-statistics are in parentheses.

estimates are the persistent differences between the estimated profit and sales coefficients. Note that in all periods the profit coefficient is significantly larger than the corresponding sales coefficient, often by a factor often or more. Thus, cross-section analysis suggests that changes in firm profits have a significantly greater impact on CEO compensation than changes in sales. The profit coefficient estimates are uniformly positive, and significantly different from zero at the 95% level of confidence.

In four of the fifteen years in which the error variance appears to be homoskedastic, the estimated sales coefficient is not significantly different from zero. In the remaining eleven regressions, the estimated sales coefficients are positive and significant, indicating that sales have a positive affect on compensation. Thus, depending on the period chosen, cross-section analysis can provide support for Baumol's (1959) sales maximization hypothesis, or support the hypothesis that managers are paid for profits, not for sales. Which of these conclusions correctly describes the incentive contract facing CEOs in the sampled firms? These results suggest that through the judicious selection of sample periods, coefficient estimates based on cross-section analysis can be used to support either of the arguments most prominent in the literature.

The results described above suggest that cross-section analysis does not provide sufficient information to accurately estimate incentives created by CEO compensation contracts; however, many researchers in the past have relied on cross-section data in their analysis of compensation. Are contracts constant over time and across industries, or are contracts more dynamic and variable? As illustrated by Figure 5, when a shock affects the performance of firms included in a cross-section sample coefficient estimates will be affected.

The coefficient estimates reported by Lewellen and Huntsman (1970) also vary over time. Lewellen and Huntsman's corresponding profit coefficient estimates range from 447.7 to 1,928.1. The corresponding sales coefficient is not significant in any of their regressions. The point estimates of profit coefficients, reported in Table 1, range from 245.1 to 1,413.86. Changes occurring over time in the estimates reported by Lewellen and Huntsman, and those reported here suggest the affect of profits on compensation is not constant. In an attempt to learn whether incentives vary across firms and industries this research will now turn to panel data to examine CEO compensation.

Panel Data Analysis

While the information content of panel data is typically greater than that of cross-section data, panel data analysis brings with it questions of its' own. Namely, what restrictions are justified by the relevant theory, and what restrictions are supported by econometric analysis and testing?

The following results rely on the method of Seemingly Unrelated Regressions, described by Zellner (1962), and report coefficient estimates based on two series of regressions for each of the fifty industries in the sample. In the first series of regressions, all coefficients are unrestricted across firms. In the second series, the profit and sales coefficients are restricted to be equal across firms within an industry. The intercept remains unrestricted across firms.

Unrestricted SUR Model

The SUR model does not restrict the variance of the residuals to be constant across firms, nor does it require there to be any direct relationship between compensation structures across firms. Therefore, the model is reasonably unrestricted. The only relationship between each equation in the SUR model is through the residuals, which are assumed to be mutually correlated. While a direct link across equations may exist[8], this model will impose little structure on that link, and permit qualitative comparisons of estimates across firms.

Using vector notation, the regression equation

[8]The oligopoly model discussed in Chapter V, and used in the regressions of Chapter VI, suggests a direct link between compensation across firms through market share.

representing incentive contracts is given by Equation 4.3:

$$\Psi_{it}=\beta_{0i}+\beta_{1i}\pi_{it}+\beta_{2i}S_{it}+\mu_{it} \; for\, i=1,\ldots,N. \tag{4.3}$$

ψ_{it} is a 19x1 vector consisting of compensation payments made to the manager of firm i each period. π_{it}, S_{it} and μ_{it} are defined similarly for profits, sales and the disturbance term respectively. Each of the individual i equations are assumed to satisfy separately the Gauss-Markov assumptions.

Before estimating the SUR model described above, OLS regressions were run for each firm. The residuals from these regressions were used to calculate the Durbin-Watson statistic. Next, for all those equations indicated to have an auto-regressive error structure, the data has been transformed using the Prais-Winston technique. Where appropriate, the transformed data is used to obtain the SUR estimates.

The unrestricted SUR model is estimated using a two step procedure. In the first step, OLS regressions are run for each firm. The residuals from these regressions are then used to compute the estimated variance-covariance matrix of the regression residuals. The residuals from each equation are assumed to be distributed normally, with $E(\mu_{it})=0$ and Variance-covariance matrix given by $E(\mu_{it}\mu_{it}')=\sigma_i^2 I_T$. I_T is a TxT identity matrix. The covariance of residuals across equations is assumed to be $E(\mu_{it}\mu_{jt}')=\sigma_{ij}^2 I_T$. This estimated variance-covariance matrix is used in the second step of the procedure to increase the efficiency of the parameter estimates.

Table 2 presents coefficient estimates generated using the unrestricted SUR model. In these regressions the dependent variable for each firm is the dollar value of cash compensation, and the reported coefficients, β_0, β_1, and β_2 are the coefficients associated with the regression intercept, and each firm's profits and sales. The independent variables are measured in millions of 1983 real dollars. The dependent variables are measured in 1983 dollars. As in the cross-section regressions above, the reported value of the estimated coefficients shows the average dollar change in compensation associated with a change of one million dollars in the associated independent variable.

Perhaps the most interesting aspect of the results reported below are the significant differences between the estimated coefficients across firms. These observed differences persist in spite of some problems with multicollinearity[9]. Of the 233 firms remaining in the sample, the coefficient associated with the profit term is

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[9]While unusually large standard errors accompanying multicollinearity often inhibit comparisons and tests of the significance of regression coefficients, multicollinearity does not result in any bias of the OLS estimates. The two principal drawbacks resulting from multicollinearity are large standard errors of coefficient estimates, and the typically small t-statistics that result (Kmenta, 1986).

Table 2-Unrestricted Estimates of Contract Coefficients

Firm	β_0	β_1	β_2	R^2
1 (1600)	575.18 (3.75)	1092.73 (2.38)	49.03 (1.30)	0.06
2 (1600)	257.93 (0.67)	-331.96 (-0.39)	95.37 (1.06)	.004
3 (2000)	152.91 (0.94)	4503.07 (2.86)	-125.29 (-1.91)	0.01
4[2] (2000)	838.87 (0.39)	1819.06 (3.29)	33.06 (0.70)	0.01
5 (2000)	608.69 (3.17)	1887.27 (2.96)	-44.94 (-0.85)	.002
6[2] (2000)	-98.38 (-0.74)	-2.86 (-1.10)	302.61 (5.99)	0.07
7[2] (2000)	340.02 (5.05)	2130.11 (4.32)	0.49 (0.12)	0.02
8[2] (2086)	-489.47 (-1.37)	5.00 (0.16)	252.64 (4.34)	.004
9 (2086)	194.92 (3.03)	1830.63 (2.18)	-121.94 (-0.96)	0.01
10[2] (2111)	375.82 (0.91)	115.92 (2.32)	101.69 (1.22)	.001
11 (2111)	202.91 (3.22)	1872.6 (2.29)	-135.46 (-1.09)	0.01
12 (2300)	655.19 (1.06)	5402.19 (2.39)	-165.64 (-1.46)	0.00
13[2] (2300)	246.09 (0.87)	1310.59 (0.69)	26.61 (0.16)	.001
14[2] (2400)	172.36 (0.70)	21.94 (0.05)	64.74 (1.45)	0.05
15[2] (2400)	296.56 (3.76)	-26.00 (-0.24)	67.80 (4.50)	0.74
16[2] (2600)	201.46 (1.26)	286.00 (1.59)	97.18 (2.43)	0.01
17[2] (2600)	371.66 (3.46)	1745.17 (2.64)	-77.98 (-0.81)	0.01
18[2] (2600)	876.87 (5.41)	246.12 (1.19)	-35.01 (-1.43)	.001

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
19 (2600)	-127.65 (-0.11)	594.20 (2.03)	179.91 (4.20)	0.00
20[2] (2600)	237.32 (1.27)	1577.76 (4.23)	0.61 (0.23)	0.02
21[2] (2600)	-6.47 (-0.01)	1821.06 (4.75)	97.19 (1.75)	0.15
22[2] (2600)	483.83 (2.43)	661.40 (0.88)	-48.23 (-0.30)	.001
23[2] (2600)	458.51 (4.10)	-12.17 (-0.03)	27.89 (0.30)	.002
24 (2649)	964.59 (3.80)	263.63 (0.17)	-32.35 (-0.29)	0.00
25[2] (2649)	557.87 (1.37)	-354.41 (-0.86)	72.95 (0.94)	0.00
26 (2711)	462.79 (11.11)	1674.54 (1.21)	-122.68 (-0.54)	0.03
27[2] (2711)	406.43 (3.53)	4544.74 (1.62)	-272.34 (-0.86)	.004
28[2] (2800)	306.20 (0.61)	1565.67 (1.74)	25.30 (-0.17)	0.06
29[2] (2800)	1296.31 (5.53)	173.44 (1.43)	-64.89 (-2.53)	0.06
30[2] (2800)	515.12 (3.58)	343.50 (2.91)	-1.08 (-0.20)	0.16
31[2] (2800)	830.01 (4.20)	606.01 (1.02)	-62.90 (-1.03)	0.04
32 (2800)	1116.51 (3.33)	640.96 (1.58)	-61.00 (-0.94)	0.04
33[2] (2800)	176.40 (0.65)	-47.01 (-0.32)	163.45 (1.57)	0.08
34[2] (2800)	-82.69 (-0.33)	572.80 (3.30)	72.62 (2.37)	0.35
35 (2800)	640.10 (5.62)	114.07 (0.48)	-2.14 (-0.04)	0.01
36[2] (2800)	-208.25 (-0.84)	454.57 (1.09)	193.14 (2.40)	0.58

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
37^2 (2800)	385.39 (5.81)	1683.90 (4.24)	-8.36 (-1.41)	0.59
38 (2800)	825.69 (4.76)	20.30 (0.19)	-5.90 (-0.31)	.002
39^2 (2830)	392.83 (1.78)	2310.79 (1.94)	-144.78 (-0.66)	0.68
40^2 (2830)	589.80 (1.10)	-820.49 (-1.23)	179.90 (-1.27)	0.02
41^2 (2830)	256.38 (1.72)	1413.83 (3.00)	-67.41 (-0.61)	0.72
42^2 (2830)	62.98 (0.36)	1485.66 (2.52)	191.73 (1.67)	0.34
43 (2830)	365.99 (1.42)	2119.31 (6.82)	125.89 (0.03)	0.65
44^2 (2830)	1027.02 (3.93)	426.83 (2.45)	-104.14 (-1.43)	0.21
45 (2834)	-126.39 (-0.66)	-386.02 (-1.05)	326.66 (3.90)	0.90
46^2 (2834)	538.28 (2.71)	287.10 (0.38)	-32.31 (-0.23)	0.06
47^2 (2834)	292.69 (3.71)	1206.40 (8.75)	12.29 (0.37)	0.99
48^2 (2834)	329.20 (2.93)	892.90 (2.15)	30.97 (0.47)	0.22
49^2 (2834)	376.82 (3.35)	2617.01 (4.50)	-162.16 (-1.75)	0.79
50^2 (2841)	723.67 (3.65)	786.95 (1.45)	-20.80 (-0.49)	0.06
51^2 (2841)	1138.92 (4.45)	-149.10 (-0.51)	-9.20 (-0.46)	0.02
52 (2844)	1418.45 (6.38)	409.38 (2.22)	-279.71 (-3.32)	0.00
53 (2844)	217.03 (2.65)	-4890.54 (-1.17)	1170.31 (1.81)	0.00
54^2 (2870)	1238.76 (3.28)	1615.51 (1.76)	-408.50 (-1.63)	0.02

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
55[2] (2870)	309.22 (3.05)	259.14 (0.94)	122.38 (2.37)	0.34
56[2] (2890)	14.19 (-0.10)	1763.17 (2.07)	126.21 (1.37)	0.68
57[2] (2890)	102.22 (1.23)	-1803.55 (-2.50)	582.78 (4.52)	0.80
58[2] (2890)	129.97 (1.15)	4925.99 (1.14)	103.36 (0.14)	0.30
59[2] (2911)	257.71 (4.62)	-67.11 (-1.91)	16.35 (2.29)	0.42
60[2] (2911)	461.06 (3.60)	297.75 (2.90)	13.18 (0.75)	0.25
61[2] (2911)	772.01 (4.87)	25.99 (0.44)	5.12 (0.60)	0.01
62[2] (2911)	115.09 (2.49)	-159.62 (-1.06)	91.20 (13.37)	0.95
63 (2911)	146.68 (4.25)	107.65 (2.33)	173.88 (15.08)	0.97
64 (2911)	567.27 (8.25)	83.93 (5.45)	-63.52 (-2.63)	0.62
65 (2911)	608.13 (9.80)	94.32 (3.42)	11.47 (9.08)	0.88
66[2] (2911)	559.96 (3.80)	-141.22 (-1.95)	35.20 (3.93)	0.12
67 (2911)	560.06 (4.97)	290.01 (1.29)	-34.93 (-0.60)	0.06
68 (2911)	738.31 (12.15)	-259.95 (-7.60)	7.45 (1.61)	0.74
69 (2911)	790.34 (6.52)	-14.14 (-0.19)	2.66 (0.68)	0.01
70 (2911)	1140.19 (21.57)	1.46 (0.05)	-10.56 (-4.01)	0.63
71 (2911)	610.55 (14.01)	-234.00 (-3.78)	20.86 (4.92)	0.958
72[2] (2911)	618.81 (3.56)	59.02 (2.70)	5.62 (1.41)	0.08

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
73 (2911)	325.45 (2.76)	313.01 (1.99)	51.99 (2.96)	0.55
74[2] (2911)	508.49 (5.34)	24.00 (0.43)	74.60 (4.60)	0.51
75[2] (3000)	605.04 (2.32)	746.76 (2.67)	-12.78 (-0.16)	0.11
76[2] (3000)	280.63 (0.60)	782.20 (2.82)	35.54 (0.77)	0.16
77 (3290)	683.63 (3.18)	897.14 (2.36)	-39.56 (-0.61)	0.10
78[2] (3290)	291.27 (0.62)	836.28 (2.89)	32.65 (0.69)	0.16
79[2] (3310)	393.76 (6.18)	237.59 (2.97)	29.71 (2.34)	0.78
80 (3310)	292.95 (3.64)	-15.88 (-0.33)	33.33 (3.07)	0.45
81 (3310)	627.87 (4.07)	925.55 (3.89)	-60.80 (-1.33)	0.46
82[2] (3310)	697.74 (3.24)	30.87 (0.71)	13.15 (0.51)	0.03
83 (3310)	245.18 (2.61)	134.19 (2.05)	76.02 (3.53)	0.72
84[2] (3330)	772.68 (4.06)	720.91 (3.38)	-43.32 (-1.05)	0.35
85[2] (3330)	326.43 (1.64)	466.33 (2.25)	44.65 (0.77)	0.51
86[2] (3510)	53.06 (0.34)	-141.19 (-0.15)	345.66 (3.50)	0.27
87[2] (3510)	121.62 (0.50)	-8.28 (-0.04)	227.02 (1.88)	0.06
88 (3510)	543.16 (5.18)	239.75 (1.41)	25.69 (0.91)	0.32
89[2] (3533)	558.84 (2.50)	646.44 (2.06)	46.92 (0.64)	0.28
90[2] (3533)	456.73 (3.45)	496.91 (1.03)	-1.48 (-0.06)	0.02

