ACCOUNTING MEASUREMENT BIAS AND EXECUTIVE COMPENSATION SYSTEMS

DISSERTATION

Presented to the Graduate Council of the

University of North Texas in Partial

Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Jeffery Paul Boone, B.B.A, M.S.

Denton, Texas

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This dissertation presents empirical evidence intended to help answer two research questions. The first question asks whether executive compensation systems appear to exploit the bias in accounting-based performance measures in order to reduce the volatility in executive compensation and to allocate incentives more effectively across the range of activities performed by the executive. The second question asks whether compensation systems systematically differ between firms that use alternative accounting methods and whether any such systematic difference helps explain accounting choice.

Parameters estimated in fixed-effects endogenous switching regression models were used to test the risk-shielding and incentive-allocation hypotheses. The models were estimated across a dataset consisting of 1151 executive-year observations of annual compensation paid to 222 top-level executives in 40 oil and gas firms. The dataset was partitioned by accounting method and separate models estimated for the full cost and successful efforts partitions. The tests provided modest support for the risk-shielding and incentive-allocation hypotheses, revealing that accounting measurement bias is used to focus incentives for effort in the exploration activity and to reduce executives' exposure to production risk.

The design also allowed an estimate of the proportional change in compensation that was realized from the accounting choice actually made. The results show that the compensation received by managers in full cost accounting firms was, on average, 23% greater than what they could expect to receive if their firms instead used successful efforts accounting. Similarly, the compensation received by managers in successful efforts firms was, on average, 13% greater than what they could expect to receive if their firms instead used full cost accounting.

The compensation a manager could expect to receive under successful efforts accounting was subtracted from the compensation expected under full cost accounting to yield a measure operationalizing the incentive for choice of full cost accounting. This incentive variable was used as an explanatory variable in an accounting choice model, and it was strongly significant and positively related to choice of the full cost accounting method.

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CHAPTER 1

INTRODUCTION TO THE STUDY

This dissertation seeks to answer two research questions. The principal question asks whether executive compensation systems appear to exploit the bias in accounting-based performance measures. This question is motivated by recent developments in accounting theory (Bushman and Indjejkian 1993a, 1993b) proposing that accounting measurement bias has two potential functions in compensation systems. First, bias can be used to reduce the volatility in executive compensation caused by uncontrollable fluctuation in firms' output. Second, bias can be used to allocate incentives more effectively across the range of activities performed by the executive. Whether extant compensation systems exploit accounting measurement bias to achieve risk shielding and incentive allocation presently is unknown. Answering this question will contribute to an accounting literature that is attempting to discover, understand, and explain the roles played by accounting-based performance measures in executive compensation systems. This research stream is motivated by an apparent anomaly: stock-based performance measures appear to be the "best" measure of managers' performance, yet empirical research shows that executive compensation systems use both accounting numbers and stock returns to measure managers' performance. That executive compensation systems use accounting numbers in addition to stock returns as performance measures implies that accounting-based performance measures are incrementally useful. Risk shielding and incentive allocation are two potential roles for accounting-based performance measures that might create this incremental usefulness.

The idea that accounting-based performance measures can be used for risk shielding and incentive allocation is consistent with the notion advanced in the positive accounting literature that accounting methods differ in their abilities to reduce contracting costs, and these differential abilities help explain accounting choice (Watts and Zimmerman 1990). This is the efficiency-in-contracting theory. Watts and Zimmerman propose that this theory implies that accounting policy and compensation policy are jointly determined. The second research question concerns this interdependence. It asks whether compensation systems systematically differ between firms that use alternative accounting methods and whether any such systematic difference helps explain accounting choice. The answer to this question will help researchers interpret the association between accounting-based bonus plans and accounting choice documented by prior research. Prior studies assume the structure of compensation plans to be exogenous and interpret this association as evidence that managers select accounting methods in order to opportunistically transfer wealth from shareholders to themselves. Watts and Zimmerman express concern that this association may not be due to opportunistic behavior, but rather endogeneity bias. By testing accounting choice jointly with the structure of the compensation system, this study will test the effect of accounting-based compensation arrangements on accounting choice, free of endogeneity bias. The findings will provide some insight into Watts and Zimmerman's concern that endogeneity bias rather than managements' opportunistic behavior explains the results found in extant tests of the bonus hypothesis.

The literature that motivates these two research questions is discussed in Chapter 2. Chapter 3 follows with theory development and hypotheses. Chapter 4 discusses the research design, while Chapter 5 presents the empirical test results. Finally, Chapter 6 summarizes the study findings and identifies potential future research.

CHAPTER 2

LITERATURE REVIEW

This dissertation draws upon both theoretical and empirical research into the use of accounting-based performance measures in executive compensation systems. The theoretical literature models optimal contracts in moral hazard settings where an agent's actions are unobservable by a principal. These studies usually assume that the principal uses two noisy measures (typically accounting information and stock price information) of the agent's performance in order to contract with the agent. The theoretical analysis frequently models the optimal compensation contract and then investigates how changes in the informational characteristics of the two performance measures influence their relative weighting within the optimal contract.

The empirical studies within the compensation literature typically seek to test theories derived from the theoretical contracting literature. The relevant studies from each literature stream are reviewed below.

Theoretical Contracting Literature

Holmstrom (1979).

Holmstrom (1979) investigates the role of information in a principal-agent relationship subject to moral hazard. His principal research aim is to understand when imperfect information about an agent's actions can be used to improve on a contract which initially is based only on payoffs. He shows that when the principal has available two signals that are informative about the agent's actions - the agent's output x and an additional signal y - both the agent and the principal benefit by incorporating both signals in the sharing agreement unless x is a sufficient statistic for the pair (x,y) (i.e., x impounds all the relevant information about the agent's actions). This informativeness condition has a direct analogy in executive compensation contracting where x is a security-price-based performance measure and y is an accounting-based performance measure.

Holmstrom's work is important because it addresses whether a variable will or will not be included in a compensation contract, but is limited because it does not address the weighting of the variables in the contract (Lambert 1993). The relative weighting of performance variables is an issue addressed by Banker and Datar (1989), discussed below.

Banker and Datar (1989).

Banker and Datar (BD) extend Holmstrom (1979) by showing that the relative weights placed on two performance measures x and y in a compensation system are directly proportional to the product of the sensitivity and precision of the measures. Precision is defined as the inverse of the measure's variance. Sensitivity is defined as the extent to which the expected value of the measure changes as the agent's action changes, adjusted for any correlation between the two performance measures. BD use their sensitivity-times-precision framework to derive several nonobvious implications, including the idea that a performance measure completely insensitive to managers' performance is useful if it is correlated with a performance measure that is sensitive, and that the relative weight placed on the insensitive performance measure increases in absolute value the more negative its correlation with the sensitive performance measure. This is an important insight because it provides the theoretical foundation for the risk-shielding role of accounting performance measures as developed by Bushman and Indjejkian (1993a, 1993b) and Sloan (1993).

<u>Sloan (1993)</u>

Sloan (1993) attempts to explain why reliance on accounting performance measures in compensation agreements varies across firms. Sloan starts with the assumption that stock returns intuitively would seem to provide the best performance measure and then attempts to explain why accounting earnings are incrementally useful in assessing performance. He extends the BD sensitivity-times-precision framework to show that accounting earnings are incrementally useful when they can shield executive compensation from market-wide fluctuations in equity values. He tests this risk-shielding hypothesis by regressing the change in log of compensation (salary plus bonus) on stock returns and earnings performance (change in earnings per share) with each performance measure interacting with variables measuring the ability of accounting earnings to filter out market-wide fluctuations in equity values. The tests yield evidence consistent with the hypothesis which is an important finding because it provides empirical evidence of a risk-shielding role for accounting performance measures.

Bushman and Indjejikian (1993a, 1993b)

Banker and Datar model the agent's action as consisting of a single dimension and consider only two generic performance measures, x and y, each of which are noisy measures of the agent's single-dimension action. Bushman and Indjejikian (1993a, 1993b) (BI) enrich the model by incorporating two-dimensional actions by the agent and an accounting earnings performance measure that is differentially sensitive to the two dimensions of action. They seek to determine how these factors influence the relative weights placed on security-price-based and accounting-based performance measures in the optimal compensation agreement.

The manager's (or agent's) bi-dimensional actions consist of effort in activity one (e_1) and effort in activity two (e_2). Effort in activity one yields payoff $x_1 = fe_1 + \theta_1$ while effort in activity two yields payoff $x_2 = ge_2 + \theta_2$, where f and g are the marginal products of effort in the two activities and θ_1 and θ_2 are random shocks to the production function that are beyond the manager's control. Total firm output is $x = x_1 + x_2$. The accounting signal y is informative about the output from activity one, uninformative about the payoff from activity two, and is affected by random shocks δ ($y = x_1 + \delta$). Stock price p is a noisy but unbiased measure of output from both activities ($p = x_1 + x_2 + z$). The noise comes from non-output-related random shocks z.

The authors argue that when the accounting measure is informative about output from both dimensions of the manager's actions (i.e., $y = x_1 + x_2 + \delta$), the sole purpose of the accounting performance measure in the optimal compensation contract is to filter out the non-output-related random shocks z to stock prices that come from events beyond the manager's control. This is the dimension of risk-shielding proposed by Sloan (1993). However, when the accounting measure is informative about the output from activity one but uninformative about the output from activity two ($y = x_1 + \delta$), then the accounting performance measure has two additional roles. First, the accounting performance measure can be used to filter away the random shocks θ_1 in the activity one production function, thereby shielding the manager's compensation from the effects of output risk σ_1 ($\sigma_1 = \text{var}(\theta_1)$) in activity one that would otherwise cause volatility in the compensation. This insight is based on the following intuition: The increased bias causes the accounting measure to convey relatively more information about the random shocks in activity one and relatively less information about the output from activity two. Consequently, reducing the weight placed on the accounting measure reduces the volatility in the manager's compensation caused by output risk σ_1.

The second role for the accounting performance measure is incentive allocation across activities: corporate directors can use the accounting performance measure to change the relative and absolute level of reward given to managers for their effort in the various activities of the firm. This precise incentive allocation is made possible by the measurement bias in the accounting measure that results from its failure to report on all activities. Placing greater weight on the accounting performance measure targets incentives to effort in activity one only, but placing greater weight on stock returns provides incentives to effort in both activities.