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_1	R^2
91[2] (3600)	202.55 (2.05)	-455.39 (-0.18)	242.54 (1.23)	0.72
92[2] (3600)	-514.92 (-1.98)	220.13 (1.77)	44.83 (3.32)	0.66
93[2] (3600)	1683.59 (6.78)	271.78 (1.29)	-204.18 (-4.57)	0.57
94 (3600)	-236.03 (-0.67)	1171.47 (6.19)	49.14 (1.73)	0.73
95[2] (3662)	342.72 (5.04)	124.83 (0.59)	1.04 (0.33)	0.04
96[2] (3662)	368.46 (2.42)	432.62 (0.77)	43.06 (0.80)	0.79
97 (3662)	334.62 (2.83)	-517.07 (-1.94)	95.18 (3.94)	0.67
98[2] (3680)	572.32 (3.14)	313.81 (2.02)	-0.11 (0.00)	0.19
99[2] (3680)	228.68 (10.21)	-196.14 (-2.25)	79.76 (8.06)	0.98
100[2] (3680)	-202.67 (-1.03)	-1284.58 (0.47)	343.59 (1.53)	0.08
101 (3680)	705.89 (2.35)	404.07 (2.68)	-23.84 (-0.43)	0.17
102[2] (3680)	310.30 (1.19)	194.93 (2.34)	-7.26 (-0.72)	0.07
103[2] (3680)	353.06 (1.84)	435.41 (4.31)	57.82 (1.21)	0.84
104 (3711)	257.35 (0.67)	82.12 (0.75)	33.33 (1.77)	0.02
105 (3711)	239.95 (0.40)	373.23 (4.27)	10.25 (0.76)	0.13
106 (3711)	848.95 (1.98)	241.16 (5.19)	-6.74 (-1.13)	0.10
107 (3711)	184.71 (0.56)	24.13 (0.10)	80.70 (1.87)	0.01
108[2] (3720)	631.53 (5.03)	721.24 (3.91)	7.09 (0.54)	0.65

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
109[2] (3720)	265.99 (2.04)	31.18 (0.04)	183.99 (1.72)	0.54
110[2] (3721)	503.93 (3.76)	502.34 (3.05)	-3.43 (-0.30)	0.63
111[2] (3721)	356.74 (1.83)	828.65 (4.75)	34.21 (1.06)	0.66
112[2] (3721)	372.25 (3.18)	183.41 (0.75)	1.86 (0.04)	0.92
113[2] (3721)	-58.79 (-0.42)	136.48 (0.23)	66.95 (4.11)	0.72
114[2] (3721)	722.22 (4.18)	21.14 (0.02)	32.78 (0.54)	0.43
115[2] (3721)	-753.95 (-3.51)	-635.15 (-0.62)	363.79 (5.52)	0.33
116 (3760)	466.34 (4.04)	794.92 (4.76)	-10.34 (-0.71)	0.55
117[2] (3760)	475.59 (2.28)	707.41 (3.54)	17.37 (0.50)	0.35
118 (3841)	306.84 (8.69)	299.82 (0.76)	95.66 (3.50)	0.85
119 (3841)	-40.07 (-0.22)	1838.22 (0.44)	398.77 (0.95)	0.22
120 (3861)	614.01 (3.85)	-18.51 (-0.27)	24.16 (1.68)	0.14
121[2] (3861)	172.73 (2.60)	365.04 (2.03)	131.14 (2.90)	0.86
122[2] (3861)	630.67 (2.97)	2874.53 (1.57)	-227.85 (-1.15)	0.02
123[2] (3861)	475.79 (2.43)	680.30 (3.53)	4.66 (0.30)	0.38
124[2] (4011)	474.96 (3.75)	144.43 (0.87)	59.23 (2.09)	0.16
125[2] (4011)	251.78 (2.00)	563.79 (3.16)	71.20 (1.48)	0.61
126[2] (4511)	464.19 (5.06)	160.84 (0.72)	-19.17 (-0.75)	0.08

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
127 (4511)	388.32 (7.57)	1370.09 (3.10)	-13.74 (-0.81)	0.51
128 (4511)	193.56 (1.29)	-124.40 (-0.95)	69.83 (1.60)	0.13
129[2] (4811)	396.31 (1.97)	-89.32 (-2.92)	20.09 (3.16)	0.21
130[2] (4811)	51.79 (0.75)	-1320.78 (-1.96)	339.08 (3.63)	0.92
131 (4911)	330.50 (6.68)	2.232 (0.11)	-39.67 -1.16)	0.11
132[2] (4911)	517.50 (4.74)	1208.93 (5.17)	-150.00 (-6.20)	0.78
133[2] (4911)	246.51 (11.37	-32.58 (-0.26)	16.68 (0.88)	0.35
134[2] (4911)	155.62 (6.57)	-17.28 (-4.95)	95.16 (6.36)	0.95
135[2] (4911)	110.32 (6.75)	1195.07 (14.55)	-58.78 (-12.93)	0.99
136[2] (4911)	488.25 (8.41)	188.11 (2.93)	-62.53 (-3.53)	0.69
137 (4911)	220.69 (7.47)	44.30 (2.59)	53.42 (3.81)	0.90
138[2] (4911)	141.79 (5.63)	-62.18 (-0.67)	68.50 (4.56)	0.96
139[2] (4911)	164.66 (10.26)	347.49 (4.50)	21.52 (1.13)	0.97
140 (4911)	349.57 (9.79)	659.24 (16.99)	-41.40 (-2.67)	0.99
141 (4911)	133.04 (7.89)	205.91 (1.78)	85.97 (4.41)	0.97
142 (4911)	206.43 (7.23)	141.55 (1.92)	29.05 (2.22)	0.81
143[3] (4911)				
144[2] (4911)	319.74 (8.39)	293.30 (5.02)	-92.05 (-3.76)	0.88

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure. 3 Indicates that this firm dropped due to multicollinearity.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
145[2] (4911)	110.18 (5.66)	868.15 (6.11)	42.16 (3.20)	0.98
146[2] (4911)	160.63 (14.03)	-3.22 (-1.10)	51.00 (5.98)	0.98
147[2] (4911)	84.53 (1.23)	4242.52 (14.67)	-282.54 (-4.50)	0.95
148[2] (4911)	123.84 (6.04)	324.19 (16.27)	29.69 (6.24)	0.99
149 (4911)	213.19 (32.53)	674.60 (30.26)	-57.07 (-17.01)	0.99
150[2] (4911)	252.14 (14.78)	-273.48 (-7.26)	107.03 (8.00)	0.99
151[2] (4922)	357.23 (8.21)	-2.018 (-0.28)	24.30 (1.23)	0.20
152 (4922)	467.01 (4.95)	175.18 (0.57)	20.22 (0.38)	0.01
153[2] (4922)	720.60 (2.09)	31.39 (-0.26)	4.81 (0.51)	.001
154 (4922)	441.22 (4.59)	52.31 (0.15)	12.33 (0.65)	0.02
155[2] (4922)	285.86 (4.75)	-137.65 (-0.47)	70.34 (3.12)	0.58
156 (4923)	329.84 (5.99)	-3244.66 (-4.31)	243.78 (6.53)	0.91
157 (4923)	473.65 (9.99)	260.25 (1.85)	-24.45 (-2.20)	0.64
158[2] (4923)	150.69 (1.15)	982.97 (1.03)	40.26 (0.94)	0.36
159 (4931)	55.83 (2.61)	1236.57 (13.22)	-24.63 (-1.53)	0.99
160 (4931)	302.60 (14.19)	673.43 (4.43)	-148.31 (-7.09)	0.98
161[2] (4931)	569.79 (8.74)	-20.93 (-2.58)	-33.27 (-2.57)	0.57
162[2] (4931)	188.95 (8.17)	156.04 (2.15)	30.14 (1.18)	0.92

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
163[2] (4931)	366.10 (13.95)	-301.72 (-5.34)	-24.64 (-1.24)	0.98
164[2] (4931)	325.36 (8.57)	431.09 (5.67)	-198.80 (-4.66)	0.97
165[2] (4931)	316.12 (12.68)	344.46 (9.38)	-64.73 (-6.55)	0.99
166[2] (4931)	241.40 (17.30)	-149.95 (-2.57)	-0.61 (-0.77)	0.94
167[2] (4931)	114.00 (1.15)	1591.86 (2.70)	-28.15 (-0.34)	0.72
168[2] (4931)	322.39 (4.49)	-68.65 (-1.32)	20.38 (1.59)	0.27
169[2] (4931)	262.02 (7.67)	-838.68 (-3.70)	177.47 (6.43)	0.89
170[2] (4931)	276.95 (9.26)	340.45 (4.45)	-42.54 (-2.57)	0.93
171[2] (4931)	269.56 (17.04	413.64 (2.88)	-71.94 (-6.01)	0.99
172[2] (4931)	166.84 (5.60)	933.85 (5.66)	-3.65 (-3.34)	0.91
173[2] (4931)	185.56 (5.77)	197.09 (7.81)	-147.60 (-3.89)	0.98
174[2] (5140)	253.45 (6.80)	7427.45 (2.88)	-6.63 (-0.38)	0.85
175[2] (5140)	-32.18 (-1.96)	753.94 (0.73)	163.38 (15.51)	0.99
176[2] (5311)	493.58 (7.47)	1679.18 (2.56)	-28.07 (-1.01)	0.72
177[2] (5311)	619.66 (0.95)	988.25 (1.63)	-22.72 (-0.49)	0.03
178[2] (5311)	762.28 (1.86)	258.15 (1.55)	-0.71 (-0.59)	0.05
179 (5331)	282.81 (8.09)	759.62 (4.09)	44.76 (5.79)	0.96
180[2] (5331)	622.28 (6.66)	331.30 (4.08)	-4.12 (-0.74)	0.60

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
181[2] (5331)	619.82 (11.07)	486.72 (2.68)	-0.40 (-0.40)	0.21
182[2] (5331)	711.89 (2.82)	1406.99 (0.89)	-86.76 (-0.88)	0.02
183[2] (5411)	106.32 (1.73)	-849.60 (-0.58)	130.71 (3.54)	0.89
184[2] (5411)	-432.87 (-3.24)	4589.12 (2.98)	456.37 (5.04)	0.93
185[2] (5411)	607.10 (3.31)	695.26 (1.17)	-1.75 (-0.08)	0.05
186[2] (5411)	147.67 (0.83)	-694.23 (-1.39)	42.02 (2.87)	0.37
187[2] (5411)	627.25 (3.51)	3436.67 (1.64)	-83.29 (-3.21)	0.50
188[2] (5812)	170.46 (10.73)	3869.07 (6.22)	-8.89 (-0.43)	0.99
189[2] (5812)	364.34 (7.81)	564.57 (3.60)	-4.35 (-0.30)	0.73
190 (6022)	280.37 (5.35)	2743.59 (3.31)	14.29 (0.27)	0.59
191[2] (6022)	464.80 (2.83)	-15.88 (-0.08)	88.51 (2.43)	0.11
192 (6022)	180.19 (15.83)	-338.6 (-0.35)	298.11 (3.68)	0.99
193[2] (6022)	254.18 (2.78)	333.74 (3.46)	76.89 (3.86)	0.50
194[2] (6022)	107.96 (2.44)	494.26 (0.52)	242.58 (2.34)	0.66
195[2] (6022)	172.51 (5.31)	3977.38 (4.81)	97.72 (0.91)	0.98
196[2] (6022)	358.24 (4.91)	-4.70 (-0.02)	28.76 (0.35)	0.01
197[2] (6022)	455.75 (3.95)	716.35 (7.90)	22.00 (1.07)	0.72
198[2] (6022)	131.86 (9.25)	633.22 (6.10)	-166.73 (-1.59)	0.99

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
199[2] (6022)	222.46 (5.46)	4822.36 (4.89)	-172.18 (-1.94)	0.92
200[2] (6025)	169.29 (12.55)	3807.34 (9.68)	-5.47 (-0.42)	0.99
201[2] (6025)	523.54 (8.25)	97.11 (3.61)	27.31 (4.76)	0.74
202 (6025)	305.41 (9.95)	300.82 (2.73)	66.58 (3.62)	0.76
203[2] (6025)	574.61 (4.40)	388.61 (3.01)	14.74 (0.43)	0.14
204[2] (6025)	86.69 (9.38)	2581.51 (10.99)	503.14 (21.18)	0.99
205[2] (6025)	540.17 (7.71)	200.63 (3.81)	26.96 (2.53)	0.42
206 (6025)	86.90 (4.10)	17321.42 (13.48)	-980.36 (-6.95)	0.99
207[2] (6025)	170.98 (5.55)	1714.20 (6.71)	112.74 (2.87)	0.90
208[2] (6025)	221.73 (7.07)	6063.92 (8.89)	-268.94 (-4.77)	0.88
209[2] (6025)	284.78 (2.80)	-408.25 (-1.34)	137.33 (3.20)	0.28
210 (6025)	262.42 (17.05)	-459.43 (-2.54)	228.99 (12.40)	0.99
211[2] (6025)	307.93 (4.77)	618.07 (4.72)	69.63 (5.01)	0.95
212 (6025)	234.78 (6.88)	-816.732 (-1.53)	208.71 (5.15)	0.68
213[2] (6025)	97.05 (2.08)	-280.80 (-0.14)	706.31 (2.28)	0.99
214[2] (6025)	297.72 (4.60)	1431.87 (1.14)	41.70 (0.18)	0.85
215[2] (6025)	293.47 (4.41)	438.68 (4.21)	114.97 (6.08)	0.82
216[2] (6120)	199.66 (7.23)	831.36 (4.41)	138.18 (3.45)	0.91

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

Table 2-Continued

Firm	β_0	β_1	β_2	R^2
217[2] (6120)	48.00 (1.50)	782.19 (3.25)	247.26 (11.58)	0.97
218[2] (6120)	181.13 (1.64)	774.67 (1.23)	147.87 (1.00)	0.10
219[2] (6199)	319.43 (1.68)	916.27 (3.74)	45.84 (2.19)	0.44
220[2] (6199)	-158.15 (1.91)	434.15 (3.75)	68.65 (5.93)	0.87
221[2] (6199)	449.37 (5.41)	-110.86 (-0.42)	11.59 (0.50)	0.01
222[2] (6199)	602.27 (2.40)	2892.25 (5.07)	-102.67 (-1.70)	0.52
223 (6312)	274246 (3.85)	456.84 (5.30)	10.24 (2.32)	0.70
224[2] (6312)	83.46 (1.47)	611.06 (2.27)	84.02 (3.14)	0.81
225[2] (6312)	415.05 (1.90)	0.67 (0.09)	-146.78 (-0.54)	0.06
226[2] (6312)	129.28 (1.46)	2550.41 (4.02)	23.32 (0.52)	0.47
227[2] (6312)	28.665 (0.09)	-1.68 (0.03)	423.42 (1.28)	0.13
228[2] (6312)	115.17 (1.54)	467.047 (0.76)	72.86 (1.83)	0.44
229[2] (6312)	211.71 (1.30)	279.27 (1.67)	27.62 (2.26)	0.41
230 (6312)	46.75 (1.03)	-1467.63 (-4.68)	657.98 (12.71)	0.99
231[2] (6332)	825.43 (4.71)	3459.60 (3.91)	-342.42 (-2.69)	0.31
232 (6332)	310.26 (11.22)	491.01 (2.05)	-134.37 (-4.74)	0.96
233[2] (6332)	191.65 (7.97)	146.23 (0.97)	70.90 (3.22)	0.98
234[2] (6332)	-44.95 (-0.47)	638.50 (4.41)	194.63 (4.92)	0.92

Notes: 2 indicates that the data for these firms has been adjusted using the Prais-Winston procedure.

positive at the 95% level of significance for 121.[10] In 18 of the remaining cases, the profit coefficient is negative. Analysis of the sales coefficients shows similar results. In 80 of 233 regressions, the sales coefficient is positive and significant, in 29 cases the sales coefficient is significant and negative, and for the remaining 124 firms the sales coefficient is not significantly different from zero. These results are summarized in Table 3. This range of results is similar to the disparate results reported in the literature.