BI argue that the accounting performance measure is unable to perform shielding of output risk or incentive allocation unless the measure is uninformative, that is, biased, with respect to at least one dimension of managerial activity. Consequently, biased accounting performance measures may have greater stewardship value than unbiased accounting measures that faithfully represent the total output resulting from managements' actions.

Empirical Literature

A logical point to begin a review of the empirical literature is Murphy (1985) whose study corrects many of the econometric problems that plagued the prior empirical research, and whose findings cast substantial doubt upon the internal validity of those studies. Ciscel and Carroll (1980) provide a comprehensive review of the earlier empirical research.

Murphy (1985)

Murphy (1985) argues that prior compensation studies are biased because they ignore many performance-sensitive components of compensation (stock options, deferred compensation, etc.) and use cross-sectional analysis which is potentially subject to a serious correlated omitted variable problem if time-invariant executive-specific characteristics vary cross-sectionally. His research objective is to control for these confounding influences and determine whether a relationship exists between executive compensation and performance. The issue is important because the prior research found no association between compensation and performance, and Murphy's reasoning suggests that problems in the prior research may have prevented the researchers from discovering any association that might exist.

Murphy examines the relationship between firm performance and managerial compensation, focusing on 500 executives from 73 firms across the period 1964-1981. Murphy operationalizes firm performance as stock returns (both absolute and relative) and as the absolute level of sales revenue. He also operationalizes the various components of compensation so that he can test the association between performance measures and both total compensation and the components of compensation. Murphy uses a fixed effects model to control for unobservable differences across executives that he believes caused an omitted variable problem in prior studies.

Contrary to the findings of the prior research, Murphy discovers that total management compensation is strongly related to both stock price and accounting performance measures. Murphy also finds that the bonus component of compensation is unrelated to raw returns but positively related to relative returns, suggesting that firms may tie bonus rewards to relative performance criteria.

Murphy also compares the robustness of his fixed-effects model with a cross-sectional model in which the intercept is constant across cross-sectional units and finds, as expected, that the cross-sectional model appears to be misspecified. Murphy's work is an important contribution because it demonstrates that econometric problems in past research obscured the actual association between compensation and performance.

Antle and Smith (1985)

Antle and Smith (1985) is a methodological paper that attempts to assess the robustness of empirical compensation models to alternative operationalizations of executive compensation. The issue they address is whether salary plus bonus is an acceptable proxy for total compensation. Their question is important because data on total compensation is extremely costly to collect while data on salary plus bonus is inexpensive to collect. The authors develop a method to measure the annual change in executives' total wealth associated with employment (called the current income equivalent) and use this method to measure the annual change in wealth from employment for a time-series cross-section of executives. They correlate this measure with the sum of salary plus bonus and find little intrafirm correlation between the two measures (mean correlation across firms is .15), suggesting that salary plus bonus is an extremely noisy measure for the theoretically desired measure of total compensation.

Coughlan and Schmidt (1985)

Coughlan and Schmidt (1985) test the hypothesis that directors use stock price performance and sales growth to make executive compensation and dismissal decisions. The thesis that directors use sales growth as a performance measure is motivated by the notion that basing compensation exclusively on share prices is inefficient because risk-averse managers will demand risk premiums for the volatility in pay caused by the swings in stock prices from exogenous events beyond managers' control. Consequently, basing compensation contracts, in part, on accounting performance measures may reduce the risk premium demanded by executives. This is an important idea because it represents an early effort within the accounting compensation studies to explain why it might be efficient to use accounting numbers as performance measures within compensation contracts. This represents an informal postulation of the risk-shielding role of accounting performance measures that is later developed more formally by Sloan (1993) and BI. The thesis that directors use stock returns in reaching dismissal decisions is important because while theory held that directors monitored management, no prior study had demonstrated an association between ineffective management and subsequent dismissal by the board of directors.

Coughlan and Schmidt first assess the association between the percentage change in executive compensation (CEO) and two measures of performance - abnormal stock returns and the percentage growth in sales - across the period 1978-1980. As did Murphy (1985), the authors assume that the regression coefficients are constant across executives. Coughlan and Schmidt operationalize compensation as salary plus bonus, purposefully excluding other components of compensation in order to focus upon compensation elements not explicitly tied to stock prices. They conclude that CEO salary-plus-bonus payments are linked to stock price performance and sales growth.

Coughlan and Schmidt also test whether directors dismiss executives who harm shareholders' interests. They test this thesis by estimating a logit model of executive turnover which models the log-odds probability of CEO turnover as a function of the CEO's age, stock price performance, and abnormal compensation paid the executive. Their results are consistent with the hypothesis that the probability of CEO turnover is inversely related to stock price performance, which is an important finding because it is consistent with the hypothesis that the board of directors use dismissal as a managerial control device.

Antle and Smith (1986)

Antle and Smith (1986) examine whether executive compensation is associated with relative measures of firm performance. The issue is important because the theoretical contracting literature (Holmstrom 1982) shows that when performance measures are subject to common exogenous shocks, use of relative measures of performance filters the effect of the exogenous shock, thereby allowing the principal to better assess worker performance.

Antle and Smith operationalize two measures of firm performance - return on common stock and return on assets - which they decompose into a component that is correlated with industry-wide performance ("systematic component") and a component not correlated with industry-wide performance ("unsystematic component"). They operationalize executive compensation as the current income equivalent [discussed above in Antle and Smith (1985)] and regress compensation on the systematic and unsystematic components of the two performance measures using individual time-series models rather than a fixed-effects model as used by Murphy (1985). Antle and Smith find little evidence consistent with the relative performance hypothesis. Nevertheless, the study is important because it documents that the accounting performance measure (return on assets) is not merely a proxy for stock returns but is incrementally informative in explaining executive compensation. The study is also important because it reveals that the slope coefficients in econometric compensation models may vary across executives.

Lambert and Larcker (1987)

Lambert and Larcker (1987) attempt to explain the relative emphasis placed on accounting-based versus security-price-based measures of performance in compensation agreements. The issue is important because the extant literature principally is concerned with *whether* an association exists between compensation and performance measures, and relatively unconcerned with *why* an association might or might not be expected. The authors observe that this void in prior research is due, in part, to the difficulty in controlling for characteristics of the manager, the firm, and the environment that might be confounding influences.

They draw upon the BD sensitivity-times-precision framework to test the notion that the relative use of security-market measures versus accounting measures is dependent upon the signal and noise characteristics of each measure. They hypothesize that accounting performance measures have a low signal-to-noise ratio in growth firms and that growth firms will therefore tend to place relatively less emphasis on accounting measures. They also posit that use of accounting performance measures will increase as a manager's wealth invested in corporate stock increases. In general, Lambert and Larcker find evidence consistent with their hypotheses.

Ely (1991)

Ely (1991) explores interindustry differences in the association between CEO compensation and measures of performance (both market-based and accounting-based) under the assumption that production environments are homogeneous within an industry but heterogeneous across industries. Her thesis is that differences in production environments interact with the accounting system to determine the relevant set of accounting performance variables. She selects four industries and, using her knowledge of the production environment and the accounting system, posits three accounting performance measures whose association with compensation should differ across industries. She then assesses the statistical association between compensation and the performance measures (three accounting performance measures and a stock return measure). She finds that the accounting performance measures vary in their association with compensation across industries as expected. She interprets this as evidence that differences in production environments, and the way those environments are reflected in the accounting variables, influence the sensitivity of compensation to accounting performance measures. Her findings are important because they suggest that accounting performance measures are incrementally useful in compensation systems because they can be tailored to reflect the unique economic environment of the firm (Pavlik, Scott, and Tiessen 1993).

Clinch (1991)

Clinch hypothesizes that since accounting earnings are largely insensitive to the value created by research and development (R&D) activity, the compensation systems in firms with high R&D spending will place less weight on accounting-based performance measures (relative to stock-based measures) than will the compensation systems in firms with low R&D spending. Using a fixed effects model, Clinch regresses total compensation (change in salary plus bonus, options, and long-term compensation) on stock and accounting (return on equity) performance measures with each performance measure interacting with the level of research and development expenditures. Clinch finds that the weight placed on the stock performance measure decreases relative to the weight on the accounting performance measure as research and development expenditures increase - an anomalous finding exactly opposite the hypothesized relationship. The discovery of this anomaly is an important contribution because it suggests that biased accounting performance measures may have some incremental usefulness in compensation systems.

Lambert, Larcker and Verrecchia (1991).

Lambert, Larcker and Verrecchia (1991) (LLV) evaluate how differences in risk aversion and degree of personal diversification cause individual executives to place lower value on stock options than the Black-Scholes value. To illustrate, the authors estimate an executive's valuation of stock options when the manager is assumed to invest 50% of his hypothetical $10 million in total wealth in securities issued by his employer. The certainty equivalent value of a stock option grant valued at $351,260 by Black-Scholes is only $284,600. Their analysis implies that researchers who attempt to operationalize a comprehensive measure of compensation (i.e., one that includes stock options or other contingent claims) by using the Black-Scholes model to value the stock options likely will introduce measurement error because the Black-Scholes value overstates the executive's certainty equivalent value for the option grant.

Clinch and Magliolo (1993)

Clinch and Magliolo (1993) (CM) explore whether components of earnings differ in their usefulness as performance measures. Earnings components should have differential usefulness because they differ in terms of their timeliness as an information source (relevance), of their susceptibility to managerial influence (reliability), and of the dimensions of executive effort they reflect.

The authors test their theory in the banking industry, arguing that the discretionary/nondiscretionary components of earnings in banks differ in terms of relevance and reliability, and in the dimensions of executive effort revealed (tax management, regulatory capital management). The authors estimate firm-specific, time-series models by regressing the change in executive compensation (salary plus bonus) on change in nondiscretionary bank earnings, change in shareholder wealth, and two measures of discretionary earnings components (discretionary earnings with cash-flow effects and discretionary earnings attributable to accounting accruals). Their results are mixed. They find that discretionary earnings components without cash-flow effects are filtered out of the compensation function as expected, but, contrary to expectation, there is no differential weighting within the compensation function of nondiscretionary earnings and discretionary earnings with cash flow effects. They also find some evidence that the relative reliance on accounting earnings as a performance measure varies according to the capital constraint facing the bank but not according to the tax status of the bank (i.e., managers are compensated for relaxing capital constraints through earnings increases but not for reducing taxes through earnings decreases). One important anomaly reported by Clinch and Magliolo is the contradictory finding that directors do not appear to distinguish between discretionary earnings with cash flow effects and nondiscretionary earnings (which are assumed to recur with cash flow effects), but do distinguish between discretionary earnings with and without cash flow effects. If one assumes that recurring earnings are more important than transitory earnings and that discretionary earnings with cash flow effects are more valuable than discretionary earnings without such effect, then the latter finding suggests efficient contracting while the former suggests inefficient contracting characterized by directors myopically focusing on earnings.

The principal contribution made by CM is to present empirical evidence that earnings components may be differentially useful in assessing managers' performance due to differences in their relevance, reliability, and sensitivity to the dimensions of managers' efforts. Another contribution is the idea that features of the firm's environment, such as regulation and taxes, can influence the use of accounting performance measures within compensation contracts. However, as the authors acknowledge, the time period of their test biased against the tax hypothesis since during that time period banks were more concerned with managing capital than managing taxes.

Summary

The contracting literature provides a theoretical structure that underpins and guides much of the empirical work. Holmstrom's (1979) informativeness condition establishes that a noisy signal z will be useful for contracting if y is not sufficient for the pair (y,z) with respect to the manager's actions. Banker and Datar (1989) demonstrate that the relative weights placed on two performance variables within a linear compensation contract are proportional to their sensitivity-to-noise ratios. Sloan (1993) extends BD to reveal a risk-shielding role for accounting performance measures in compensation systems. Bushman and Indjejikian (1993a, 1993b) extend both BD and Sloan by introducing multi-dimensional actions and endogenous stock prices. Their work reveals an incentive-allocation role for accounting performance measures as well as a risk-shielding role much broader than that in Sloan (1993).

The extant empirical literature documents that both market-based and accounting-based performance measures are associated with executive remuneration. The literature identifies and addresses several econometric issues of importance, including i) the important theoretical and practical issues involved in operationalizing compensation and ii) the importance of controlling for time invariant differences across executives and regression coefficients on performance measures that differ across executives. Further, the empirical literature documents that the informational characteristics of accounting performance measures influence their relative weighting within compensation contracts.

Both the theoretical and empirical compensation literature evidence a very distinct focus: Accounting researchers wish to understand why and how accounting-based performance measures are used in executive compensation contracts. The "why" question arises because current theory maintains the hypothesis that security-price-based performance measures are the best measure of managers' performance. Given this apparent superiority of stock-based performance measures, researchers seek to understand the features of accounting numbers that give them incremental usefulness as a performance measure in executive compensation contracts. The "how" question arises because accounting performance measures differ in their sensitivity to managerial performance, and observing how their use varies across firms may provide insight into the interaction between firms' accounting and compensation systems.

Perhaps the most important unaddressed issue that emerges from the extant literature is whether compensation systems appear to exploit the incentive-allocation and risk-shielding capabilities of accounting performance measures created through measurement bias. This question is of theoretical importance because the answer will provide insight into the complex roles played by accounting performance measures in compensation systems and because evidence that bias is useful will challenge the conventional wisdom that bias is an undesirable characteristic in accounting numbers. The question is also of practical importance because evidence that bias in accounting measures has contracting value may provide information that will allow contracting agents to design more effective and efficient contracts.

CHAPTER 3

THEORY DEVELOPMENT AND HYPOTHESES

Institutional Setting

The oil and gas industry is an ideal institutional setting in which to test the risk-shielding and incentive-allocation roles of accounting in compensation systems because it features a production environment characterized by two principal activities (exploration and production) and compensation systems that use accounting measures (earnings, SFAS 69 reserve additions) that are differentially sensitive to the output from the two principal activities. These characteristics of the setting are described below.

The delivery of oil and gas products to consumers is the last of four sequential functions that collectively define the oil and gas industry. Each of these four functions - exploration and production, transportation, refining, and marketing - represent distinct industry segments. Fully-integrated oil and gas firms will operate in all four industry segments while non-integrated firms may operate in only one or two segments (Brock, Klingstedt, and Jones, 1990).

The exploration and production segment discovers and extracts oil and gas reserves. It is the segment normally regarded as the "oil industry." Exploration and production are two distinct activities. Management of the exploration activity is responsible for economically and efficiently discovering oil and gas reserves.

Management of the production activity is responsible for economically and efficiently extracting reserves at a rate that maximizes the present value of the reserve stocks.

Traditional historical cost accounting earnings are differentially sensitive to the production and exploration activities in oil and gas firms. Earnings do not recognize the value created by the exploration activity through reserve discovery until the reserves are actually produced, often years later. Earnings do report the value created by the production activity, the optimal extraction of reserves, with little or no lag.

Because historical cost accounting earnings are insensitive to value created by exploration, the Securities and Exchange Commission proposed in 1978 to replace historical cost accounting within the petroleum industry with an alternative accounting method (reserve recognition accounting) that would immediately recognize the value of oil and gas reserves added to the reserve stock through the exploration activity. While the proposal was later withdrawn, Statement of Financial Accounting Standards No. 69 (SFAS 69) subsequently required oil and gas firms to disclose the value of oil and gas reserve additions. The reserve addition measure, like the net income measure, is differentially sensitive to the production and exploration activities but in a mirror-image sense. Specifically, the reserve addition measure is sensitive to the value added by the exploration activity and insensitive to the value added by the production activity.

Earnings and reserve addition performance measures are both biased measures. The notion of measurement bias used in this dissertation is that of Bushman and Indjejikian (1993a), discussed in Chapter 2. Specifically, a performance measure is biased if it is insensitive to output from at least one activity performed by the manager. A performance measure is insensitive to output from an activity if the expected value of the measure *does not* change as the manager's effort in that activity changes and is sensitive to output from an activity if the expected value of the measure *does* change as the manager's effort changes. A performance measure based on accounting earnings is insensitive to output from the exploration activity, and a performance measure based on reserve additions is insensitive to output from the production activity; therefore, both are biased measures. In contrast, a stock-return performance measure is unbiased because it is sensitive to output from both activities.

Proxy disclosures made by oil and gas firms show that firms' compensation systems supplement stock returns with both earnings and reserve addition performance measures. In other words, an unbiased stock-price measure is supplemented with two biased accounting measures. If the disclosures are meaningful, then stock returns, net income, and reserve addition performance measures all receive nonzero weights in the compensation systems of oil and gas firms.

Theory and Hypotheses - Incentive Allocation and Risk Shielding

Managers in an oil and gas firm devote effort to expanding their firm's reserve stock through exploration and they devote effort to exploiting the firm's existing reserve stock through production. They must allocate their effort between the two activities. Output from effort in the exploration activity (value of reserve additions) is determined by the managers' [1] marginal productivity of effort in exploration plus a random shock term that represents exploration risk. Output from effort in the production activity (value of reserves produced) is determined by the managers' marginal productivity of effort in production plus a random shock term that represents variation in oil and gas prices, variation in the volume that is economically extractable, and variation in extraction costs.

Incentive-Allocation Hypothesis

An optimal compensation system allocates incentives between the exploration and production activities in proportion to the managers' marginal productivity in each (Bushman and Indjejkian, 1993b). Stock-based performance measures are unbiased and thus provide equal incentives to both activities; consequently, compensation systems *cannot* use this type of measure to allocate incentives. Earnings provide strong incentives for effort in the production activity

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[1] The BI theory is specified in terms of individual managers rather than the management group as a whole. For example, marginal productivity is a manager-specific characteristic. However, since only firm-level data are available the theory must be applied to the management group at the firm level, requiring one to assume that managers within firms have similar risk attitudes and marginal productivities. Thus, the use of the plural-possessive form "managers'".

but no incentives for effort in the exploration activity. Conversely, reserve additions provide strong incentives for effort in the exploration activity but no incentives for effort in the production activity. These two accounting-based performance measures are biased; therefore, compensation systems *can* use these accounting measures to allocate incentives between the two activities.

For example, say that directors wish to increase the incentives for effort in the production activity. Because stock price is an unbiased performance measure, increasing the sensitivity of compensation to the stock-based performance measure would have the desired effect of increasing the reward for production output, but it would also have the undesired effect of increasing by an equal amount the reward for exploration output. The unbiasedness in stock price precludes incentive allocation.

In contrast, accounting earnings fail to report output from the exploration activity. Consequently, reward for effort in the production activity, but not the exploration activity, will increase if compensation is made more sensitive to earnings. The bias enables earnings to precisely focus incentives in a way that an unbiased stock-price measure cannot. Similarly, reserve additions are insensitive to production output, so that reward for effort in the exploration activity, but not the production activity, will increase if compensation is made more sensitive to reserve additions.

The preceding discussion leads to the hypothesis that compensation systems in oil and gas firms exploit the bias in accounting-earnings and reserve-addition performance measures in order to allocate incentives for managerial effort between the exploration and production activities. Specific predictions from the incentive-allocation hypothesis are formalized as P1-P4 below.

P1: Compensation will become more sensitive to accounting earnings (relative to stock returns) as the managers' marginal productivity in the production activity increases.

P2: Compensation will become less sensitive to accounting earnings (relative to stock returns) as the managers' marginal productivity in exploration increases.

P3: Compensation will become more sensitive to reserve additions (relative to stock returns) as the managers' marginal productivity in the exploration activity increases.

P4: Compensation will become less sensitive to reserve additions (relative to stock returns) as the managers' marginal productivity in the production activity increases.

Risk-Shielding Hypothesis

The maintained hypothesis that stock price measures output without bias implies that volatility in output due to exploration and production risk will create volatility in stock price. Consequently, exploration and production risk create volatility in executives' compensation if compensation is tied to a stock-based performance measure. Tying executives' compensation to one or more biased accounting performance measures in addition to an unbiased stock measure can help reduce this volatility.

To illustrate, say that a firm embarks on a new, risky exploration program, and directors would like to prevent the added exploration risk from increasing the volatility in the executives' compensation. The directors can accomplish this by making compensation less sensitive to stock returns and reserve additions and more sensitive to earnings. This will work because accounting earnings are relatively insensitive to the exploration activity and therefore are unaffected by the volatility in exploration output.

As a second example, assume that management becomes uncertain about the volume of economically extractable hydrocarbons that remains within its reservoirs, and directors would like to shield executive compensation from any volatility that might arise from this heightened production risk. The directors can accomplish this by making compensation less sensitive to stock returns and earnings and more sensitive to reserve additions. This works because reserve additions are completely insensitive to the production activity and therefore are unaffected by the volatility in production output.