Table 3-Summary of Results for Unrestricted Linear Model

	β_1 +	β_1 -	β_1 0
β_2 +	32	14	34
β_2 0	65	3	56
β_2 -	24	1	4

The estimates reported in Table 3 include every possible combination of incentives. In 32 cases, estimates indicate contracts reward managers for increases in both sales and profits. In 14 cases, contracts appear to penalize managers for profits, and reward managers for sales. In 24 cases, managers are rewarded for profits and

[10]One firm, number 143, in the electric service industry was dropped because of the high degree of multicollinearity between it and another firm in the same industry. The choice of which firm to drop was ad hoc, but the choice itself does not appear to have a dramatic impact on the coefficient estimates of the remaining firms.

penalized for sales, and owners of one firm in the electric service industry appear to be penalizing their manager for increases in both sales and profits. These results suggest that there are differences in the terms of compensation contracts across firms. The coefficient estimates reported here may be used to support either of the theories most often proposed in the literature, that sales are an important factor, or that profits are the only relevant factor in compensation contracts.

Industry mean coefficients are also indicative of differences between incentives across industries. Tables 4 and 5 show the mean and standard deviation of coefficient estimates by industry.[11] These means include all possible combinations of incentives, except penalties for increases in both profit and sales. Examination of industry means, and standard deviations suggests that simply pooling firms and running regressions is not an appropriate way to estimate terms of incentive contracts.

The mean values of the profit coefficients reported in Table 4 range from -729.8 up to 2756.06. The mean values of the sales coefficients reported in Table 5 range from -79.68 up to 397.52. If these means indicate differences between incentives across industries, then clearly some consideration must be given to how and why data are grouped

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[11]The arithmetic mean is reported for industries in which the estimated coefficient is significantly different from zero for two or more firms.

Table 4-Mean Profit Coefficient Estimates by Industry for Unrestricted Linear Model

SIC # Firms	β_1 (Std Dev)	SIC # Firms	β_1 (Std Dev)
2000 4	2584.88 (1285.74)	3721 2	665.5 (230.74)
2111 2	994.26 (1242.16)	3760 2	751.17 (61.88)
2600 4	1434.55 (569.38)	3861 2	522.67 (222.92)
2800 3	866.73 (716.91)	4811 2	-729.8 (905.78)
2830 5	1551.28 (739.44)	4911 15	673.5 (1076.19)
2834 3	1572.1 (918.39)	4923 2	-1492.2 (2478.34)
2890 2	-20.19 (2522.05)	4931 14	357.66 (624.49)
2911 10	-6.62 (182.36)	5331 3	525.88 (216.83)
3000 2	764.48 (25.06)	5812 2	2216.82 (2336.63)
3290 2	866.71 (43.03)	6022 6	2204.44 (1921.99)
3310 3	606.15 (386.73)	6025 12	2756.06 (4961.92)
3330 2	593.62 (180.02)	6120 2	806.78 (34.77)
3600 2	695.8 (672.7)	6199 3	1414.22 (1302.51)
3680 5	230.42 (256.1)	6312 4	537.67 (1641.57)
3711 2	307.2 (93.39)	6332 3	1529.7 (1672.97)

Notes: The number of firms in each industry is recorded below the SIC code.

Table 5-Mean Sales Coefficient Estimates by Industry for Unrestricted Linear Model

SIC # Firms	β_2 (Std Dev)	SIC # Firms	β_2 (Std Dev)
2000 2	88.66 (302.57)	4811 2	179.59 (225.56)
2600 3	124.76 (47.76)	4911 16	-11.4 (104.12)
2800 3	66.96 (129.11)	4923 2	109.67 (189.67)
2834 2	82.25 (345.65)	4931 9	-59.26 (109.25)
2844 2	445.3 (102.32)	5411 4	136.45 (230.64)
2911 10	40.15 (64.05)	6022 5	106.78 (183.09)
3310 3	46.35 (25.76)	6025 13	55.99 (397.52)
3510 2	286.34 (83.89)	6120 2	192.72 (77.13)
3600 2	-79.68 (176.08)	6199 2	57.25 (16.13)
3711 2	57.02 (33.5)	6312 5	170.54 (274.2)
3721 2	215.37 (209.9)	6332 4	-52.82 (235.98)

Notes: The number of firms in each industry is recorded below the SIC code.

together. Finally, the standard deviations of the meanprofit and sales coefficients suggest differences between firms exist. While differences in the number of firms included in each industry make comparisons difficult, the standard deviation of mean coefficients ranges from less than 1/20 as large, to 125 times larger than the industry mean profit coefficient. The standard deviations of the mean sales coefficients range from 1/4 as large, to 9 times larger than the mean itself. Finally, the overall mean profit coefficient is 1076.73, with a standard deviation of 1997.18. The overall mean sales coefficient is 76.08, with a standard deviation of 228.08. Given the results reported in Tables 4 and 5, it is not surprising that researchers have found dramatically different estimates of contract coefficients.

The results discussed here are not intended to add to the results already reported in the literature. These results are intended to provide an explanation of the variety of estimates discussed in Chapter II. The following section presents industry specific estimates of contract coefficients, and results of a test of the restriction that coefficients are equal across firms within an industry.

Restricted SUR Results

As noted above, much of the empirical work in the area of compensation has proceeded under the assumption that terms of compensation contracts are constant across firms. The analysis of the preceding section suggests that incentives vary across and within industries. If the homogeneity restriction is not supported by the data, then econometric models restricting coefficients to be the same across firms are miss-specified.

This section reports estimates of incentives for specific industries using a seemingly unrelated regression model. The initial specification of the regression equation is given in Equation 4.4:

$$\Psi_{it}=\beta_{0i}+\beta_1\pi_{it}+\beta_2 S_{it}+\mu_{it} \tag{4.4}$$

As in the cross-section model discussed above, analysis of the regression residuals suggests that the variance of the residuals is closely related to firm size. This section proposes to test the restriction of slope homogeneity across firms within an industry. Heteroskedasticity is problematical in this situation. To facilitate tests of the restrictions imposed, all variables and the intercept have been deflated by the book value of assets. This specification is given by Equation 4.5:

$$\frac{\Psi_{it}}{A_{it}}=\beta_{0i}\frac{1}{A_{it}}+\beta_1\frac{\pi_{it}}{A_{it}}+\beta_2\frac{S_{it}}{A_{it}}+\frac{\mu_{it}}{A_{it}} \tag{4.5}$$

In this model the slope coefficients, β_1 and β_2, are restricted to be equal across firms within an industry. To capture the relationship between firm size and a manager's salary, the intercept is free to vary across firms. If all owners create similar incentives, then statistical tests will fail to reject the null hypothesis of slope homogeneity.

Assuming the model specification is correct, the method of feasible seemingly unrelated regressions will produce residuals that are homoskedastic across firms. This will permit use of the Chow test to test the validity of the restrictions imposed by the econometric model.[12] As in the unrestricted model, when the Durbin-Watson statistic, calculated using the initial OLS estimates of the regression residuals, indicates that a firm's error structure is autoregressive, the observations for that firm have been replaced with data transformed using the Prais-Winston procedure.

The coefficients of interest in this section are the slope coefficients, reported in Table 6 below. Results of the tests of the within industry restrictions are mixed. In 22 of 49 cases, the Chow test rejects the null hypothesis of homogeneous slope coefficients across firms. In the remaining 27 cases, the Chow test fails to reject the null

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[12]For a discussion of the use of the Chow test see Fomby, Hill and Johnson (1984).

Table 6-Restricted Estimates of Contract Coefficients Based on a Linear SUR Model

SIC	β_1	β_2	F
1600	621.25 (1.67)	36.80 (1.09)	5.19[4]
2000	21.26 (0.82)	4.96 (1.19)	5.63[4]
2086	1.56 (0.05)	190.57 (4.47)	1.28
2111	122.00 (2.45)	97.88 (1.86)	0.49
2300	3076.3 (2.33)	-110.34 (-1.15)	0.81
2400	-22.95 (-0.22)	67.51 (4.78)	0.01
2600	593.18 (6.29)	92.07 (7.26)	2.41[4]
2649	-247.05 (0.70)	36.62 (0.64)	0.21
2711	889.80 (0.88)	33.81 (0.22)	1.87
2800	245.22 (5.35)	-4.68 (-1.46)	0.75
2830	727.53 (5.38)	109.89 (3.11)	1.76
2834	1174.06 (10.14)	11.15 (0.43)	1.00
2841	21.67 (0.08)	-10.76 (0.58)	0.73
2844	330.07 (1.80)	-120.03 (-1.74)	2.85[4]
2870	264.14 (0.96)	106.41 (2.09)	1.84
2890	-20.10 (-0.04)	291.28 (3.87)	1.62
2911	-229.11 (-25.8)	7.15 (9.75)	7.59[4]
3000	748.93 (3.62)	28.31 (0.63)	7.87[4]

Notes: 4 Indicates that the null hypothesis is rejected by the Chow test at the 95% level of confidence.

Table 6-Continued

SIC	β_1	β_2	F
3290	189.5 (4.29)	30.5 (6.13)	5.19
3310	70.97 (2.63)	35.08 (5.17)	1.82
3330	610.89 (4.07)	-14.7 (0.43)	0.36
3510	67.39 (0.39)	67.89 (2.71)	1.90
3533	654.24 (2.66)	2.53 (0.11)	0.08
3600	535.84 (7.23)	29.32 (3.17)	7.35[4]
3662	280.19 (2.57)	2.81 (0.93)	3.89[4]
3680	189.54 (4.29)	30.50 (6.13)	5.19[4]
3711	252.10 (6.71)	-2.31 (-0.41)	1.31
3720	768.64 (4.38)	11.05 (0.86)	1.15
3721	370.14 (3.83)	49.00 (4.89)	1.82[4]
3760	751.19 (5.79)	-7.93 (-0.59)	0.26
3841	376.68 (8.91)	86.30 (3.20)	4.45[4]
3861	126.10 (2.12)	14.45 (1.60)	1.13
4011	348.66 (2.85)	59.88 (2.51)	0.89
4511	66.27 (0.61)	-7.12 (-0.53)	1.39
4811	-79.66 (-2.62)	19.49 (3.07)	0.51
4911	56.44 (61.89)	22.50 (128.9)	10.4[4]

Notes: 4 Indicates that the null hypothesis is rejected by the Chow test at the 95% level of confidence.

Table 6-Continued

SIC	β_1	β_2	F
4922	-13.24 (-0.21)	30.56 (2.37)	0.07
4923	29.07 (0.23)	14.58 (1.66)	5.38[4]
4931	102.44 (17.35)	-0.85 (1.47)	5.01[4]
5140	2841.72 (2.96)	89.82 (10.99)	49.36[4]
5311	462.48 (3.11)	5.6 (0.60)	0.36
5411	1913.23 (6.14)	82.74 (9.81)	10.59[4]
5812	700.07 (4.70)	78.28 (10.89)	28.69[4]
6022	745.79 (15.67)	143.24 (20.46)	4.09[4]
6025	306.99 (31.46)	87.19 (40.77)	5.06[4]
6120	877.45 (6.75)	218.25 (17.09)	n.a.
6199	400.4 (5.02)	39.36 (5.85)	5.35[4]
6312	443.84 (6.99)	24.55 (6.70)	4.97[4]
6332	473.79 (5.02)	29.53 (1.88)	4.01[4]

Notes: 4 Indicates that the null hypothesis is rejected by the Chow test at the 95% level of confidence. n.a. indicates that the degree of multicollinearity was sufficiently high as to prevent use of the Chow test.

hypothesis at the 95% level of confidence.[13] These results suggest two things. First, while pooling data can increase efficiency, pooling must be done according to theoretic and econometric principles. Secondly, while the majority of sampled industries appear to create similar incentives, these results suggest that a large percentage of industries in the sample have managers with heterogeneous incentive structures.

It is appropriate to point out that the econometric model includes a second (implicit) restriction. The estimation procedure restricts coefficients to be constant over time. Owners of firms within an industry may well create identical incentives at a point in time; however, those incentives may change over time. If this is the case, then the Chow test will reject the null hypothesis not because of heterogeneities across firms, but because of heterogeneities across time.

Of the 27 industries where the null hypothesis is not rejected, managers in 15 industries appear to have positive incentives for profits. Mangers of telecommunications firms appear to be penalized for increases in firm profits. Managers of firms in 11 of the 27 industries face positive incentives for sales. In only 5 of 27 industries are both

[13]In one case the degree of multicollinearity between firms is so great that application of the Chow test is not possible. Simple diagnostic procedures indicate that multicollinearity, although present, is less of a problem in the remaining industries.

the profit and sales coefficients significant: in 4 both are positive, in one the sales coefficient is positive and the profit coefficient is negative.