These ideas lead to the hypothesis that compensation systems in oil and gas firms exploit the bias in accounting performance measures in order to shield executives from production and exploration risk. Specific predictions from this risk-shielding hypothesis are formalized in P5-P8 below.

P5: Compensation will become less sensitive to accounting earnings (relative to stock returns) as production risk increases.

P6: Compensation will become more sensitive to accounting earnings (relative to stock returns) as exploration risk increases.

P7: Compensation will become less sensitive to reserve additions (relative to stock returns) as exploration risk increases.

P8: Compensation will become more sensitive to reserve additions (relative to stock returns) as production risk increases.

Noise Hypothesis

The sensitivity-times-precision framework of BD, Sloan, and BI predicts that compensation will be less sensitive to noisy performance measures and more sensitive to less-noisy measures. This noise hypothesis is unrelated to either the presence or absence of bias in the accounting performance measure. Since prior research supports the noise hypothesis, variables from the hypothesis are proposed here as explanatory factors to avoid a possible correlated omitted variable problem.

There are at least two important potential sources of noise in accounting earnings of oil and gas firms, and both come from the effect of accounting cost allocations. The first source of noise in accounting earnings arises from the interaction of cost allocations and the exploration cycle of the firm. Sunder (1976) shows that differences in cost allocation algorithms cause earnings computed under the full cost method of accounting to be less variable than earnings computed under the successful efforts method of accounting. Differential variation in earnings between accounting methods due to cost allocations implies that the noise characteristics of the earnings may also differ.

Noise in earnings also arises from the interaction between cost allocations and error in reserve quantity estimates. Any error in estimating reserve quantities introduces error into earnings via the depletion computation since depletion expense is computed as the product of the book value of oil properties times the fraction of reserves produced.

Thus, firms' exploration cycle and reserve estimation errors interact with cost allocations to create an earnings component not correlated with the managers' contribution to firm value. It is useful and reasonable to view that component as a random noise term.

Error in estimating reserve quantities not only introduces noise into earnings, but the estimation error itself constitutes noise in the reserve addition performance measure. Finally, market-wide movements in stock prices are unrelated to the managers' contribution to firm value and therefore constitute noise in the stock return performance measure (Sloan 1993).

The noise hypothesis predicts that compensation will be less sensitive to noisy performance measures and more sensitive to less-noisy measures. The effect of noise in accounting earnings, stock returns, and reserve addition performance measures are formalized in P9-P12 below.

P9: Compensation will become less sensitive to accounting earnings (relative to stock returns) as the noise in accounting earnings increases.

P10: Compensation will become more sensitive to accounting earnings (relative to stock returns) as the noise in stock returns increases.

P11: Compensation will become less sensitive to reserve additions (relative to stock returns) as noise in the reserve addition performance measure increases.

P12: Compensation will become more sensitive to reserve additions (relative to stock returns) as noise in stock prices increases.

Theory and Hypothesis - Accounting Choice

Modified Bonus-Plan Hypothesis

The positive accounting literature proposes two different theories to explain accounting choice. The opportunism theory proposes that managers choose accounting methods that benefit themselves at the expense of shareholders. For example, managers might select income-increasing accounting methods if their compensation is tied to accounting net income. Any resulting gain in compensation represents wealth transferred from shareholders to managers. Alternatively, the efficiency-in-contracting theory proposes that accounting is part of the contracting technology of the firm and that accounting methods are chosen to optimally minimize the contracting costs within the firm.

For example, corporate directors might cause managers to choose accounting methods that optimally allocate incentives across managers' range of activities. The efficiency-in-contracting theory implies that accounting policies are jointly determined along with all other important corporate policies, including compensation decisions.

Studies of accounting choice find that formal accounting-based bonus plans in firms' compensation systems are associated with the choice of income-increasing accounting methods. Researchers interpret this association as evidence that managers choose income-increasing accounting methods to maximize the present value of their bonuses. This is the bonus-plan hypothesis. Watts and Zimmerman (1990) believe that this interpretation may be incorrect. They argue that if accounting decisions and compensation decisions are jointly determined (i.e., if the efficiency-in-contracting theory is valid), the documented association between accounting-based bonus plans and accounting choice might actually be due to endogeneity bias rather than opportunistic behavior by management. Endogeneity bias would be expected since the extant studies assume that compensation decisions and accounting decisions are recursive (compensation policy affects accounting choice but not the reverse).

While the principal purpose of this dissertation is to test the incentive-allocation, risk-shielding, and noise hypotheses, the experimental design (to be discussed in Chapter 4) allows a direct test, free of endogeneity bias, of the notion that accounting-based compensation arrangements influence accounting choice.

Specifically, the prediction is that accounting-based compensation arrangements influence accounting choice by enabling managers to increase their expected compensation by judicious accounting choice. This is a variant of the bonus-plan hypothesis and is formalized in P13 below.

> P13: Managers who expect to earn more under full cost accounting than under successful efforts accounting will be more likely to choose full cost accounting; managers who expect to earn more under successful efforts accounting than under full cost accounting will be more likely to choose successful efforts accounting.

Managers might expect to receive different amounts of compensation under alternative accounting methods for at least three reasons. First, expected compensation might differ between accounting methods if managers expect the volatility of the compensation streams to differ, and they demand a risk premium to compensation them for bearing the incremental risk. However, since a risk premium is intended to make a decision-maker indifferent between choices with different levels of risk, any difference in expected compensation between the two accounting methods due to risk premium should not influence managers' accounting choices. Second, expected compensation might differ between accounting methods if one accounting method permits optimal incentive allocation while the alternative accounting method does not. The enhanced incentive structure under the optimal accounting method may elicit increased effort, expanded firm output, and therefore greater compensation. Managers who maximize expected compensation by choosing an accounting method that optimally allocates incentives make efficient accounting choices. Third, expected compensation might differ between accounting methods if corporate directors fail to completely offset the compensation effects of managers' accounting choices that merely increase accounting earnings (and bonuses) without increasing firm value. Managers who maximize expected compensation by choosing an income-increasing accounting method that does not increase firm value make opportunistic accounting choices.

Thus, maximization of expected compensation is consistent with both efficiency-in-contracting and opportunism theories of accounting choice, which implies that P13 does not discriminate between efficient and opportunistic accounting choices.

Summary of Theory and Hypotheses

The theory motivating the four hypotheses can now be summarized in the following way. Compensation systems in the oil and gas industry use measures of stock returns, earnings, and reserve additions to gauge managers' performance. Two of these measures - earnings and reserve additions - are biased. The bias in these two measures can be used to target incentives toward activities that the directors wish to encourage and to shield managers from exploration and production output risk. The sensitivity of compensation to accounting earnings and reserve additions, relative to their sensitivity to stock returns, is expected to vary as a function of i) the managers' marginal productivity in each activity, ii) the output risk associated with each activity, and iii) the noise in the three performance measures.

The presence of accounting-based performance measures in compensation arrangements enables management, through judicious accounting choice, to change the amount of compensation they can expect to receive. Risk premiums, enhanced incentive allocation, and wealth transfers from shareholders to managers will cause expected compensation to differ between accounting methods. This expected compensation differential may be an important factor in explaining accounting choice.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

Introduction

The research uses an endogenous switching regression model to control for the interdependence between accounting choice and compensation systems. This model is a simultaneous equations model with a binary qualitative dependent variable (accounting choice) and limited dependent variables (compensation). This model is used to control for two different potential forms of bias - self selection and endogeneity.

Self-selection bias will arise if the modified bonus-plan hypothesis is valid. If managers self-select into accounting methods to maximize their expected compensation, the compensation dependent variable will be truncated. Ignoring this truncation will bias the tests of the incentive-allocation, risk-shielding, and noise hypotheses. The model controls for this potential self-selection bias by correcting for the truncation of the dependent variable.

In addition to self-selection bias, endogeneity bias is also a potential concern if compensation and accounting method choice are jointly determined. Estimating the accounting choice and compensation functions as a simultaneous model controls for the threat of endogeneity bias.

Sample Selection

Oil and gas firms used in this dissertation must pass the following data availability screens. First, firms must have financial statement information available on Compustat and security price information on CRSP for the period 1973-1992. This time interval was chosen because it gives a time-series sufficiently long to permit reasonably accurate estimation of firm-specific noise measures. In imposing this screen, an important trade-off between statistical power and measurement error occurs. Many of the firms that concentrate exclusively on exploration and production merged or otherwise changed reporting entity during the period 1973-1992, so that the desired time-series of accounting and security price data for these firms is unavailable. Including these firms would produce the strongest test of the theory because executives in these firms were exposed to greater exploration and production risk (in relative terms) than executives in integrated firms. However, including these firms would also introduce measurement error because the reduced time-series yields less precise noise measures. Thus, I trade statistical power for reduced measurement error.

Second, proxy statements must be available through SEC Q-Data or LEXIS for the period 1985-1992. The annual proxy filings are the source for the compensation information. The 1985 year is chosen as the initial year principally because the extent of coverage in the proxy database increases substantially beginning in 1985. Third, firms' oil and gas reserve disclosures must be available in the Arthur Andersen & Co. Oil and Gas Disclosures Database in order to minimize data collection costs. Fourth, firms must use the same method of accounting for oil and gas operations throughout the 1985-1992 period to ensure that an accounting change would not alter the noise characteristics of earnings during the experimental period. Fifth, each executive must be observed for at least three years to be included in the sample. These five data screens yield a sample of 1151 executive-year observations of annual compensation paid to 222 top-level executives in 40 oil and gas firms during the period 1985-1992. Summary and descriptive statistics appear in Tables 1-3.

Models

The theory predicts that the sensitivity of compensation to the three performance measures will vary cross-sectionally as a function of exploration and production output risk; the managers' marginal productivity in the exploration and production activities; and the noise in earnings, stock prices, and reserve additions. The compensation model used in this dissertation allows the slope coefficients on the three performance measures to vary across firms as a function of output risk, marginal productivity, and noise in the performance measures; otherwise, the slope coefficients are constant across executives and firms. Prior empirical research shows that intercepts and slopes may vary across executives, firms, and industries in compensation models. I do not control for nonconstant slopes across firms or executives because the data time series is too short and because the intra-industry setting substantially reduces the effect of any factors (other than those being tested) that would otherwise cause slope coefficients to vary. I do control for cross-sectional heterogeneity attributable to unobserved time-invariant factors that vary across executives and position by including executive and position dummies. The model also includes time dummies to control for unobserved factors that are constant across executives but vary across years.

Since the marginal effects of the explanatory factors are expected to differ between contracts written under full cost versus successful efforts accounting, the sample is partitioned by accounting method and the compensation model separately estimated for each partition. Further, the two models are estimated as a two-stage switching regression with endogenous switching to control for selection bias (Lee 1978). Selection bias is expected if managers systematically self-select into accounting methods to maximize their expected compensation. The two-stage switching model is specified by the following three equations.

(1)

$$lnC_{FC,ijt} = \beta_{fc_{0ij}} + \beta_{fc_1}R_{jt} + \sum_{k=1}^{7} \beta_{fc_{1k}}R_{jt}*I_{jkt} + \beta_{fc_2}NI_{jt} + \sum_{k=1}^{7} \beta_{fc_{2k}}NI_{jt}*I_{jkt}$$
$$+ \beta_{fc_3}RA_{jt} + \sum_{k=1}^{7} \beta_{fc_{3k}}RA_{jt}*I_{jkt} + \beta_{fc_4}K_{jt} + \epsilon_{fc_{ijt}}$$

(2)

$$lnC_{SE,ijt} = \beta_{se_{0ij}} + \beta_{se_1}R_{jt} + \sum_{k=1}^{7} \beta_{se_{1k}}R_{jt}*I_{jkt} + \beta_{se_2}NI_{jt} + \sum_{k=1}^{7} \beta_{se_{2k}}NI_{jt}*I_{jkt}$$
$$+ \beta_{se_3}RA_{jt} + \sum_{k=1}^{7} \beta_{se_{3k}}RA_{jt}*I_{jkt} + \beta_{se_4}K_{jt} + \epsilon_{se_{ijt}}$$

(3)

$$A = \gamma' Z_j - u_{jt}$$
$$Z_j' = \left[(lnC_{fc,jt} - lnC_{se,jt}),\ LEV_{jt},\ SIZE_{jt}\right]$$

where

A_{jt}	=	benefit to manager from selecting full cost accounting, observed as A=1 if full cost accounting selected, A=0 if successful efforts accounting selected
$SIZE_{jt}$	=	end-of-year market value of firm j plus book value of long-term debt
lnC_{ijt}	=	log transformed compensation paid to executive i

$(\ln C_{fc}-\ln C_{se})$	=	proportional effect on compensation of full cost accounting choice
LEV_{jt}	=	leverage of firm j
R_{jt}	=	stock return of firm j
RA_{jt}	=	reserve additions of firm j
NI_{jt}	=	net income of firm j
I_{1j}	=	noise in stock returns of firm j
I_{2j}	=	noise in earnings of firm j
I_{3j}	=	noise in reserve additions of firm j
I_{4j}	=	exploration risk of firm j
I_{5j}	=	production risk of firm j
I_{6j}	=	managers' marginal productivity in the exploration activity of firm j
I_{7j}	=	managers' marginal productivity in the production activity of firm j
$K_{FC,jt}$	=	$-\phi(\gamma'Z_j)/\Phi(\gamma'Z_j)$
$K_{SE,jt}$	=	$\phi(\gamma'Z_j)/1-\Phi(\gamma'Z_j)$
$\Phi(\cdot)$	=	cumulative distribution of the standard normal function
$\phi(\cdot)$	=	standard normal density function
Z_j	=	vector of explanatory variables in equation 3
γ'	=	vector of coefficients in equation 3

The explanatory variables in the accounting choice model are motivated by existing theoretical and empirical work in the determinants of accounting choice (Watts and Zimmerman 1986; Ball and Smith 1992). Specifically, SIZE operationalizes the incentive to choose an income-decreasing accounting method (the successful efforts method) that will reduce firms' exposure to political costs, while LEV operationalizes the incentive to choose an income-increasing accounting method (the full cost method) that reduces the probability of violating accounting-based debt covenants. The compensation differential ($\ln C_{fc}$-$\ln C_{se}$) measures the proportional change in compensation that would accompany the use of full cost accounting. Thus, it operationalizes the incentive for accounting choice created by accounting-based compensation arrangements. Finally, notice that accounting choice and the compensation decision are simultaneously determined.

If self-selection is present, the expected value of the error term in models 1 and 2 before correction for self-selection would be $-\sigma_{fc,u}*[\phi(\gamma'Z_i)/\Phi(\gamma'Z_i)]$ and $\sigma_{se,u}*[\phi(\gamma'Z_i)/1-\Phi(\gamma'Z_i)]$, respectively, where $\sigma_{fc,u} = \text{cov}(\epsilon_{fc},u)$ and $\sigma_{se,u} = \text{cov}(\epsilon_{se},u)$. The selectivity correction factors K_{fc} and K_{se} in models 1 and 2 correct for the nonzero expected value of the disturbance term that is due to self-selection.

Principal Variable Operationalization

The following discusses the operationalization of variables in models 1 and 2.

Operationalization of Performance Measures

The three performance measures are stock returns (R), earnings (NI), and reserve additions (RA). R is an annual measure that is computed by compounding monthly stock returns reported on CRSP across a 12-month compounding interval. Two compounding intervals are used. For the measure of R used in the market model, compounding begins in the fourth month of the fiscal year and continues through the third month of the succeeding fiscal year. This compounding interval corresponds to the period when the firm releases quarterly and annual financial reports to the public. The R used as a performance measure in model 1 and 2 is compounded across the firm's fiscal year.

NI is operationalized as total earnings before extraordinary items, scaled by the beginning-of-year market value of the firm. RA is operationalized as the volume of oil and gas reserve additions, scaled by the volume of oil and gas reserves as of the beginning of the year. To permit aggregation, gas is converted to a unit that approximates the energy content of a barrel of oil (barrel of oil equivalent, or BOE units) at the rate of 6 mcf of gas equal one barrel of oil. Descriptive statistics appear in Table 4.

Operationalization of Compensation

Prior research operationalizes compensation in either of two ways: cash compensation only (salary plus bonus) or cash compensation plus noncash compensation (salary plus bonus plus stock options plus other long-term compensation). Several studies operationalize compensation both ways and compare the sensitivity of their results to the alternative operationalization. Murphy (1985), Antle and Smith (1986), Clinch (1991), and Ely (1991) operationalize compensation as cash compensation plus the value of stock options and other stock-based awards and compare the robustness of their results to those found when operationalizing compensation more narrowly as salary plus bonus. Murphy (1985) finds that his results are robust to the operationalization of compensation (in fact, the reported statistical association is stronger when compensation is operationalized as salary plus bonus). Ely (1991) concludes that her results are weaker but not qualitatively different when compensation is operationalized as total compensation. The results of both Murphy (1985) and Ely (1991) are consistent with the idea that including non-cash components does not add significantly to the analysis and in fact may introduce substantial measurement error. In contrast, Clinch (1991) and Antle and Smith (1986) found their results sensitive to the operationalization of the compensation variable.

Thus, measurement error exists under either operationalization of compensation: Cash compensation ignores the value of stock options and other noncash compensation that are important elements within the total compensation package, but valuing these noncash elements of compensation without knowing the executive's degree of risk aversion and degree of personal diversification overestimates the value assigned by the executive to these elements of compensation. This study uses salary plus bonus under the assumption that valuing other components of compensation will introduce substantial measurement error. This assumption has empirical support and has been frequently used in prior studies. Compensation data for the five most highly compensated executives in each firm are collected from the annual proxy statement filed by each firm.

Operationalization of I_1

I assume that managers wish to be evaluated by their contribution to firm value (Sloan 1993). This assumption implies that changes in the firm's stock price attributable to market-wide movement in stock prices, while value relevant, are not useful in evaluating managers. Hence, market-wide stock price movements constitute noise, and changes in the firm's stock price that are not associated with market-wide stock price movements measure managers' contribution to firm value. Accordingly, the monthly stock returns for each sample firm are decomposed into a signal and a noise component by estimating a two-factor market model for each firm across the 20-year period 1973-1992. The decomposition model appears below:

(4)

$$R_{jt} = \alpha_{0j} + \alpha_{1j} R_{Mt} + \alpha_{2j} R_{It} + S_{jt}$$

where

R_{jt} = monthly return of firm j in month t

R_{Mt} = equal weighted market return index for month t

R_{It} = equal weighted industry return index for month t

S_{jt} = residual representing managers' contribution to firm value during month t.

The estimated parameters in model 4 operationalize the noise in stock returns, I_1, as $I_{1j} = \hat{\alpha}_{1j}^2 var(R_M) + \hat{\alpha}_{2j}^2 var(R_I) + 2\hat{\alpha}_{1j}\hat{\alpha}_{2j} cov(R_I, R_M)$. The residual represents the signal component of stock returns.

Table 5 presents a summary of the parameters estimated in each of the firm-specific market models.

Operationalization of I_2

Accounting recognition and measurement rules may create a lag between the period of managers' contribution to firm value and the period in which accounting earnings reflect the same. Current research maintains the hypothesis that the value added by a manager is contemporaneously reflected in stock prices. I follow Sloan (1993) and operationalize noise in accounting earnings as the portion of accounting earnings not correlated with the managers' contribution to firm value as reflected in stock price. Accounting earnings are decomposed into components correlated and uncorrelated with the managers' contribution to firm value by regressing accounting earnings on the managers' contribution to firm value (S from model 4). The variance of the disturbance term is the measure of the noise in accounting earnings, as shown in model 5 below.

(5)

$$NI_{jt} = \alpha_{0j} + \alpha_{1j}S_{jt} + \eta_{jt}$$

where

NI_{jt} = net income before extraordinary items scaled by lagged market value of equity

S_{jt} = managers' contribution to firm value

$\alpha_{0,1j}$ = firm-specific parameters

and I_2 = $var(\eta_{jt})$.

A summary of the firm-specific parameters estimated for model 5 are presented in Table 6.

Operationalization of I_3.

I assume that error in estimating reserve additions creates noise in the reserve addition performance measure, and the study measures that noise as the variation in a firm's reserve revisions (scaled by beginning reserve stock in equivalent units) across the period 1981-1992. The time period is determined by data availability. Descriptive statistics on I_3 appear in Table 7.