In 10 industries, the profit coefficient alone is significant, and positive. This suggests that the predictions of classical microeconomic theory are correct. The positive sales incentives in 11 industries suggest that Baumol (1959, 1967) was right. Are both these models of incentives correct? Can we explain all observed incentive structures with these theories? The results discussed above identify one source of the differences between estimates of incentives reported in the literature; however, these results do not provide definitive answers as to the question of the incentive structure of contracts within industries. Considering the assumption of linearity, and the restriction that coefficients must be constant across time, the fact that in more than 50% of the industry regressions the null hypothesis is not rejected is encouraging for further research.

Summary

The results presented above suggest that the practice of grouping firms together when estimating compensation structures is not innocuous. Much of the previous research in this field has proceeded under the assumption that the pooling of firms is an appropriate technique, and has not tested the poolability of data. Large and significant differences in estimated coefficients across firms, and across industries logically suggests that by analyzing the structure of firms and industries, information pertaining to the factors affecting incentives may be found.

Finally, given the dynamic nature of the economy, the changing nature of firms, and the nature of the competition between firms it is unlikely that compensation contracts are static. Changes in tax laws, information flows, technology, and product lines will invariably lead to changes in the incentives created by compensation contracts. The results reported above do not constitute a test of the hypothesis that incentives change over time; however, the changing estimates found with cross-section analysis suggest that the affects of profits and sales on compensation vary over time. The firm and industry specific estimates indicate that incentives vary across industries.

In the following chapter, a model of incentives based on oligopoly theory will be presented. This model suggests that incentives for profits and sales will be functions of the number of firms in an industry, the variance and the covariance of production costs, and whether firms compete by choosing quantities or by choosing prices. As these variables change, the model suggests that sales and profit incentives will change predictably. The empirical results presented in this chapter do not constitute a test of the oligopoly model of incentives. However, these results are able to explain the apparently contradictory results summarized in Chapter II, and suggest that the affects of profits and sales on compensation are not constant.

CHAPTER V

OPTIMAL INCENTIVES IN OLIGOPOLISTIC INDUSTRIES

This chapter discusses a generalization of the Fershtman and Judd (1988) model of optimal incentive contracts. Fershtman and Judd describe optimal incentive contracts for a one shot game in oligopolistic industries. The contracts considered are linear functions of sales. This chapter describes how their model might be adapted to incorporate the repeated play nature of markets, introduces salary payments, and a contract coefficient representing the degree of dependence of compensation on performance.

Previous empirical research in the area of executive compensation has proceeded under the implicit assumption that incentives created by compensation contracts are static over time. In contrast, the work of Fershtman and Judd (1988) suggests that the incentives created by owners through contracts are determined in part by cost and demand conditions facing firms. Their model predicts that as cost and demand conditions change so will the relative weight on profits and sales in incentive contracts. Thus, according to the oligopoly model of incentives, estimated profit and sales coefficients will be functions of specific market conditions, and will change predictably over time.

Performance Contingent Payments

As discussed in Chapter II, in the usual contracting game the principal-agent problem to be solved by the compensation contract is a result of differences between the objectives of owners and managers. The owner's primary objective is the maximization of firm profits. The owner is the residual claimant; therefore, any change in firm profits will affect the owner's income. Viewed in the context of a repeated play game, the firm's profits will affect the value of the firm and the wealth of the owner. In either case, the owner's primary concern is with the firm's profits.

In contrast, the manager's interest in profits exists only to the extent that profits affect his income. The following analysis assumes that given an incentive contract, a manager will act to maximize his income. In the absence of a performance contingent compensation contract, a manager will have little incentive to exert effort in excess of the level needed to prevent his termination. Performance contingent contracts are designed in part to increase the manager's level of effort, and to realign the manager's incentives to coincide with the owner's goals.

As described above, empirical analyses of incentive contracts have relied on linear models; however, as will be described below, in addition to deciding how firm performance is to be measured, an owner must choose to what degree measured performance will affect compensation. If compensation contracts are actually nonlinear functions, linear regressions will not be able to estimate accurately the terms of compensation contracts.

No matter how performance is to be measured, the costs and efficiency of monitoring efforts will be key determinants of the extent of the principal-agent problem to be resolved by the contract. For example, if the principal is able to monitor perfectly the actions of the agent, then the problem to be resolved by the contract is reduced significantly, and little is to be gained from making compensation contingent on observed firm performance. In this situation, contracts that tie compensation payments to observed effort will be more efficient than those tieing payments to observed performance. However, when a manager's actions are not observable, but outcomes are observable, performance contingent contracts will play an important role.

Additionally, if a manager is has superior information about demand or cost conditions than the owner, owners will rely on performance contingent contracts that allow managers to respond to realized market conditions. For example, incentive contracts will allow managers to increase production when demand is high or costs are low, and reduce output when demand is low or costs are high. This ability to respond to market conditions will result in higher long run profits, as compared to the profits resulting from simple forcing contracts specifying output or price. As the costs of monitoring or the information advantage of managers increases, principals will write contracts in which a larger fraction of the manager's income is dependent on measured firm performance.

An owner's choice of the degree to which compensation will be dependent on performance also will be influenced by the degree to which the actions of the manager affect the performance of the firm. It is reasonable to assume that as the impact of a manager's decisions on firm performance increases, owners will choose compensation contracts that tie a manager's income more closely to the performance of the firm. Heterogeneity between the impact of managers' decisions on firm performance suggests that terms of compensation contracts will vary with the characteristics of firms and industries.[14]

While the determination of the extent to which firm performance will affect compensation is an integral part of the owner's optimization problem, in the analysis that follows the choice of the degree of dependence of compensation on performance for any given manager will be taken as given. A coefficient representing the degree of

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[14]Jensen and Murphy (1990) find empirical evidence that suggests the degree of dependence of compensation on performance varies according to the size of firms. These authors find that managers of small firms have compensation more closely tied to firm performance than do managers of large firms.

the dependence of compensation on performance will be included in the set of coefficients estimated by the econometric model discussed in Chapter VI. The analysis of the following section focuses on the measurement of performance, and the effects of industry and firm specific characteristics on compensation contracts.

Model Specification

When writing an incentive contract, an owner will attempt to create incentives for the manager that result in profit maximizing behavior; however, the manager does not operate in a vacuum. Realizing this, an owner will consider the effects of the contract written with his own manager on the behavior of competing managers. Given the information structure of the model (discussed below), when writing the contract the owner has an opportunity to act as a Stackelberg leader with respect to competing managers. As a result of the strategic interdependence of firms, optimal incentive contracts will depart from traditional incentive contracts based solely on profits. The results of the model indicate that at the margin, optimal contracts will either compensate or penalize the manager for increases in sales, depending on whether the firm is competing through quantities or prices.

The simple form of the model assumes that duopolists compete in a repeated play game in a single market. Each period is divided into two stages. During the first stage of each period, owners hire risk-neutral managers, and simultaneously write compensation contracts with their respective managers. These contracts are designed to affect the actions of the manager directly involved in the contract, and the choices of the manager of the competing firm. The decisions of each manager will be affected by changes in their respective residual demand curves, which will shift in response to choices made by their competitor.

This investigation assumes risk-neutral owners independently seek to maximize the present value of the firms' long run profits. Additionally, firms are assumed to be infinitely lived, and ownership is assumed to be transferable. Owners will be concerned with profits over the infinite future for several reasons. These include a bequest motive, and a desire to maximize the value, i.e. selling price, of the firm.

The following considerations motivate the assumption that firms and managers cannot collude in the repeated game. First, U.S. anti-trust statutes are designed, in part, to prevent collusion between firms or their owners. In addition, Green and Porter (1984) find that given a sufficiently large degree of uncertainty, managers attempting to collude will be unable to determine when low realized prices are the result of cheating by competing firms, or when low prices are the result of an adverse demand shock. This indeterminancey results in the breakdown of the collusive agreement. Finally, the Folk Theorem of repeated games suggests that if owners have a sufficiently high discount rate, then collusion will not emerge as an equilibrium. Since each owner places little value on future profits, they become myopic, caring only about current period profits.

Further, the model assumes that competitive supply conditions prevail in the market for managers. More specifically, a large number of managers compete for positions in a limited number of firms. As a result of this competition among managers, expected payments under the contract will be equal to each manager's opportunity cost of participation; therefore; any rents resulting from the firm-manager relationship will accrue to firms and their owners. The question of whether owners or potential managers make contract offers is unimportant provided there exists a competitive number of potential managers, that firms to be managed are a scarce resource, and that any contract offered by an owner may be offered by a manager, and vice-versa.

Given an incentive contract, each manager attempts to maximize his compensation payment. This assumption reflects the competitive conditions of the managerial labor market. Because of cost or demand shocks, during any given period a manager's income may be greater or less than his or her opportunity cost; however, no manager's *expected* income will exceed his or her opportunity cost of participation.[15] With the restriction that the manager's expected income under the contract is equal to his or her opportunity cost, owners are free to choose contracts that maximize the firm's expected long run profits.

The model assumes that cost or demand uncertainty is sufficiently large that simple forcing contracts specifying a price or quantity are excluded from the class of efficient contracts. By assumption, managers receive information concerning cost and demand conditions at the beginning of the production stage of the game, whereas owners do not. Under these conditions, forcing contracts would prevent managers from adjusting price and/or output in response to the realized values of these variables each period. Simple forcing contracts tie the hands of managers, and with sufficient uncertainty will be inefficient.

During the first stage of each period, owners and managers know the true probability distribution of costs and demand; however, neither owners nor managers know the value the variables will attain until the second stage of each period. During the second stage, each manager's information set includes details of all incentive contracts, and the realizations of cost and demand conditions. Thus, managers

[15]This assumption maybe adjusted to allow for payments for firm specific human capital. However, doing so will not alter the optimal incentive contract, only the level of payment.

have complete information over cost and demand conditions, and the terms of the incentive contracts of each of their competitors. Managers use this information when making production and pricing decisions.

At the end of the second stage, owners observe only the actual costs, sales, and profits of their firms. Owners use this information to make compensation payments to their respective managers. Owners do not receive information about the actual realizations of cost and demand conditions for any period at any time during the game.

The compensation received by a manager is assumed to consist of two distinct parts. The first portion of the compensation payment is invariant with firm performance, and is analogous to a manager's salary. The portion of the compensation payment of primary interest here is the portion that is dependent on firm performance.

As described above, the compensation payment received by a manager will depend on the firm's measured performance, and the degree to which performance affects compensation. In the course of this investigation, two questions arise: how will performance be measured and how will measured performance affect compensation? The model assumes the performance measure consists of a linear combination of profits and sales. Given the structure of the model outlined above, the class of contracts considered are of the form:

$$\Psi_{it}=\kappa_i+\delta_i[\alpha_{it}\pi_{it}+(1-\alpha_{it})S_{it}] \quad (5.1)$$

In this specification, Ψ_{it} represents the compensation paid to the manager of firm i in period t, κ_i represents the salary payment to the manager of firm i, π_{it} and S_{it} are respectively the profits and sales of firm i in period t. Finally, δ_i is the degree of dependence of compensation on measured firm performance. α_{it} is the owner's choice variable when writing the incentive contract, and determines the relative weight placed on profits and sales in the compensation contract. As shown below, this formulation may be interpreted as defining incentives to be a linear combination of profits and sales, or sales and costs.[16] The model places no further restrictions on the value of α_{it}.

When writing compensation contracts, owners have three choice variables: κ_i, δ_i and α_{it}. Recall that competition in the managerial labor market will ensure that a manager's expected income in any period is equal to his or her opportunity cost, which is assumed to be constant. The owner must choose κ_i, δ_i and α_{it} so that the expected payment under the contract is equal to the manager's opportunity cost. Assuming the manager is risk-neutral, and receives no

[16]Holmstrom and Milgrom (1987) show that under similar conditions, a principal-agent relationship with uncertainty, that the optimal incentive contract is linear in the set of observable variables.

disutility from effort, if δ_i is positive, then only α_{it} will affect the manager's behavior. Neither κ_i, nor δ_i will affect the manager's production or pricing decisions; therefore, the following analysis concentrates on the owner's choice of α_{it}.

As illustrated by the contract above, the selected value of α_{it} determines whether managers are rewarded or penalized for sales. A value of α_{it} equal to one creates incentives that comply with traditional profit maximizing contracts; compensation will be a function of profits alone. With α_{it} equal to one, costs and sales affect Ψ_{it} only through their effects on profits. A value of α_{it} that is less (greater) than one implies managers will be rewarded (penalized), ceteris paribus, for higher sales levels. Because of the sales (dis)incentive when $\alpha_{it}<1$ ($\alpha_{it}>1$), the contract results in output that is more (less) than the output produced when managers are compensated for profits alone. The following section presents the derivation of the owner's profit maximizing choice of α_{it} when firms compete in quantities.

Quantity Competition

The solution to the contract problem is found through backward induction. When derived in this way, the owner's choice of α_{it} in the first stage will be the Nash equilibrium value of α_{it} during the second stage. During the second stage, managers use all available information, including the terms of all incentive contracts, to make decisions regarding output and price to maximize Ψ_{it}. When chosen in this way α_{it}, output, and price are sub-game perfect Nash equilibrium solutions in the contracting game. The results for the Cournot (quantity) duopoly game, under the assumption that the intercept of demand is random, are shown below.

Demand, represented below by Equation 5.2, is assumed to be linear and random.

$$P_t = A_t - BQ_t, \quad A_t, B>0 \tag{5.2}$$

Q_t is the sum of the two firms production in period t. As implied by the common price effect, B, q_{it} and q_{jt} are perfect substitutes. P_t is the common product price, and A_t is the price intercept of demand in period t. The price intercept of demand is assumed to be random over time, with the following distribution:

$$A_t \sim N(\bar{A}, \sigma^2) \tag{5.3}$$

This distribution implies that: $E[A_t]=\bar{A} \ \forall \ t$.

Assuming each firm has constant marginal costs of C_i, i=1,2, manager i's expected income under the incentive contract may be written as:

$$\Psi_{it}=\kappa_i+\delta_i[\alpha_{it}[A_{it}-B(q_{it}+q_{jt})-C_i]q_{it}+ (1-\alpha_{it})[A_{it}-B(q_{it}+q_{jt})]q_{it}],\ \forall\, i\neq j \tag{5.4}$$

Given firms compete in quantities, the manager of firm i maximizes his compensation with respect to q_i. The solution to this optimization problem yields the reaction function for the manager of firm i, given by Equation 5.5:

$$q_{it}=\frac{A_t-Bq_{jt}-\alpha_{it}C_i}{2B},\ \forall\, i\neq j \tag{5.5}$$

Solving these reaction functions for their simultaneous solution will yield manager i's income maximizing output as a function of cost, demand, and contract variables, shown by Equation 6:

$$q_{it}=\frac{A_t-2\alpha_i C_i+\alpha_{jt}C_j}{3B} \tag{5.6}$$

Assuming a symmetric equilibrium, this level of output may then be used to derive the equilibrium market price, and each firm's profits as functions of demand and cost conditions, and contract coefficients. The price and profit equations are given by Equations 5.7 and 5.8:

$$P_t = \frac{A_t + \alpha_i C_i + \alpha_{jt} C_j}{3} \qquad (5.7)$$

$$\Pi_{it} = \frac{(A_{it} + \alpha_{it} C_i + \alpha_{jt} C_j - 3C_i)(A_{it} - 2\alpha_{it} C_i + \alpha_{jt} C_j)}{9B} \qquad (5.8)$$

The owner uses this solution to the manager's second stage income maximization problem when choosing the value of α_{it} that maximizes the firm's expected long run profits.