Operationalization of I_4-I_7

The theory assumes that each executive's output in each of the two activities is a stochastic linear function of effort expended. Consequently, a linear regression of output on effort will measure both the manager's marginal productivity in the activity (the coefficient on effort) and the output risk associated with the activity (the variance of the disturbance term). Output risk in the exploration activity consists of exploration risk, which is the uncertainty in discovering hydrocarbons when exploration effort is expended. Output risk in the production activity consists of production risk, which comes from the uncertainty in the net revenue stream attributable to unexpected variation in production costs and oil/gas market prices.

While the theory assumes separate output functions for each executive, data are available only at the firm level so that only firm-specific output can be estimated. Consequently, the estimation of output risk and output productivity discussed in the following paragraphs implicitly assumes identical output functions for all executives in a given firm.

I assume that exploration effort can be measured as exploration dollars spent, and exploration output measured as the value of reserve additions . Thus, the exploration output function expresses the linear stochastic relationship between the value of reserve additions and exploration expenditures. However, since a quantity measure of reserve additions is available for a longer time-series than a value measure of reserve additions, the quantity measure is used as a proxy for the value measure. The parameters of the exploration output function are estimated by regressing the quantity of reserves discovered (scaled by beginning of year BOE reserves) on exploration expenditures (also scaled by beginning of year BOE reserves). As explained above, the estimated coefficient on exploration expenditures measures managers' exploration productivity, while the variance of the regression error measures exploration risk. This approach assumes that current-year exploration expenditures serve as an instrumental variable for exploration expenditures made in prior years that yield current-period reserve additions. More precise estimation using a distributed lag model is infeasible due to the limited time-series available for each firm. The estimated exploration output function appears in model 6, and the estimates of the model parameters appear in Table 8.

I assume that production effort can be measured as the units of reserves produced and production output measured as net oil and gas sales. Thus, the production output function expresses the linear stochastic relationship between the firm's net sales revenue and the quantity of reserves produced. The parameters of the production activity output function are estimated by regressing sales revenue (net of direct extraction costs) on quantity of reserves produced, both scaled by beginning-of-year BOE oil and gas reserves. The estimated coefficient on the regressor measures the managers' marginal productivity in the production function, while the variance of the regression error measures production risk. The production output function appears below as model 7, and the estimated model parameters are presented in Table 8. Notice that in both models the intercept is constrained to zero under the assumption that output cannot occur without effort.

(6)

$$RA_{jt} = \alpha_{x_j} Expl_{jt} + \eta_{x_{jt}}$$

(7)

$$NetRev_{jt} = \alpha_{p_j} EU_{jt} + \eta_{p_{jt}}$$

where

RA_{jt} = reserve additions for firm j during period t

$Expl_{jt}$ = exploration expenditures for firms j during period t

$NetRev_{jt}$ = oil and gas sales revenue less production costs

EU_{jt} = quantity of oil units produced plus quantity of gas units produced, with gas converted to equivalent units of oil based upon relative energy content

and $I_{4j}=var(\eta_{x,jt})$, $I_{5j}=var(\eta_{p,jt})$, $I_{6j}=\alpha_{xj}$ and $I_{7j}=\alpha_{pj}$.

Operationalization of K

Finally, models 1 and 2 require selectivity correction factors to control for potential selection bias that will occur if managers select accounting methods to maximize their expected compensation. The selectivity correction factor K for full cost firms is measured as $-\phi(\hat{\gamma}'Z_i)/\Phi(\hat{\gamma}'Z_i)$, and for successful efforts firms as $\phi(\hat{\gamma}'Z_i)/1-\Phi(\hat{\gamma}'Z_i)$, where $\hat{\gamma}$ is a vector of coefficients in an accounting choice probit model, and Z_i is the vector of explanatory variables. The structural-form accounting choice model is shown in equation 3.

Alternative Variable Operationalization

Theory does not specify the nature of noise, output risk, and productivity that may influence compensation contracts; consequently, each of the variables I_1-I_7 are reoperationalized in a different way to assess how sensitive the test results are to alternative definitions of the explanatory variables.

As in prior work (Lambert and Larcker 1987; Sloan 1993), I_1 and I_2 are reoperationalized as the total variation in stock prices and accounting earnings. This operationalization is chosen to assess whether contracting agents simply regard the total dispersion in these two performance measures as the relevant measure of noise.

Output risk in the exploration activity is reoperationalized as the estimated variance of the inverse of the per-unit average cost of discovering oil and gas reserves, and output risk in the production activity is reoperationalized as the variance of the net revenue per BOE unit of reserves produced. Similarly, productivity in the exploration activity is reoperationalized as the inverse of mean finding costs, and productivity in the production activity reoperationalized as the mean net revenue per BOE unit of reserves produced. These variables are selected because they are important measures used by financial analysts in assessing the performance of oil and gas firms (Mayer 1992; Moore 1992). Descriptive statistics comparing the principal and alternative operationalizations appear in Table 9.

CHAPTER 5

TESTS OF HYPOTHESES AND STATISTICAL INFERENCES

Estimation of Reduced-Form Accounting Choice Model

Because the structural-form accounting choice model includes the compensation differential ($\ln C_{fc}$-$\ln C_{se}$) as an endogenous explanatory variable, the determinants of ($\ln C_{fc}$-$\ln C_{se}$) from models 1 and 2 are substituted into the accounting choice model and the reduced-form accounting choice model estimated. This reduced-form model appears in equation 3A below.

(3A)

$$A = \pi_0 + \pi_1 R_{jt} + \sum_{k=1}^{7} \pi_{1k} R_{jt} * I_{jkt} + \pi_2 NI_{jt} + \sum_{k=1}^{7} \pi_{2k} NI_{jt} * I_{jkt} + \pi_3 RA_{jt} + \sum_{k=1}^{7} \pi_{3k} RA_{jt} * I_{jkt} + \pi_4 SIZE_{jt} + \pi_5 LEV_{jt} - u_{jt}^{*}$$

Equation 3A excludes time, position, and individual dummies under the assumption that the effect of these factors is the same in both groups and thus disappears in differenced form. I make this simplifying assumption and estimate the reduced-form accounting choice probit model by pooling recurring annual accounting choices made by firms across time. The estimated parameters of the model are presented in Table 10. The value of the log-likelihood function declines substantially when zero value restrictions are imposed on the coefficients chi-square 332.16(27), p=.0001), suggesting that the model can be used to estimate $\phi(\gamma'Z_i)/1-\Phi(\gamma'Z_i)$ and $-\phi(\gamma'Z_i) / \Phi(\gamma'Z_i)$.

Estimation of Fixed Effects Compensation Model

The estimated coefficients for models 1 and 2 appear in Tables 11 and 12. Lee (1978) shows that the variance of the error terms in models 1 and 2 is heteroskedastic, and Greene (1990) expresses the variance as $\sigma_j^2=\sigma^2(1-\rho^2\delta_j)$, where σ^2 is the homoskedastic variance and ρ is the correlation between the error term in the choice model and the error term in the compensation model. For full cost firms,

$\delta_j = [-\phi(\gamma'Z) / \Phi(\gamma'Z)] [-\phi(\gamma'Z) /\Phi(\gamma'Z)+\gamma'Z]$

while

$\delta_j = [\phi(\gamma'Z)/1-\Phi(\gamma'Z)] [\phi(\gamma'Z) / 1-\Phi(\gamma'Z)-\gamma'Z]$

for successful efforts firms.

The variance σ_j^2 is estimated in an effort to use $1/\hat{\sigma}_j^2$ as a weight in weighted least squares to correct the heteroskedasticity. A few estimates of ρ were outside the range -1 to 1, so the estimated value was either set to -1 or 1. The estimate of ρ can lie outside the interval - 1 to 1 because it is not directly estimated but is calculated from the ratio of two other estimates (see Greene 1990, p. 747). Setting $\hat{\rho}$ to these polar values caused $(1-\hat{\rho}^2\delta_j)$ to be negative in some instances, which is invalid. Accordingly, a consistent estimate of σ_j^2 is unavailable for all observations, so that weighted least squares cannot be used unless observations with $\hat{\sigma}_j^2 < 0$ be discarded or some other equally ad hoc method used to deal with the negative estimated variances.

An alternative to weighted least squares is to estimate the model coefficients by OLS and perform hypothesis tests by using a separately estimated consistent covariance matrix. The drawback to this approach is that the estimated coefficients are inefficient but the advantage is that it obviates the need to discard observations with negative estimated variances. This is the approach I adopt. The estimated covariance matrix is based on Froot (1989), which extends White's (1980) heteroskedasticity-consistent covariance matrix to account for cross-sectional dependence in the error term. Froot's covariance matrix is used rather than White's because a likelihood ratio test rejected the null hypothesis of residual independence within firms, but not across firms (Table 13). The error terms in models 1 and 2 are correlated because the models are estimated from a dataset consisting of multiple observations on executives within a firm at a point in time. Unknown factors that explain compensation paid to executives within a firm at a point in time will cause dependency among the residuals within firms, but not across firms. Thus, I assume that the error covariance matrix is block-diagonal with each block measuring the contemporaneous correlation among executives within a firm at a point in time.

Given this structure, the Froot (1989) method requires formation of N groups of P cross-sectional units whose error terms exhibit intragroup dependency but intergroup independence. The average error covariance matrix Θ is then estimated by averaging across the N groups and T time periods as shown below.

(9)

$$\hat{\Theta}_{NT} = \frac{1}{N}\sum_{n=1}^{N}[\frac{1}{T}\sum_{t=1}^{T}[\sum_{j=1}^{P}\sum_{k=1}^{P} x_{jnt}x'_{knt}\mu_{jnt}\mu_{knt}]]$$

where

x'_{nt}	=	P X K matrix of regressors for the p executives in firm n at time t
x'_{jnt}	=	K X 1 partition for the j^th executive in x'_{nt}
μ_{nt}	=	P X 1 vector of OLS disturbance terms for each of the p executives in firm n at time t
μ_{jnt}	=	1 X 1 partition for the j^th executive in μ_{nt}.

Notice that Θ is identical to White's (1980) heteroskedasticity consistent matrix when P=1.