Assuming each owner shares a common discount rate, r, the present value of firm i's expected future profits is given by Equation 5.9:

$$E\Pi_i^{lr} = E\sum_{t=0}^{\infty}\left\{\frac{1}{(1+r)}\right\}^t \left\{\frac{(A_t + \alpha_{it} C_i + \alpha_{jt} C_j - 3C_i)(A_t - 2\alpha_{it} C_i + \alpha_{jt} C_j)}{9B}\right\} \qquad (5.9)$$

If r is sufficiently large, firms and owners are unable to collude, and since expected value of A_t is constant over time, owners can do no better than maximize their firm's profits each period; therefore, each owner's profit maximization problem reduces to choosing the value of α_{it} that maximizes long run profits, given by Equation 5.10:

$$E\Pi_i^{lr} = \left\{\frac{1+r}{r}\right\}\frac{(\bar{A} + \alpha_{it} C_i + \alpha_{jt} C_j - 3C_i)(\bar{A} - 2\alpha_{it} C_i + \alpha_{jt} C_j)}{9B} \qquad (5.10)$$

The solution to this problem yields the owner's stage one reaction functions, given by Equation 5.11, for each owner's choice of α_{it}. These reaction functions show each owner's best choice of α_{it} as a function of expected demand and cost conditions, and the competing owners choice of α_{jt}.

$$\alpha_{it}=\frac{6}{4}-\frac{\bar{A}}{4C_i}-\frac{\alpha_{jt}}{4C_i},\ for\ i\neq j \tag{5.11}$$

By solving these reaction functions simultaneously, the long run profit maximizing contract coefficient is found. The equilibrium choice of α_{it} is given by equation 5.12:

$$\alpha_{it}=1-\frac{\bar{A}+2C_j-3C_i}{5C_i} \tag{5.12}$$

As shown by Equation 5.12, provided each firm produces a positive quantity, owners will write contracts rewarding managers for sales ($\alpha_{it}<1$) in an attempt to gain a larger share of the market, and effectively will become a Stackelberg leader. However, since it is in each owner's interest to write contracts creating positive sales incentives, each manager will select an output level greater than the profit maximizing output in the standard Cournot duopoly game without contracting. These output levels will result in lower prices and profits, and improved allocative efficiency, as compared to the outcome in the standard

Cournot game.

The results of the repeated game outlined above duplicate the results of the one shot game of Fershtman and Judd (1987). In addition, Fershtman and Judd show similar results for the cases of cost uncertainty, uncertainty with respect to the slope of demand, and changes in the number of firms in the market.

With cost uncertainty, Fershtman and Judd show that as the variance of production costs increases, ceteris paribus, the benefits of strategic contracting decrease. This is because owners will not want their managers to produce large levels of output when their firms experience an adverse cost shock. With quantity competition, the profit maximizing value of α_{it} is an increasing function of the variance of production costs. They also show that as the correlation of cost shocks increases, the benefits of strategic contracting are regained. Therefore, α_{it} will be a decreasing function of the covariance of cost shocks. Finally, the authors show that as the number of firms in a market increases, the benefits of strategic contracting decrease. α_{it} is an increasing function of the number of firms in the industry. The following list summarizes these results.

Given quantity competition:

(1) The incentive contract will create a positive incentive for sales: H_1: $\alpha_{it} < 1$.

(1a) H_{1a}: α_{it} is a decreasing function of the covariance of production costs.

(1b) H_{1b}: α_{it} is an increasing function of the variance of production costs.

(1c) H_{1c}: α_{it} is a decreasing function of the number of competing firms.

The results corresponding to price competition are described below.

Price Competition

For differentiated product duopolists engaging in price competition, the contract phase provides each owner with an opportunity to signal a willingness to price less aggressively. By writing an incentive contract that penalizes the manager for sales (α_{it}>1), the owner is able to commit the manager to a price higher than that resulting from the usual Bertrand (price) competition. This commitment is made in an attempt to induce competing managers to reduce production, and increase the price of their firm's product. The result being a smaller equilibrium quantity in the market, with higher prices and profits for each firm than in the Bertrand competition without contracting.

Fershtman and Judd discuss the cases of cost and demand uncertainty. With cost uncertainty and price competition, Fershtman and Judd again find, as the variance of production costs increases, ceteris paribus, the benefits of strategic contracting decrease. In this case, the profit maximizing value of α_{it} will be a decreasing function of the variance of production costs. They also show that as the correlation of cost shocks increases, the benefits of strategic contracting are regained. Here, α_{it} will be an increasing function of the covariance of cost shocks.

The following list summarizes the model's predictions for the case of price competition.

2) The incentive contract will penalize managers for sales: H_1: $\alpha_{it} > 1$.

2a) H_{2a}: α_{it} is an increasing function of the covariance of production costs.

(2b) H_{2b}: α_{it} is a decreasing function of the variance of production costs.

The affects of changes in the number of firms on the optimal value of α_{it} in the price game is not considered by Fershtman and Judd. However, the gain from strategic contracting results from the affects of the contract on the behavior of competing managers. Intuition suggests that as the number of firms increases, the affect of a contract on the behavior of competing managers will decrease. Therefore, the empirical analysis of the following chapter assumes that for firms engaging in price competition, the profit maximizing value of α_{it} is a decreasing function of the number of firms in an industry.

Summary

The model described above analyzes the issue of executive compensation in a model of market competition. The industrial organization literature finds dramatic differences in the output, price, and profits of firms in oligopoly markets depending on whether firms compete in prices or in quantities. This suggests that the incentives facing managers will also vary according to the form of competition in the product market. The results of the theoretical model outlined above confirm this intuition. In addition, the model incorporates predictions of classical microeconomic theory as special cases.

Incentive contracts written by owners distort the profit maximizing incentives implied by classical microeconomic theory. These contracts are designed to affect the production and pricing decisions of competing managers so that each firm's profits increase. The specific value of α_{it} selected by an owner will be determined by the strategic variable chosen, quantity or price, the variance and covariance of cost shocks, and the number of firms in the market.

With cost uncertainty, it can be shown that the weight placed on profits and sales by the incentive contract will be a function of the variance and covariance of costs and the number of firms competing in the market. This implies that the incentives created by the owner through the contract will not be static over time, but will change predictably with each of these variables.

Although each owner is choosing α_{it} to maximize long run profits of the firm, it is possible that the resulting contract equilibrium is one of lower profits for all firms, as in the case of quantity competition. In both settings, price and quantity competition, the contract equilibrium satisfies the best response property of a Nash equilibrium, so no firm can unilaterally increase profits by changing either price or quantity.

Given the results of the model outlined above, it is not surprising that attempts to estimate the terms of incentive contracts have generated apparently contradictory results. Some empirical researchers have reported managers are rewarded for increases in sales, others have found evidence suggesting that managers are penalized for sales growth, and some have found that sales are unimportant and that profits are the sole determinant of a manager's compensation. With the oligopoly based theory of compensation, all of the results described above can be explained.

The oligopoly model of compensation has presented the owners' contracting problem in the context of a principal-agent model. The model's foundation is built on research from the field of industrial organization. As a result, empirical research into the issue of management incentive contracts may now be guided by a well specified theory. It is this issue that will be analyzed in the following chapter.

CHAPTER VI

THE OLIGOPOLY MODEL OF COMPENSATION: AN EMPIRICAL ANALYSIS

This chapter seeks to bridge the gaps between the theory of incentives presented in the previous chapter, prevailing industry conditions, and available data. The model of incentives presented in Chapter V includes a number of assumptions that make empirical estimation difficult. For example, the model assumes both owners and managers know the distribution of cost and demand variables. This assumption makes it possible to write a contract under which the expected payment is equal to the manager's opportunity cost. In addition, Fershtman and Judd assume homogeneous firms, and conditions that result in a symmetric equilibrium.

This chapter considers the implications of these assumptions, and describes how available data may be used to estimate the terms of incentive contracts based on the model described above. Throughout the following discussion, the assumption that owners and managers are risk-neutral is maintained. However, the discussion will consider the affects of a firm's market share, and available information on the estimation problem. Finally, estimates of incentives based on the oligopoly model of compensation will be presented.

A Testable Form of the Model

Presumably, incentive contracts are written to elicit effort from managers. The model generates clear predictions about the value of α_{it}. The model predicts that when duopolists compete in prices, owners will write incentive contracts penalizing managers for sales, and when firms compete in quantities, managers will be compensated for sales.

When analyzing proxy statements, no explicit link between compensation, profits, and sales is found. The difference between the time the contract is written and the time data becomes available creates a problem for empirical researchers. The indicators of performance available to empirical researchers are the past values of profits, sales, and costs. At the time the compensation contract is written, owners know the distribution of variables affecting costs and demand; however, owners do not know the true value of demand or cost variables for any given period. Given the available information, owners make predictions about the future values of cost and demand variables. Therefore, when writing the incentive contract owners have expectations about the firm's future profits and sales, while researchers attempting to estimate the terms of those contracts must rely on realized profit and sales data.

The value of α_{it} is chosen at the time the contract is negotiated. To estimate α_{it}, as described by theory, the researcher must know the owner's beliefs about the distribution of cost and demand variables, which is of course not possible. Taking the existing information state into consideration, the expected payment under the incentive contract for the manager of firm i is given by equation 6.1:

$$E[\Psi_{it}I_{t-1}] = E[\kappa_i+\delta_i\{(\alpha_{it}|I_{t-1})(\Pi_{it}|I_{t-1})+ (1-(\alpha_{it}|I_{t-1}))(S_{it}|I_{t-1})\}] \tag{6.1}$$

As in Chapter V, Ψ_{it} represents compensation paid to the manager of firm i in period t, κ_i represents the salary payment, δ_i is the degree to which compensation depends on performance, and α_{it} determines the relative weight placed on sales and profits by the contract. This specification shows that expected compensation, and the value of α_{it} chosen by the owner are functions of the information available during the preceding period.

Data available to the empirical researcher are actual sales (S_{it}), cost (C_{it}), and profit (Π_{it}) data, and the manager's compensation payment (Ψ_{it}), received by the manager at the end of period t. To estimate α_{it}, certain assumptions about the distribution of profits, costs, and sales must be made. Equations 6.2 and 6.3 specify the assumptions made about the distribution of sales and costs, respectively.

$$S_{it}=S_{it-1}+\mu_{it},\ where\ \mu\sim N(0,\sigma_\mu^2), \tag{6.2}$$

so that $E[S_{it}|I_{t-1}] = S_{it-1}$, and

$$C_{it} = C_{it-1} + \nu_{it}, \ where\ \nu \sim (0, \sigma_\nu^2) \tag{6.3}$$

so that $E[C_{it}|I_{it-1}] = C_{it-1}$. Given these assumptions, the expected profits of firm i in period t can be written as follows:

$$E[\Pi_{it}|I_{t-1}] = E[(S_{it-1}+\mu_{it}) - (C_{it-1}+\nu_{it})] \tag{6.4}$$

with the result that: $E[\Pi_{it}|I_{t-1}] = \Pi_{it-1}$.

Assuming demand and cost shocks are independent, the variance of profits is equal to the sum of the variance of demand and cost variables. This is given by equation 6.5:

$$\sigma_\eta^2 = \sigma_\mu^2 + \sigma_\nu^2 \tag{6.5}$$

Given these assumptions, and substituting expected sales and costs for the profit term in equation 6.1, the expected compensation equation may be written as follows:

$$E[\Psi_{it}|I_{it-1}] = \kappa_i + \delta_i(S_{it-1} - \alpha_{it}C_{it-1}) \tag{6.6}$$

This shows that expected compensation may be written as a function of observable past variables. Note the assumptions made about the distribution of demand and cost shocks imply that, on average, observed compensation, profits, and sales will equal their expected levels.

If in any period the realized cost and/or demand variables are not equal to their expected values, then observed profits, sales, and compensation will be greater or less than expected. This compounds the estimation problem facing the empirical researcher; however, given the assumptions about the distribution of demand and cost shocks, by using time series data, estimates of α_{it} will be asymptotically unbiased.

Empirical estimation of α_{it} will likely suggest that certain industries are engaging in price or quantity competition; however, the model predicts that the contract coefficient is itself a function of market conditions that are changing over time. Estimation of a single value of α_{it} will not provide a test of the theory, or give any dependable indication of which industries compete in prices, or which industries compete in quantities. To test the theory, the factors underlying the owner's choice of α_{it} must be examined.

The observed values of α_{it} will be functions of the form of competition, the number of firms in an industry, and the variance and covariance of cost shocks. As discussed in Chapter V, an increase in the variance of cost shocks, ceteris paribus, will reduce the gains from strategic contracting.

The model assumes owners base the choice of α_{it} on some hypothesis about the affects of the incentive contract on the behavior of their rival's manager. No attempt will be made here to model how owners determine the affect of a contract on the behavior of competing managers; however, it is reasonable to expect that the strategic aspect of the contract will be of greater importance to large firms, than to small firms. Assuming imperfectly competitive markets, the larger a firm is, ceteris paribus, the greater will be the affect of it's production and pricing decisions on conditions in the product market. For example, a relatively small firm, such as Amerada Hess, will be more concerned with the production and pricing decisions of Chevron, than Chevron will be with the production and pricing policies of Amerada Hess.

In both the price and quantity games, the model finds as competition increases the magnitude of the distortion from traditional profit maximizing contracts decreases. If N_i represents the number of identical firms in an industry, then $1/N_i$ is equal to the fraction of the market served by the firm, each firm's market share. Note that when market share replaces the number of firms in the equation defining α_{it} the predicted sign of the coefficient will change. Therefore, when firms compete in quantities, α_{it} will be an decreasing function of market share, and when firms compete in prices, α_{it} will be an increasing function of market share.[17] The equation showing α_{it} as a function of market share and the variance of production costs is given below:

$$\frac{\sum_{t=1}^{T}\alpha_{it}}{T}=\frac{\sum_{t=1}^{T}\beta_0+\beta_1\theta_{it}+\beta_2\sigma_t^2}{T} \qquad (6.7)$$

By estimating the terms of compensation contracts, using the model specified above, each observed value of α_{it} may be tested for consistency with the model, rather than merely providing suggestive evidence as to whether particular firms and industries compete in prices or quantities.