Froot shows that a consistent estimate of the coefficient covariance matrix that controls for both heteroskedasticity and cross-sectional dependence is

(10)

$$Var(\hat{\beta}) = NT(X'X)^{-1}\hat{\Theta}(X'X)^{-1}$$

Thus, I estimate both models 1 and 2 by OLS, retain the residuals, estimate an average error covariance matrix Θ for each of the two models, and use the average covariance matrix to estimate the coefficient covariance matrix for each model. The resulting consistent covariance matrix is used in all hypotheses tests. Test results using the OLS covariance matrix are also presented for comparison when space permits. However, I confine discussion to tests based on the Froot covariance matrix since only these tests are valid.

Tests of Hypotheses

The analysis begins by testing a series of linear restrictions on the slope coefficients in each model. The tests, summarized in Tables 14 and 15 under the column heading "Principal Tests," evaluate whether selected subsets of the explanatory variables have explanatory power. In these and other tables, results presented under the column heading "Robustness Tests" duplicate the principal tests using alternative operationalizations of the explanatory variables. Further discussion of the robustness tests follows in a later section.

The overall significance of the model is tested by constraining the coefficients in each model to zero and observing the magnitude of the decline in the explanatory power of the model (LR1). The data strongly reject the zero-value linear restrictions in both the FC and SE models, suggesting that the models have explanatory power.

To assess the significance of the non-dummy explanatory variables as a group, the coefficients on all performance measures and explanatory variables are constrained to zero (LR2). Again, the data in both groups strongly reject the linear restrictions, demonstrating that as a group the performance measures and interaction variables explain executive compensation.

Next, zero-value restrictions are imposed on the coefficients of each performance measure and each explanatory variable to assess which performance measures and which explanatory variables are significant (LR3-LR12). The data strongly reject the zero-value restrictions on each performance measure (LR3-LR5), a finding consistent with the notion that these performance measures are used in compensation systems of oil and gas firms to determine the compensation paid to top executives.

The results from tests of the explanatory variables (LR6-LR12) are similar to, but weaker than, the linear restrictions imposed on the performance measures. The data reject all zero-value restrictions imposed on the explanatory variables in the FC model and all restrictions in the SE model except for LR12 on variable I_6. The results of the zero-value linear restrictions on the coefficients of the interaction variables are generally consistent with the thesis that the explanatory variables influence the sensitivity of compensation to the three performance measures.

The preceding linear restrictions tested whether the slope coefficients on the three performance variables vary cross-sectionally as a linear function of the seven explanatory factors. These restrictions test whether the explanatory factors influence the *absolute* sensitivity of compensation to the three performance measures. However, the hypotheses predict that the explanatory factors influence the sensitivity of compensation to NI and RA *relative* to the sensitivity of compensation to R. Consequently, rejection of the zero-value linear restrictions on the interaction variable coefficients is a necessary but not sufficient condition to support the research hypotheses.

To directly test the research hypotheses requires evaluating the seven explanatory factors to see if they influence the sensitivity of compensation to NI and RA (relative to R) as predicted. This can be done by determining the relationship among the estimated coefficients that is implied by the theory, and then imposing this relationship on the coefficients in the form of a nonlinear restriction to determine whether the actual relationship among the estimated coefficients is as predicted. This approach is used to test P1-P12.

The slope coefficients in each of the pooled fixed-effects compensation models imply the relative sensitivity of compensation to earnings and reserve additions that are shown in equations 11 and 12. Since the dependent variable in models 1 and 2 is a logarithmic transformation and the performance measures are scaled measures, the estimated sensitivity of compensation to these performance measures approximate elasticities. Table 16 presents descriptive statistics on the empirical estimates of these sensitivities. Notice that the estimated earnings and reserve addition elasticities are both less than one, and the stock return elasticity is very small and negative in sign. The negative stock return elasticity suggests that managers suffer a small penalty for increasing shareholder wealth, which seems anomalous. In the sensitivity-times-precision theoretical framework, a performance measure will receive a negative weight [2] if it is relatively insensitive to output but relatively sensitive to noise in other performance measures. However, this explanation for the negative sensitivity of compensation to stock returns is not pleasing because the study maintains the hypothesis that the stock return performance measure is unbiased. This empirical result is difficult to explain.

(11)

$$\frac{\frac{\partial lnC}{\partial NI}}{\frac{\partial lnC}{\partial R}} = \frac{\hat{W}(NI)}{\hat{W}(R)} = \frac{\hat{\beta}_2 + \sum_{k=1}^{7} \hat{\beta}_{2k} * I_{jk}}{\hat{\beta}_1 + \sum_{k=1}^{7} \hat{\beta}_{1k} * I_{jk}}$$

(12)

$$\frac{\frac{\partial lnC}{\partial RA}}{\frac{\partial lnC}{\partial R}} = \frac{\hat{W}(RA)}{\hat{W}(R)} = \frac{\hat{\beta}_3 + \sum_{k=1}^{7} \hat{\beta}_{3k} * I_{jk}}{\hat{\beta}_1 + \sum_{k=1}^{7} \hat{\beta}_{1k} * I_{jk}}$$

Evaluating the partial derivative of equations 11 and 12 with respect to each of the seven explanatory factors reveals how each factor affects the relative weight. For example, consider the partial derivative of equation 11 with respect to I_6 as shown in equation 13.

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[2] As equations 11 and 12 make clear, the phrase "the weight placed on performance measure X " means the same as "sensitivity of compensation to performance measure X". Both expressions are used interchangeably throughout the remainder of the paper, depending upon which phrase communicates most clearly.

(13)

$$\frac{\partial\left[\frac{\hat{W}(NI)}{\hat{W}(R)}\right]}{\partial I_6} = \frac{\hat{\beta}_{26}\hat{W}(R) - \hat{W}(NI)\hat{\beta}_{16}}{\hat{W}(R)^2}$$

P1 predicts that compensation will become more sensitive to accounting earnings (relative to stock returns) as I_6 increases. Thus, a positive (negative) value for the expression in equation 13 will constitute evidence consistent (inconsistent) with P1. Since the numerator in equation 13 determines the sign of the partial derivative, imposing the numerator in 13 as a nonlinear restriction on the coefficients estimated for models 1 and 2 will test the alternative hypothesis P1 against the null hypothesis that the restriction function is less than or equal to zero.

To briefly summarize, P1-P12 are tested by evaluating the partial derivative of equations 11 and 12 with respect to each of the explanatory factors. The numerator of each partial derivative is a function of the estimated coefficients. Theory predicts the sign of this function, and this prediction can be tested by imposing the function as a nonlinear restriction on the coefficients. Because the values of I_1-I_7 appear as arguments in the partial derivatives, and since I_1-I_7 are firm-specific measures, each partial derivative is evaluated using the median values of I_1-I_7 from Table 9. Median values were chosen as a measure of central tendency to reduce the potential effect of any extreme values. [3]

This approach is analogous to testing hypotheses about the marginal effects of explanatory variables in logit models by evaluating the marginal effect at the mean value of the explanatory variables. The results of the nonlinear restrictions appear in Tables 17 and 18.

Tests of the Incentive-Allocation Hypothesis

P1-P4 predict how the sensitivity of compensation to the performance measures will vary if compensation arrangements exploit the measurement bias in the accounting performance measures in order to optimally allocate incentives across activities. P1 and P3 predict that performance measures sensitive to a dimension of executive activity will receive greater weight as the managers' marginal productivity in that activity increases because the measurement bias in the performance measure provides stronger and more direct incentives for effort in that activity than do unbiased performance measures.

Similarly, P2 and P4 predict that performance measures sensitive to a dimension of executive activity ("sensitive activity") will receive less weight as the managers' marginal productivity increases in the other activity ("insensitive activity") because a direct reduction of incentives for the sensitive activity effects a relative increase in incentives for the insensitive activity.

[3] Results, discussed below, are qualitatively unchanged when mean values are used.

The data reject null-form P3 and P4 but not P1 and P2. Against the alternative hypothesis that $f(\$)=\beta_{26}W(R)-W(RA)\beta_{36} > 0$, the FC data reject the null that $f(\beta)\leq 0$ at the .05 level of significance, a finding consistent with P3. Similarly, against the alternative hypothesis that $f(\beta)=\beta_{27}W(R)-W(RA)\beta_{37} < 0$, the data in the FC group reject the null that $f(\beta)\geq 0$ at the .05 level of significance, a finding consistent with P4.

The results are consistent with the theory that compensation systems in FC firms exploit the measurement bias in the reserve addition performance measure to focus incentives in a way that will encourage executives to optimally allocate their effort across activities. The SE data do not reject either null hypothesis.

Neither do the data reject the null-form of P1 and P2 in either group. Assuming a .05 probability of Type I error for each test and independence across tests, the probability is .051 that the observed results (at least two of the four predictions supported in at least one of the FC or SE tests) would occur by chance.

Tests of the Risk-Shielding Hypothesis

P5 and P7 test whether corporate directors adjust the weights placed on performance measures in order to shield executives from uncontrollable output uncertainty. P5 predicts that compensation will be less sensitive to earnings (relative to stock returns) as production risk increases, and P7 predicts that compensation will be less sensitive to reserve additions (relative to stock returns) as exploration risk increases.

The data reject null-form P5 and P7 but reject neither null-form P6 nor P8. Against the alternative hypothesis that $f(\beta)=\beta_{26}W(R)-W(NI)\beta_{16} < 0$, the FC data reject the null that $f(\beta)\geq 0$ at the .05 level of significance, a finding consistent with P5. This result suggests that compensation arrangements in FC firms place less weight on accounting earnings as production risk increases in order to shield executives from production risk. Null-form P5 could not be rejected by the SE model.

Against the alternative hypothesis that $f(\beta)=\beta_{24}W(R)-W(NI)\beta_{34} < 0$, the null that $f(\beta)\geq 0$ can be rejected by the SE model at the .05 level of significance. This result is consistent with P7 and suggests that compensation arrangements in SE firms place less weight on reserve additions as exploration risk increases in order to shield executives from exploration risk. Null-form P7 could not be rejected by the FC model. Finally, the null forms of P6 and P8 could not be rejected in either the FC or SE model.

Assuming a .05 probability of Type I error for each test and independence across tests, the probability is .051 that the observed results (at least two of the four predictions supported in at least one of the FC or SE tests) would occur by chance.

Tests of the Noise Hypothesis

P9-P12 predict how noise in the performance variables will affect the weight given them in compensation systems. Theory and prior empirical work suggest an inverse relationship between the noise in performance measures and their use in compensation arrangements. However, the data are unable to reject the null form of P9-P12 so the principal test results are inconsistent with the noise hypothesis.