Estimation Method and Results

The theory of incentive structures, presented in Chapter V, is designed to explain and predict how owners of firms competing in oligopolistic industries will structure incentives. By including firms ranked consistently among the largest in the country, and therefore the largest in their respective industries, the data set has been designed to include information about the type of firm with which the theory is concerned.

As described above, the observed relationship between performance and pay will be affected by realizations of cost

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[17]When there are N homogeneous firms in an industry, 1/N will be equal to each firm's market share, s_i/M, where s_i is equal to a firm's sales, and M is the sum of all firms' sales.

and demand shocks. In any given year, a shock to either costs or demand will result in an observed payment that reflects the effects of the managers decisions, his effort, and the affect of shocks on firm performance. Time series analysis will be able to separate the affects of shocks to demand and costs on compensation, from the incentives created by the contract. Therefore, time series data will provide a richer data set, and facilitate more efficient estimation of contract coefficients than will cross-section data.

In contrast, estimates of incentive structures based on cross-section data will be biased. Cross-section data that includes firms from a variety of industries will not allow estimation of the affects of firm or industry specific variables. If there are systematic differences in the structure of incentives across industries, as suggested by the oligopoly model of compensation, a regression model that pools firms across industries will be miss-specified. These observations suggest the assumption of homogeneity of contracts across firms should be treated as a testable hypothesis. For these reasons the data set used in the empirical analysis that follows only includes firms appearing in Forbes rankings throughout the sample period.

A potential complication arising from the use of large firms to test the theory results from the fact that many firms in the sample compete in more than one product market.

According to the theory, whether managers are compensated or penalized for increases in sales depends on whether firms compete in quantities or prices. If a firm is operating in more than one market, then it is possible that it is competing in prices in some markets, and competing in quantities in others. The firm's presence in markets with different strategic variables suggests that estimates of the terms of incentive contracts may not conform to the predictions of the theory. In this case, managers may be compensated or penalized for sales, or be compensated only for maximizing profits. The reported compensation figure does not report compensation based on each divisions performance; therefore, it will be impossible to determine whether the measure of performance, and its effect on compensation, is the same for each division. If compensation and performance data for division managers were available, it may be possible to determine if incentives predicted by the model are passed on to lower level managers. Finally, although large, firms in the sample may compete in competitive markets and owners pay managers only for profits. For these reasons results suggesting that the CEO of a firm has his compensation determined by profits alone will not be sufficient to reject the oligopoly theory of compensation.

Finally, to facilitate estimation of the variance of costs and each firm's market share, only industries where at least two firms satisfy the conditions to be included in the sample are represented. While these conditions precluded many firms from being included in the final sample, the sample that remains is sufficiently large to permit estimation of the performance pay relationship.

The incentives created by an employment contract will be dependent on the firm's market share, and the variance of production costs. Each of these factors will affect the relative weight placed on sales and profits by the compensation contract. It is easy to show empirically that both market share and the variance of production costs change over time; therefore, incentives created by compensation contracts will also vary over time. By including these variables in the regression equation, given by Equation 6.8, it will be possible to capture some of the dynamic nature of compensation contracts.

$$\Psi_{it}=\kappa_i+\delta_i\{S_{it-1}+[\beta_0+\beta_1\theta_{it}+\beta_2\sigma_v^2]\,C_{it-1}\}+\mu_{it} \qquad (6.8)$$

Descriptions of Ψ_{it}, κ_i, and δ_i have been given above. β_0 is the intercept of the function determining the value of α_{it}. β_1 is the coefficient on market share, θ_{it}, and β_2 is the coefficient on the variance of costs in the α function. For the purposes of estimation, each period the market is defined to be the sum of the sales of all firms included in the sample competing in an industry. Industries are defined according to four digit SIC codes. The market share of a firm in any given year has been defined to be equal to the firm's sales, divided by market sales during that year.

The estimate of the variance of costs also relies on industry data. The cost term in the model presented in Chapter V is the marginal cost of production. To approximate marginal costs, and to facilitate estimation of the variance of costs, the total cost figure for each firm for each year is calculated. To adjust for differences in firm size, and to minimize differences in measured costs resulting from product heterogeneity, each firm's total cost is divided by the firm's total sales. The estimated variance of costs in a given year is defined to be equal to the variance of costs per dollar of sales across all firms in an industry during a given year.

To facilitate estimation, sales and costs have been used as independent variables in the regression equation, rather than profits and sales. This substitution has no affect on the estimated coefficients. The econometric technique used to estimate incentives is similar to that described in Chapter 4; however, the incentive contract described above is nonlinear in the coefficients. Therefore, the estimation method employed is nonlinear Seemingly Unrelated Regressions. When coefficient estimates are unrestricted, this method produces unbiased coefficients, even though the error variance is heteroskedastic across equations. However, to facilitate comparisons with the results of the linear model, reported in Chapter IV, the sales and cost data have been deflated by asset value. Equation 6.9 shows the final specification of the regression model.

$$\frac{\Psi_{it}}{A_{it}} = \frac{\kappa_i}{A_{it}} + \delta_i \left(\frac{S_{it}}{A_{it}} - (\beta_0 + \beta_1 \theta_{it} + \beta_2 \sigma_t^2) \frac{C_{it}}{A_{it}} \right) + \frac{\mu_{it}}{A_{it}} \qquad (6.9)$$

As described previously, this specification is analogous to a model where managers maximize their income, subject to capital constraints. Since this specification is linearly homogeneous in assets, interpretation of the regression coefficients is unaffected by this adjustment.

The reasons for selecting a SUR model are similar to those expressed in Chapter IV: cost and demand shocks are likely to result in non-zero covariance of residuals across firms, and the SUR model is able to use this information to improve the efficiency of estimates. The nonlinear SUR model in the SAS program is used to estimate regression coefficients. This program uses the Gauss-Newton iterative technique to minimize a generalized mean square error, referred to as the objective. The objective is defined as follows:

$$objective = r'(\Sigma^{-1} \otimes I_t)\, r/t \qquad (6.10)$$

r is an Nt*1 vector of the residuals for the N equations, and t is the number of observations per firm.[18]

Two series of regressions are run. In both series, the intercept, and the degree of dependence of compensation on performance are unrestricted across firms. As noted in Chapter V, a manager's expected compensation is equal to his opportunity cost. Owners have three choice variables, α_{it}, δ_i, and κ_i. The optimal value of α_{it} has been shown to be a function of firm and industry characteristics. By allowing both δ_i, and κ_i to remain unrestricted, owners will be able to write contracts where expected payments will equal a manager's opportunity cost.

The theory suggests that the affect of firm and market conditions on α_{it} will be the same across firms in an industry; therefore, in the first series of regressions the coefficients determining the value of α_{it} (β_0, β_1, and β_2) are restricted to be equal across all firms in an industry. With this specification, the coefficient estimates failed to converge for 8 of 50 industries in the sample. For the remaining industries, coefficient estimates were assumed to converge to their true value if the norm of the gradient of the objective function becomes sufficiently small (0.001). The norming matrix is proportional to the covariance of the parameter estimates. In the 42 industries where the

[18]For a complete description of the objective function, convergence criteria and other aspects of the statistical methodology see the SAS Econometric and Time Series manual, version 6.03.

estimates converged, the regression coefficients are robust to changes in the starting values of the coefficients.

In the second series of regressions, both β_1 and β_2 were restricted to be equal to zero, this specification will be referred to as the restricted model in the discussion that follows. To facilitate testing of the restriction, the variance-covariance matrix from the unrestricted model is used in the second step of the estimation of the restricted model. The difference between the value of T*objective from the restricted and the unrestricted models can be used as an asymptotically valid Chi-square test of the restriction. This test can be shown to be analogous to a Likelihood Ratio test (Gallant 1975).

As expected, the Durbin-Watson statistic indicates the error structure for many firms in the sample is autoregressive. When the Durbin-Watson statistic failed to reject the hypothesis of non-autoregressive disturbances at the 5% level of significance, the data has been corrected using the Prais-Winston procedure. Each of the systems of SUR equations was again estimated using the adjusted data. When the estimated correlation coefficient was not statistically different from zero, the correction for auto-regression was dropped, and the uncorrected data was used in the regressions.

In 27 of the 42 industries where convergence was obtained, the test of the joint significance of β_1 and β_2

rejected the null hypothesis, H_0: $\beta_1=\beta_2=0$, at the 90% level of confidence. Table 7 presents the estimated values of β_0, β_1, and β_2, with their respective t-statistics for all industries where β_1 and β_2 are shown to be jointly significant. With nonlinear estimation, individual t-tests are valid only asymptotically; therefore, caution should be exercised when interpreting individual coefficient estimates. To assist interpretation, the number of firms included in each industry is recorded below the SIC code.

As described in Chapter V, when oligopolistic firms compete in quantities, the optimal value of α_{it} will be less than one: managers are compensated for increases in sales. Gains from strategic contracting increase as the firm's market share increases. Therefore, when firms compete in quantities, the optimal value of α_{it} will be less than one, and will decrease further as a firm's market share increases: β_1 will be negative for firms competing in quantities. In contrast, as the variance of production costs increases, gains from strategic behavior decrease. Therefore, as the variance of production costs increases, the profit maximizing value of α_{it} increases: β_2 will be positive for firms competing in quantities.

Results of the theoretical model indicate, when firms compete in prices, manager's are penalized for sales; the profit maximizing value of α_{it} is greater than one. The benefits of strategic contracting increase with increases in

Table 7-Industry Specific Estimates of the Coefficients Underlying the Value of α_{it}

SIC	β_0	β_1	β_2
2000 5	1.031 (118.81)	-0.051 (-3.29)	-0.099 (-3.26)
2086 2	0.519 (1.35)	0.773 (1.33)	0.073 (0.88)
2111 2	0.542 (1.20)	0.546 (1.17)	-0.465 (-1.08)
2300 2	1.029 (11.27)	-0.529 (-0.87)	-1.235 (-0.03)
2800 11	0.548 (7.50)	3.146 (6.19)	-12.455 (-3.82)
2830 6	0.837 (13.50)	0.799 (3.39)	-4.096 (-1.72)
2834 5	0.911 (10.97)	0.438 (1.45)	-9.543 (-1.63)
2841 2	0.877 (15.37)	0.334 (2.74)	-20.184 (-1.26)
2870 2	2.460 (1.91)	-1.185 (-0.97)	0.720 (0.02)
2911 16	0.762 (29.21)	2.062 (6.62)	-44.977 (-9.62)
3510 3	-1.935 (-1.04)	5.179 (1.3)	-2.005 (-0.77)
3711 4	0.747 (6.11)	-0.184 (-2.22)	1.090 (0.46)
3720 2	0.549 (2.00)	0.601 (0.98)	13.655 (0.68)
3721 6	0.549 (2.00)	3.369 (1.69)	26.729 (1.27)
3861 4	1.042 (9.74)	0.359 (0.44)	44.398 (1.53)
4011 2	0.644 (3.06)	0.465 (2.15)	-5.273 (-3.04)

Notes: The number of firms in each industry is given below the SIC codes. t-statistics are in parentheses.

Table 7-Continued

SIC	β_0	β_1	β_2
4911 20	0.947 (210.8)	0.393 (23.21)	0.044 (4.93)
4922 5	1.090 (9.90)	-0.875 (-0.72)	-20.075 (-5.01)
4923 3	1.190 (13.41)	-0.541 (-1.96)	0.324 (0.04)
4931 15	2.460 (1.91)	-1.185 (-0.97)	0.72 (0.02)
5311 3	1.090 (58.50)	-0.213 (-4.70)	-13.342 (-0.66)
5411 5	-0.268 (-0.12)	4.656 (0.56)	-99.795 (-0.55)
6025 16	0.849 (54.61)	1.218 (7.96)	-1.148 (-1.13)
6120 3	0.536 (6.41)	1.303 (5.55)	5.909 (0.91)
6199 4	1.039 (57.31)	0.081 (2.22)	9.416 (2.33)
6312 8	-0.569 (-0.80)	20.826 (2.15)	-22.847 (-1.66)
6332 4	0.639 (5.19)	1.193 (3.09)	0.252 (0.05)

Notes: The number of firms in each industry is given below the SIC codes. t-statistics are in parentheses.

market share, and decrease with increases in the variance of production costs. With price competition, β_1 will be positive, and β_2 will be negative. For both price and quantity competition, as a firm's market share approaches zero, or the variance of production costs approaches infinity, α_{it} will approach unity, and terms of incentive contracts will approach the terms of more traditional contracts based only on profits. The influence of sales on compensation will fall.

Estimated values of α_{it} suggest that the terms of compensation contracts vary significantly over firms and industries. Table 8 presents the estimated mean and standard deviation of α_{it} for each of the firms in the 27 industries where β_1 and β_2 are jointly different from zero. The mean value of α_{it} is simply the mean calculated over time for a firm. The equation used to calculate α_{it} is given by equation 6.11:

$$\frac{\sum_{t=1}^{T}\alpha_{it}}{T}=\frac{\sum_{t=1}^{T}\beta_0+\beta_1\theta_{it}+\beta_2\sigma_t^2}{T} \tag{6.11}$$

Table 8 also reports estimates of δ_i, and t-statistics, for each firm.

Many of the calculated values of α_{it} are clustered around one; however, the mean value of α_{it} ranges from a high of 7.64 for Aetna Life Insurance Corporation, indicating the CEO is penalized for sales, to a low of -0.867 for Brunswick

Table 8-Mean Estimated Value of α_{it} for Each Firm, and Estimates of δ_i for Each Firm

Firm SIC	δ_i	$\bar{\alpha}$ (Std Dev)
3 2000	6.18 (5.15)	1.020 (0.003)
4 2000	2.10 (3.75)	1.017 (0.004)
5 2000	1.50 (2.91)	1.017 (0.003)
6 2000	0.01 (0.39)	1.023 (0.003)
7 2000	1.88 (2.28)	1.021 (0.003)
8 2086	0.05 (0.55)	0.909 (0.044)
9 2086	0.87 (1.48)	0.904 (0.044)
10 2111	0.13 (2.68)	0.757 (0.062)
11 2111	0.50 (1.34)	0.864 (0.074)
12 2300	0.09 (0.33)	0.679 (0.023)
13 2300	1.35 (0.91)	0.850 (0.023)
28 2800	0.03 (0.08)	0.700 (0.031)
29 2800	0.18 (1.83)	0.975 (0.066)
30 2800	0.002 (0.15)	1.404 (0.255)
31 2800	0.42 (2.24)	0.700 (0.050)
32 2800	0.35 (3.04)	0.804 (0.071)

Notes: t-statistics are in parentheses.

Table 8-Continued

Firm SIC	δ_i	$\bar{\alpha}$ (Std Dev)
33 2800	0.27 (1.20)	0.652 (0.028)
34 2800	0.38 (3.28)	0.838 (0.045)
35 2800	0.40 (2.50)	0.640 (0.048)
36 2800	0.44 (2.56)	0.070 (0.023)
37 2800	1.18 (7.05)	0.635 (0.079)
38 2800	0.12 (2.43)	0.961 (0.109)
39 2830	1.16 (3.16)	0.937 (0.029)
40 2830	0.21 (1.09)	1.034 (0.025)
41 2830	1.02 (3.99)	0.974 (0.021)
42 2830	2.20 (4.77)	0.909 (0.013)
43 2830	1.98 (8.36)	0.922 (0.021)
44 2830	0.62 (2.82)	1.001 (0.037)
45 2834	1.10 (5.09)	1.020 (0.011)
46 2834	-0.09 (0.22)	0.987 (0.007)
47 2834	1.10 (7.19)	1.011 (0.010)
48 2834	0.74 (2.84)	0.962 (0.020)

Notes: t-statistics are in parentheses.

Table 8-Continued

Firm SIC	δ_i	$\bar{\alpha}$ (Std Dev)
49 2834	1.01 (2.28)	0.959 (0.070)
50 2841	1.60 (2.62)	0.969 (0.016)
51 2841	0.17 (0.86)	1.103 (0.018)
54 2870	0.90 (1.36)	1.899 (0.103)
55 2870	0.01 (0.05)	1.837 (0.104)
59 2911	0.06 (2.64)	0.773 (0.040)
60 2911	0.21 (4.11)	0.781 (0.033)
61 2911	0.17 (3.36)	0.871 (0.040)
62 2911	0.38 (9.17)	0.757 (0.026)
63 2911	0.82 (9.57)	0.739 (0.034)
64 2911	0.22 (2.18)	0.742 (0.034)
65 2911	-0.05 (-3.68)	1.131 (0.033)
66 2911	0.06 (1.87)	0.829 (0.028)
67 2911	0.05 (0.37)	0.737 (0.035)
68 2911	-0.08 (-3.05)	0.818 (0.034)
69 2911	0.05 (2.39)	0.981 (0.052)

Notes: t-statistics are in parentheses.

Table 8-Continued

Firm SIC	δ_i	$\bar{\alpha}$ (Std Dev)
70 2911	-0.02 (-0.93)	0.905 (0.035)
71 2911	0.08 (2.44)	0.808 (0.037)
72 2911	0.08 (4.70)	1.078 (0.064)
73 2911	0.33 (6.80)	0.797 (0.034)
74 2911	0.42 (9.22)	0.761 (0.028)
86 3510	0.21 (1.26)	-0.867 (0.231)
87 3510	0.28 (1.23)	-0.675 (0.179)
88 3510	-0.03 (0.89)	0.868 (0.270)
104 3711	0.13 (1.78)	0.802 (0.013)
105 3711	0.22 (3.18)	0.890 (0.008)
106 3711	0.14 (2.51)	0.965 (0.014)
107 3711	0.26 (2.30)	0.767 (0.009)
108 3720	0.49 (1.35)	0.944 (0.028)
109 3720	0.39 (1.17)	0.532 (0.036)
110 3721	0.02 (1.06)	1.551 (0.097)
111 3721	0.01 (0.17)	1.147 (0.063)

Notes: t-statistics are in parentheses.

Table 8-Continued

Firm SIC	δ_i	$\bar{\alpha}$ (Std Dev)
112 3721	0.09 (0.95)	0.812 (0.047)
113 3721	-0.07 (-1.31)	1.355 (0.084)
114 3721	2.06 (2.01)	0.833 (0.061)
115 3721	0.002 (0.03)	1.029 (0.108)
120 3861	-0.02 (0.27)	1.269 (0.051)
121 3861	0.19 (1.36)	1.129 (0.041)
122 3861	3.55 (1.94)	1.133 (0.036)
123 3861	0.03 (0.38)	1.244 (0.034)
124 4011	1.06 (2.29)	0.915 (0.040)
125 4011	0.23 (1.54)	0.804 (0.044)
131 4911	-0.02 (-0.60)	0.962 (0.002)
132 4911	0.50 (1.65)	0.984 (0.003)
133 4911	-0.14 (-0.52)	0.958 (0.002)
134 4911	-0.02 (-3.25)	0.961 (0.002)
135 4911	8.50 (9.04)	0.970 (0.016)
136 4911	-0.11 (-1.07)	0.988 (0.004)

Notes: t-statistics are in parentheses.

Table 8-Continued

Firm SIC	δ_i	$\tilde{\alpha}$ (Std Dev)
137 4911	0.07 (2.22)	0.971 (0.003)
138 4911	-0.22 (-7.64)	0.969 (0.002)
139 4911	0.38 (5.13)	0.955 (0.002)
140 4911	0.77 (15.89)	0.969 (0.003)
141 4911	0.80 (9.18)	0.958 (0.002)
142 4911	0.30 (10.14)	0.972 (0.002)
144 4911	-0.04 (-0.37)	0.964 (0.003)
145 4911	-0.19 (-1.36)	0.961 (0.002)
146 4911	0.21 (2.58)	0.955 (0.002)
147 4911	-0.01 (-4.01)	0.961 (0.002)
148 4911	-0.43 (-9.26)	0.958 (0.002)
149 4911	0.54 (18.53)	0.992 (0.004)
150 4911	0.14 (5.13)	0.973 (0.005)
151 4922	0.26 (1.33)	0.976 (0.062)
152 4922	1.24 (2.26)	0.991 (0.063)
153 4922	0.04 (0.75)	0.552 (0.082)

Notes: t-statistics are in parentheses.

Table 8-Continued

Firm SIC	δ_i	$\bar{\alpha}$ (Std Dev)
154 4922	0.09 (0.69)	0.917 (0.066)
155 4922	0.09 (1.50)	0.969 (0.080)
156 4923	-1.89 (-2.29)	1.116 (0.019)
157 4923	0.07 (0.80)	0.917 (0.017)
158 4923	1.41 (2.02)	0.997 (0.009)
159 4931	1.09 (7.65)	1.029 (0.001)
160 4931	-0.05 (-0.29)	1.030 (0.001)
161 4931	-0.02 (-3.29)	1.018 (0.003)
162 4931	-0.08 (-1.99)	1.030 (0.001)
163 4931	-0.43 (-8.74)	1.028 (0.0004)
164 4931	0.61 (2.50)	1.030 (0.001)
165 4931	0.40 (7.20)	1.027 (0.001)
166 4931	-0.08 (-2.03)	1.028 (0.005)
167 4931	2.38 (4.70)	1.029 (0.001)
168 4931	0.01 (0.17)	1.016 (0.002)
169 4931	-0.12 -0.45	1.030 (0.001)

Notes: t-statistics are in parentheses.

Table 8-Continued

Firm SIC	δ_i	$\bar{\alpha}$ (Std Dev)
170 4931	0.28 (2.73)	1.026 (0.001)
171 4931	0.14 (0.89)	1.029 (0.001)
172 4931	0.75 (3.47)	1.029 (0.005)
173 4931	0.58 (2.30)	1.029 (0.007)
176 5311	1.54 (1.61)	1.070 (0.006)
177 5311	2.86 (4.09)	1.032 (0.007)
178 5311	0.06 (0.44)	0.951 (0.004)
183 5411	0.25 (0.57)	0.219 (0.125)
184 5411	0.55 (0.57)	-0.016 (0.021)
185 5411	0.21 (0.60)	0.635 (0.327)
186 5411	0.004 (0.22)	1.650 (0.142)
187 5411	-0.24 (-0.55)	0.692 (0.056)
200 6025	0.27 (6.26)	1.15 (0.059)
201 6025	0.06 (2.37)	1.081 (0.024)
202 6025	0.36 (3.83)	0.894 (0.007)
203 6025	0.43 (3.84)	0.947 (0.013)

Notes: t-statistics are in parentheses.

Table 8-Continued

Firm SIC	δ_i	$\bar{\alpha}$ (Std Dev)
204 6025	3.53 (13.63)	0.859 (0.002)
205 6025	0.26 (6.47)	0.997 (0.016)
206 6025	1.96 (1.40)	0.856 (0.002)
207 6025	1.19 (7.88)	0.867 (0.004)
208 6025	1.20 (6.06)	0.878 (0.009)
209 6025	-0.68 (3.32)	0.896 (0.006)
210 6025	1.09 (8.32)	0.877 (0.013)
211 6025	0.57 (6.40)	0.954 (0.018)
212 6025	1.12 (5.17)	0.867 (0.002)
213 6025	3.57 (7.18)	0.859 (0.003)
214 6025	1.08 (2.06)	0.875 (0.010)
215 6025	0.16 (1.25)	0.926 (0.006)
216 6120	0.77 (3.48)	0.782 (0.043)
217 6120	-0.003 (-0.05)	1.251 (0.094)
218 6120	1.45 (4.49)	0.910 (0.096)
219 6199	-0.68 (-1.16)	1.073 (0.007)

Notes: t-statistics are in parentheses.

Table 8-Continued

Firm SIC	δ_i	$\bar{\alpha}$ (Std Dev)
220 6199	0.08 (1.69)	1.068 (0.006)
221 6199	0.69 (3.00)	1.061 (0.006)
222 6199	2.62 (6.42)	1.065 (0.008)
223 6312	0.002 (1.51)	7.640 (1.627)
224 6312	0 (0)	1.343 (0.425)
225 6312	0.65 (1.65)	-0.109 (0.129)
226 6312	0.51 (1.29)	0.050 (0.238)
227 6312	1.29 (2.12)	-0.001 (0.141)
228 6312	0.14 (1.74)	0.288 (0.163)
229 6312	-0.002 (-1.23)	6.651 (0.933)
230 6312	0.06 (1.13)	-0.055 (0.115)
231 6332	3.08 (3.37)	0.945 (0.025)
232 6332	1.54 (5.35)	0.874 (0.043)
233 6332	0.35 (3.47)	0.914 (0.018)
234 6332	0.77 (5.10)	1.016 (0.033)

Notes: t-statistics are in parentheses.

Corporation, indicating increases in sales will have strong positive affects on compensation. In 5 of the 27 industries, the mean calculated value of α_{it} for each firm in the industry is consistently greater than one, while in 9 industries the mean calculated value of α_{it} is less than one. This suggests in these industries, owners write similar contracts with their managers, either rewarding or penalizing managers for sales.

However, estimates of the Herfindahl index, reported in Table 9, suggest the affects of industry concentration are unclear.[19] In some of the industries with the largest estimated Herfindahl indexes, the estimated values of β_1 and β_2 are not jointly different from zero. This is indicative of other differences between the coefficient estimates, and the predictions of the theory.

Hypothesis tests indicate that in 27 of 42 industries β_1 and β_2 are jointly significant. In 11 of those 27 industries, the estimates of β_1 and β_2 are consistent with the predictions of the model for firms competing in prices. In 3 of the 27 industries, the estimates of the β_1 and β_2 are consistent with the model's predictions for quantity competition. Of the 159 firms included in those 27 industries where β_1 and β_2 are jointly significant, the estimates of β_1 and β_2, and mean values of α_{it} conform with the

[19]The definition of market share used to calculate the Herfindahl index is the same as that used in the regressions, and is described above.

Table 9-Estimates of Herfindahl Index by Industry

SIC	$\bar{H}$	H_{min}	H_{max}
1600	.565	.500	.723
2000[5]	.221	.202	.325
2086[5]	.506	.500	.524
2111[5]	.546	.500	.665
2300[5]	.556	.511	.610
2400	.503	.500	.510
2600	.152	.139	.168
2649	.516	.502	.589
2711	.550	.503	.590
2800[5]	.153	.117	.218
2830[5]	.189	.162	.235
2834[5]	.219	.209	.231
2841[5]	.585	.539	.694
2844	.745	.662	.798
2870[5]	.516	.500	.567
2890	.422	.393	.448
2911[5]	.116	.105	.126
3000	.627	.602	.705
3290	.512	.500	.548
3310	.222	.208	.245
3330	.519	.508	.542
3510[5]	.405	.342	.448
3533	.513	.500	.629
3600	.424	.389	.494
3662	.359	.334	.611

Notes: 5 Indicates that β_1 and β_2 are jointly significantly different from zero.

Table 9-Continued

SIC	$\bar{H}$	H_{min}	H_{max}
3680	.421	.389	.455
3711[5]	.378	.335	.417
3720[5]	.740	.626	.838
3721[5]	.207	.185	.227
3760	.611	.563	.710
3841	.540	.500	.679
3861[5]	.378	.361	.408
4011[5]	.539	.500	.608
4511	.364	.342	.403
4811	.956	.918	.970
4911[5]	.066	.063	.091
4922[5]	.384	.306	.459
4923[5]	.404	.345	.423
4931[5]	.108	.095	.153
5140	.565	.544	.582
5311[5]	.499	.474	.533
5331	.377	.316	.668
5411[5]	.281	.257	.319
5812	.534	.500	.651
6022	.202	.176	.229
6025[5]	.141	.108	.162
6120[5]	.414	.369	.478
6199[5]	.275	.250	.326
6312[5]	.302	.279	.331
6332[5]	.260	.252	.269

Notes: 5 Indicates that β_1 and β_2 are jointly significantly different from zero.

predictions of the theory for only 20 firms. Of those 20 firms, 14 appear to be competing in prices, and 6 appear to compete in quantities. In no industry do all firms conform with the predictions of the theory for either price or quantity competition, although in several industries only one or two firms fail this test. Table 10 summarises these results.

Table 10-Summary of Incentive Structures

	$\alpha>1$		$\alpha<1$	
	$\beta_1>0$	$\beta_1<0$	$\beta_1>0$	$\beta_1<0$
$\beta_2>0$	10	10	21	14 (Q)
$\beta_2<0$	12 (P)	7	64	21

In addition to the wide variety of estimated values of α_{it}, the estimates of δ_i indicate that the affect of performance on compensation varies widely across firms. Relying on t-statistics to assign significance, the value of significant estimates of δ_i range from -1.89 to 8.5. While the optimal choice of δ_i has not been modeled, only estimated, this appears to be an area of research with significant potential. Both the estimated values of δ_i, and their associated t-statistics suggest that owners' reliance on performance dependent compensation contracts varies tremendously, and must be included in analyses of incentive contracting.

Summary

The oligopoly theory of compensation assumes that firms compete in oligopolistic industries. While the data used to estimate the terms of incentive contracts has been gathered from sources that include data only for large firms, the number of small firms competing in the industry, and not included in the data set, is unknown. If there is a large number of small competitors, then the large firm(s) included in the data set may be forced to behave competitively. There is no guarantee that all industries included in the data set are oligopolistic.

The results presented do not provide a definitive answer as to the question of the terms of CEO compensation contracts, these results do indicate that contracts vary significantly across firms. The evidence presented here indicates that compensation contracts are considerably more complex and dynamic than suggested by the models of previous authors.

As indicated by the disparate estimates of α_{it}, terms of compensation contracts differ widely across firms and industries. Also, there is a relatively large number of industries where β_1 and β_2 are jointly significantly different from zero. Finally, within industries there appear to be similar incentives created by the contracts, although these incentives do not conform with the predictions of the model.

CHAPTER VII

CONCLUSIONS

In addressing the issue of executive compensation, industry and firm characteristics are shown to be important factors. Chapter II presents results of empirical research in the field of CEO compensation, and highlights differences in the terms of incentive contracts reported by previous authors. In addition, Chapter II discusses the results of theoretical research in the area of the principal-agent problem. The significant differences in the results of previous empirical research motivate the analysis of chapters IV, V and VI.

The results of chapter IV suggest that given a linear model, the estimated terms of contracts will vary over time and across industries. Cross-section results indicate that the terms of contracts change over time. Sales appear to have an impact on payments in some years, while in other years sales are unimportant. Industry specific regressions indicate that the terms of these contracts vary across industries. Again, sales appear to affect the compensation of some managers, with payments being positively related to sales for some managers, and negatively related to sales for others. Finally, in some cases compensation and sales appear to be unrelated. These results indicate that simply pooling firms without regard to industry boundaries ignores valuable information, and the interpretation of results based on these data is unclear.

The industry and firm specific estimates reported in chapter IV represent an improvement over results based on data that has been pooled across industries. The reported coefficient estimates, and the model on which they are based, provide an explanation of the apparently contradictory results reported in the literature; however, the industry and firm specific coefficients reported in chapter IV are essentially industry and firm specific tests of the Baumol hypothesis. The Baumol hypothesis is based on observations of the apparent relationship between the size of a firm and the size of compensation payments, and conjectures about benefits accruing to large firms that are not enjoyed by their smaller competitors. In contrast the oligopoly model of compensation has as it's foundation the widely known and accepted theory of oligopoly. Chapter V presents a derivation of optimal incentive contracts for duopolists competing in quantities in a repeated play game, and describes the empirical predictions of the model.

The oligopoly model of incentives suggests that the incentives created by contracts will depend on whether firms compete by setting prices or production levels, the firm's market share, and the variance of production costs. In oligopolistic industries firms are inter-dependent; therefore, when creating incentives for their managers owners have an opportunity to contract strategically. This interdependence among firms results in contracts that reward or penalize managers for changes in the sales of firms. The research presented here is unique in as much as it takes account of the interdependence of firms when estimating the terms of contracts.

Chapter VI presents an the econometric model designed to more closely reflect the conditions of the contracts written between owners and managers. The econometric model recognizes that the extent to which compensation will be affected by measured performance will not necessarily be identical across firms. The amount of control exercised by a manager, and the degree to which a manager's actions are observable are each likely to have an impact on the amount of risk born by the manager. The greater the dependence of compensation on performance, the greater will be the risk born by managers. This issue is addressed in the specification of the econometric model.

The predictions outlined above indicate that incentive contracts will not be static, as previous researchers have implicitly assumed. Rather, the model predicts contracts will be dynamic instruments that change as the conditions facing firms change. The coefficient estimates reported in Chapter VI confirm the hypothesis that terms of compensation contracts change over time. However, the test of the affects of market share and cost variance on optimal contracts does not confirm the predictions of the theory.

In analyzing incentive structures the dissertation addresses several questions that have heretofore been ignored. However, several questions have been raised in the course of this investigation that have not yet been addressed. Throughout the dissertation it has been assumed that managers are risk neutral. One natural extension is to explicitly model the utility maximization problem for a risk-averse manager to determine how risk aversion will affect the terms of compensation contracts, and identify contracts that minimize the effects of risk aversion on management decisions.

Another issue concerns stock options, and stock ownership by managers. While a significant fraction of a manager's wealth is often held in the form of stock in the managed firm, and stock options are often included in compensation packages, relatively little has been done to investigate the reasons for including stock options in compensation packages. One potential explanation concerns the affect of stock ownership on the manager's incentives. For example, when managers are compensated for sales, or face incentives independent of the compensation contract to increase firm sales, industry output will increase, and firm profits will fall. Lower profits will adversely affect stock prices. As the manager's stock holdings increase the manager will become more concerned with stock price changes, and less concerned with cash compensation. Therefore, stock ownership may reduce the affect of strategic contracts, and the affects of the incentives for sales outlined in Chapter II, on management decisions.

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APPENDIX 1

1600 (1) Construction-Not Building
Fluor, Halliburton

2000 (2) Food and Kindred Products
Campbell, CPC International, General Mills, Kellog, Quaker Oats

2086 (3) Bottled-Canned Soft Drinks
Coca-Cola, Pepsi

2111 (4) Cigarettes
American Brands, Philip Morris

2300 (5) Apparel and Other Finished Products
Gulf and Western, Interco

2400 (6) Lumber and Wood Products
Georgia Pacific, Weyerhauser

2600 (7) Paper and Allied Products
Boisie Cascade, Great Northern Nekoosa, International Paper, Kimberly Clark, Meade, Scott Paper, Union Camp, Westvaco

2649 (8) Convertible Paper-Paper Board Products
Johnson & Johnson, Minnesota Mining and Manufacturing

2711 (9) Newspapers: Publishing-Print
Dow Jones, Gannet

2800 (10) Chemicals and Allied Products
American Cyanamid, Dow Chemical, E.I.DuPont, FMC, W.R. Grace, Hercules, Monsanto, Olin, PPG, Rohm Haas, Union Carbide

2830 (11) Drugs
Abbot Labs, American Home Products, Merck, Schering Plough, Squibb Beechnut, Warner Lambert

2834 (12) Pharmaceutical Preparations
Bristol Myers, Eli Lilly, Pfizer, Smithkline & French, Upjohn

2841 (13) Soap and other detergents
Colgate Palmolive, Proctor and Gamble

2844 (14) Perfumes and Cosmetics
Avon, International Flavors and Fragrances

APPENDIX 1-Continued

2870 (15) Agriculture Chemicals
International Mining and Chemicals, Williams Company

2890 (16) Chemical Products
Ethyl, Lubrizol, Nalco

2911 (17) Petroleum Refining
Amerada Hess, Amoco, Ashland, Arco, Chevron, Coastal States Gas, Diamond Shamrock, Kerr-McGee, Mobil, Occidental, Pennzoil, Phillips, Sun Oil, Texaco, Unocal, Union Pacific Corp.

3000 (18) Rubber & Miscellaneous Plastic Products
Goodrich, Goodyear

3290 (19) Abrasive Asbestos and Miscellaneous Minerals
Manville, Owens Corning Fiberglass

3310 (20) Blast Furnaces & Steel Works
Armco, Bethlehem Steel, Inland Steel, LTV, National Intergroup

3330 (21) Primary Smelting Refining Nonferrous Metals
Alcoa, Reynolds Metals

3510 (22) Engines & Turbines
Brunswick, Cummins Engine, Teledyne

3533 (23) Oil Field Machinery & Equipment
Combustion Engineering, Dresser Industries

3600 (24) Electric & Electronic Machinery, Equipment and Supplies
Emerson Electric, General Electric, Litton, North American Phillips, Westinghouse

3662 (25) Radio-TV Transmitting Equipment
Motorola, Raytheon, TRW

3680 (26) Electronic Computing Equipment
Control Data Corporation, Digital Equipmment Corporation, Hewlett-Packard, Honeywell, IBM, NCR

3711 (27) Motor Vehicles and Car Bodies
Chrysler, Ford, General Motors, International Harvester

3720 (28) Aircraft and Parts
United Technologies, U.S. Gypsum

APPENDIX 1-Continued

3721 (29) Aircraft
Boeing, General Dynamics, Grumman, McDonald Douglas, Northrop, Textron

3760 (30) Guided Missiles and Space Vehicles
Martin Marietta, Rockwell International

3841 (31) Surgical and Medical Instruments
Baxter Labs, Becton-Dickinson

3861 (32) Photographic Equipment and Supplies
Eastman Kodak, Polaroid, Tandy, Xerox

4011 (33) Railroads, Line Haul Operating
Burlington Northern, Norfolk Western

4511 (34) Air Transportation
Delta, Northwest Airlines, Pan Am

4811 (35) Telephone Communication
AT&T, Southern New England Telephone

4911 (36) Electric Services
Allegheny Power, American Electric Power, Boston Edison, Carolina Power and Light, Central and Southwest, Commonwealth Edison, Detroit Edison, Duke Power, Duquense, General Public Utilities, Gulf States Utilities, Middle South Utilities, North East Utilities, Ohio Edison, Oklahoma Gas and Electric, Penn Power and Light, Potomac Power, Southern Company, Texas Utilities, Union Electric

4922 (37) Natural Gas Transmission
Panhandle Eastern, Southern Natural Gas, Tenneco, Texas Eastern, Transco

4923 (38) Natural Gas Transmission-Distribution
Arkla, Columbia Gas, Consolidated Natural Gas

4931 (39) Electric and other Service
Baltimore Gas and Electric, Cincinnati Gas and Electric, Consolidated Edison, Illinois Power, Long Island Lighting, New York State Electric and Gas, Niagara Mohawk Power, NIPSCO, Northern States Power, Pacific Gas and Electric, Pacific Power and Light, Philadelphia Electric, Public Service of Colorado, San Diego Gas and Electric, Wisconsin Electric Power

5140 (40) Wholesale Groceries and Related PDS
Fleming, Wetterau

APPENDIX 1-Continued

5311 (41) Retail-Department Stores
May Dept. Stores, J.C. Penney, Sears

5331 (42) Retail Variety Stores
Dayton Hudson, K-Mart, Woolworth, Zayre

5411 (43) Retail-Grocery Stores
Albertson's, Giant Food Stores, Household Finance, Kroger, Winn Dixie

5812 (44) Retail Eating Places
Marriott, McDonalds

6022 (45) State Banks-Federal Reserve System
Bank of New York, Bankers Trust of New York, Barnett Banks of Florida, Chemical N.Y., Commerce Bank, First Empire State Bank, First Pennsylvania Corp., J.P. Morgan, Old Kent Financial, Shawmutt

6025 (46) National Banks-Federal Reserve System
Bankamerica, Chase Manhattan, First Bank Systems, First Chicago, Huntington, Manufacturers Hanover, Marshall and Isley, Michigan National Group, NCNB, North West Bankcorp, PNC Corp., Security Pacific Corp., Southeast Bankcorp, United Jersey Banks, Wachovia, Wells Fargo

6120 (47) Savings and Loan Associations
Gibraltar Financial, Great Western Financial, Imperial Corporation of America

6199 (48) Finance-Services
American Express, Loews Corporation, Federal National Mortgage, Transamerica

6312 (49) Life Insurance
Aetna, American General Insurance, American National Insurance, Capital Holding, Jefferson Pilot, Provident Life, Travellers, U.S. Life Corporation

6332 (50) Property-Casualty Insurance
Chubb, General Reinsurance, Safeco, St Paul

APPENDIX 2

Industry SIC code-Name	Av. Comp($)[6]	Profits[6] ($x1,000)	Assets[6] ($x1,000)
1600-Construction	778,272	171,620	3,069,810
2000-Food	622,356	200,878	2,037,730
2086-Soft Drinks	935,466	571,251	4,331,160
2111-Cigarettes	911,609	616,731	8,928,230
2300-Apparel	794,449	177,930	4,859,470
2400-Lumber & Wood	502,036	195,349	3,187,770
2600-Paper	565,053	159,153	2,805,530
2649-Convertible Paper	866,343	569,272	4,805,390
2711-Newspapers	624,179	120,528	1,042,630
2800-Chemicals	724,036	357,003	6,557,910
2830-Drugs	768,579	328,482	2,651,320
2834-Pharmaceuticals	725,887	318,042	2,757,960
2841-Soap	835,489	444,949	5,485,500
2844-Perfumes	596,373	136,233	1,158,670
2870-Ag. Chemicals	633,638	94,304	2,404,050
2890-Chem. Products	429,874	91,999	1,060,030
2911-Petr. Refining	753,986	670,302	12,161,380
3000-Rubber & Plastics	745,436	190,763	4,997,340
3290-Abrasive Asbestos	524,847	95,380	1,904,230
3310-Blast Furn.& Steel	593,319	11,047	4,771,119
3330-Prim. Smelting	638,991	199,655	5,317,240
3510-Engines & Turbines	622,032	154,540	2,333,930

Notes: 6 indicates that figures are reported in 1983 real dollars.

APPENDIX 2-Continued

Industry SIC code-Name	Av. Comp($)[6]	Profits[6] ($x1,000)	Assets[6] ($x1,000)
3533-Oil Field Mach	638,196	111,954	2,568,450
3600-Elec. & Electronic	874,277	652,840	10,467,550
3662-Radio & TV Trans	590,370	209,533	3,014,200
3680-Electronic Comp	653,719	890,744	10,205,240
3711-Motor Veh	1,051,536	1,286,489	26,094,030
3720-Aircraft & Parts	787,953	217,674	4,202,280
3721-Aircraft	646,108	180,136	3,685,010
3760-Missiles & Space	810,756	252,657	3,954,297
3841-Surg. & Med. Inst	523,591	113,347	1,849,170
3861-Photo. Equip	684,350	466,987	5,955,690
4011-Railroads	681,937	239,259	6,839,870
4511-Air Trans	445,334	45,636	2,769,400
4811-Telephone Com	607,187	2,622,379	6,067,130
4911-Electric Serv	304,607	249,698	6,182,280
4922-Nat. Gas Trans	534,604	208,619	5,876,490
4923-Nat. Gas Dist	384,135	138,034	3,442,290
4931-Elec. & Other Ser	273,969	229,220	5,109,783
5140-Whsl Groc & Rel	373,386	24,034	481,200
5311-Retail Dept. St	805,086	579,263	16,938,890
5331-Retail Variety St	641,654	180,120	3,459,320
5411-Retail Groc. St	560,472	99,554	2,855,696
5812-Retail Eating	503,962	178,493	2,631,510

Notes: 6 indicates that figures are reported in 1983 real dollars.

APPENDIX 2-Continued

Industry SIC code-Name	Av. Comp($)[6]	Profits[6] ($x1,000)	Assets[6] ($x1,000)
6022-State Banks	448,600	109,385	19,135,240
6025-Federal Banks	498,473	130,741	7,609,980
6120-Sav. & Loans	366,952	47,164	9,405,690
6199-Fin. Services	654,139	279,458	32,087,780
6312-Life Ins	466,691	194,232	12,725,110
6332-Prop. & Cas. Ins	466,042	140,400	4,234,762

Notes: 6 indicates that figures are reported in 1983 real dollars.

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