Summary of Principal Tests

The results provide modest support for the notion that measurement bias expands the roles played by accounting performance measures in compensation systems. The pattern of relative weights assigned to stock returns, earnings, and reserve addition performance measures offers some evidence that compensation systems exploit the measurement bias in accounting performance measures to shield executives from uncontrollable output risk and to encourage executives to optimally allocate their effort across activities.

Most of the supportive evidence comes from the FC group rather than the SE group. One possible explanation for the extremely weak results in the SE group is that SE accounting earnings are not completely insensitive to exploration activity as are FC accounting earnings. In fact, since dry-hole costs are expensed under SE accounting, SE earnings are negatively sensitive to exploration activity, and the degree of negative sensitivity increases as the level of exploration risk increases. As compared to FC earnings, the negative sensitivity of SE earnings to exploration activity will i) reduce the covariance between earnings and stock returns and ii) increase the variance of earnings. It can be shown that the overall effect will be increased relative weight on accounting earnings if exploration risk is large relative to production risk. Intuitively, this occurs because the negative sensitivity of accounting earnings shields the executive from exploration risk and is analogous to the risk-shielding role of accounting earnings in Sloan (1993).

This analysis suggests that the slope coefficients on all $NI*I_i$ interaction variables in model 2 should be free to vary across firms as a function of exploration risk (I_4). Model 2 was reestimated after adding three-way interaction terms ($NI*I_i*I_4$) for each I_i to assess the effect of relaxing the assumption that SE earnings are completely insensitive to the exploration activity in SE firms. Zero value restrictions were imposed on all the three-way interaction coefficients to test the null hypothesis that the slope coefficients on $NI*I_i$ are constant across firms. The data strongly reject the null hypothesis, suggesting that cross-sectional variation in the negative sensitivity of SE earnings conditions the effect of the explanatory variables. However, the parameter estimates and tests are not reported because the tests of the nonlinear restrictions using the parameters from the revised model 2 are qualitatively unchanged. The fact that the theory assumes earnings to be insensitive to exploration output while SE earnings are negatively sensitive does not appear to explain the poor results in the SE group.

Robustness Tests

To assess the robustness of the results, the preceding tests are repeated using the alternative variable operationalization to assess the robustness of the results. This section reports those results.

As Table 14 shows, when the tests are repeated using the alternative variable operationalizations the data in the FC group cannot reject the null hypotheses that the coefficients on I_2, I_4, and I_7 are zero. Thus, under the alternative operationalizations I_2, I_4, and I_7 appear to have no effect upon the slope coefficients of the performance measures in model 1. In contrast to the results from the FC group, the results of the linear restriction tests for the SE group are even stronger under the alternative operationalization (Table 15).

As compared to the principal nonlinear restriction tests, the robustness nonlinear restriction tests provide stronger evidence in support of the noise hypothesis and weaker evidence in support of the risk-shielding hypothesis and the incentive-allocation hypothesis (Tables 17 and 18). None of the null-form predictions made by the noise hypothesis (P9-P12) are rejected under the FC principal tests, but the FC robustness tests do reject the null-form of P10, P11, and P12. Unlike the results of the principal tests, these results suggest that the relative weights placed on stock returns and reserve additions are inversely related to the noise within each. Thus, the robustness tests support the noise hypothesis while the principal tests do not.

Support for predictions made by the risk-shielding hypothesis (P5-P8) decrease under the robustness tests. Null-form P5 is rejected under the FC principal tests and null-form P7 is rejected under the SE principal tests, but only P5 is rejected under the FC robustness test. Thus, while the total evidence in support of the risk-shielding hypothesis declines under the robustness tests, the results do reinforce the support for P5 found in the principal tests.

Finally, support for the predictions made by the incentive-allocation hypothesis (P1-P4) also decreases under the robustness tests. Null-form P3 and P4 are rejected under the FC principal tests, but only null form P3 is rejected under the FC robustness tests. Again, while the total supporting evidence decreases under the robustness tests the results do reinforce the principal test results supporting P3.

Overall, the robustness tests reveal the sensitivity of the support found for P4 and P7 to alternative operationalizations of the variables but provide convergent evidence in support of P5 and P3.

Economic Significance

Both the FC and SE models are significant in a statistical sense, but statistical significance does not necessarily imply economic significance. This section reports on tests designed to evaluate the effectiveness of earnings and reserve addition performance measures in risk shielding and incentive allocation. The approach is adopted from Sloan (1993) and assesses the degree of incentive allocation and risk shielding that is implied by the estimated parameters in models 1 and 2 relative to the degree of incentive allocation and risk-shielding in a benchmark compensation system that uses only a stock-based performance measure. Under the benchmark system, executives will receive identical incentives for production and exploration activity and will be equally exposed to both exploration and production risk. The risk-shielding hypotheses are based on the idea that measurement bias in performance measures enables those measures to more effectively shield managers from uncontrollable output risk. Under the benchmark compensation system, executives' exposure to exploration risk relative to their exposure to production risk is 1:1. Evaluating the partial derivative of model 1 with respect to I_4 (I_5) gives the FC executives' exposure to exploration (production) risk, while the partial derivatives in model 2 give the SE executives' risk exposure. The ratio of partial derivatives

$(\partial \ln C/\partial I_4)$: $(\partial \ln C/\partial I_5)$ expresses the executives'

exposure to exploration risk relative to production risk. Comparing this ratio to the benchmark 1:1 ratio reveals the extent to which the biased performance measures insulate the executives from uncontrollable output risk.

Substituting median values of I_1-I_7 (from Table 9) into the partial derivatives yields $(\partial \ln C/\partial I_4):(\partial \ln C/\partial I_5)=-1.95:-0.11$, or

1:0.056, in the median FC firm; similarly,

$(\partial \ln C/\partial I_4):(\partial \ln C/\partial I_5) = -10.9371: -0.73708$, or 1:0.067, in the

median SE firm. Relative to the benchmark compensation system, the extant compensation systems appear to dramatically reduce executives' exposure to production risk. This is a curious finding since hedging strategies can reduce at least some of the production risk while exploration risk cannot be hedged, suggesting that production risk is a less important source of uncertainty than exploration risk in the oil and gas business. One possible explanation is that exploration activity was depressed during much of this period while oil and gas prices were quite volatile making production risk a more pressing concern. At least one paper (Williams and Jackson, 1994) argues that price risk was of greater consequence than exploration risk to oil and gas firms during the 1980s.

The incentive-allocation hypotheses are based on the idea that measurement bias in performance measures enables those measures to optimally direct incentives across the range of managers' activities. The benchmark compensation system provides equal incentives to both the exploration and production activities (1:1). The extant compensation systems provide incentives to the exploration and production activities in the following ratio: $\hat{W}(RA)+\hat{W}(S)$: $\hat{W}(A)+\hat{W}(S)$. For the median FC and SE firms, those ratios are 0.97742 : 0.58424 (or 1.67 : 1) and 0.6940 : 0.5002 (or 1.38 : 1), respectively. The results suggest that compensation systems in both FC and SE firms exploit measurement bias in the accounting performance measures to increase (decrease) the level of incentives provided for the exploration (production) activity, relative to the level of incentives that could be provided in the benchmark compensation system.

Economic significance is also analyzed by assessing the proportion of predicted compensation attributable to the non-dummy explanatory variables in each model. If executive-specific and time-specific effects explain most of expected compensation, then one might question whether bias in accounting measures could offer behaviorally significant levels of incentive allocation or risk-shielding. The proportion explained by each model is computed as shown below in equation 14.

(14)

$$prop = 1 - \frac{e^{\ln \hat{C}_{ijt} - \hat{\beta}' X}}{e^{\ln \hat{C}_{ijt}}}$$

where

$\ln C_{ijt}$ = fitted value from fixed-effects model

$\hat{\beta}'$ = vector of estimated coefficients

X = vector of explanatory variables

Table 19 presents the proportion of predicted compensation explained by the performance measures. The table shows that very little of the explanatory power of the models is attributable to the performance measures. Dummy variables capturing unobservable executive, position, and time-specific factors explain much more of expected compensation than firm performance. The median proportion of expected compensation explained by the performance measures is only .012 for the FC group and .055 for the SE group. Overall, the results suggest that firm-level performance is less important than time-specific or executive-specific factors in explaining executive compensation.

Self-Selection

The null hypothesis of no self-selection implies that accounting choice and compensation decisions are not interrelated and is expressed as H_0: $\beta_{fc4}=0$, $\beta_{se4}=0$ (parameters from models 1 and 2). Lee (1978) shows that β_{fc4} and β_{se4} can be expressed as shown in equation 15.

(15)

$$\beta_{fc_4} = E(\epsilon_{fc}u) - \gamma[E(\epsilon_{fc}^2) - E(\epsilon_{fc}\epsilon_{se})]$$

$$\beta_{se_4} = E(\epsilon_{se}u) + \gamma[E(\epsilon_{se}^2) - E(\epsilon_{fc}\epsilon_{se})]$$

where γ is the coefficient on $(\ln C_{fc} - \ln C_{se})$ from model 3.

The selectivity correction factor in the FC model is statistically significant and positive in sign. The statistical significance of the coefficient suggests that managers in FC groups have self-selected into their accounting method. The positive sign, however, reveals nothing about the direction of the self-selection (compensation maximization or minimization) because the sign is determined by $E(\epsilon_{fc}\epsilon_{se})$. To understand why the sign is uninformative, notice that if managers self-select to maximize expected compensation then $\gamma > 0$, $E(\epsilon_{fc}u) < 0$, and $E(\epsilon_{se}u) > 0$.[4] The signs among these covariances and γ imply that $[E(\epsilon_{fc}u) - \gamma E(\epsilon^2_{fc})] < 0$, so $\hat{\beta}_{fc,4}$ can be less than zero if $E(\epsilon_{fc}\epsilon_{se})$ is negative, or $\hat{\beta}_{fc,4}$ can be greater than zero if $E(\epsilon_{fc}\epsilon_{se})$ is positive and large in value. Consequently, while the FC test results are indicative of self-selection, the tests do

[4] The reasoning behind $E(\epsilon_{fc}u) < 0$ if $\gamma > 0$ is this: If the probability of choosing full cost accounting is low, and yet the manager chooses full cost accounting anyway, then we would expect the manager's compensation to be higher than average given that he chooses accounting methods to maximize expected compensation. Thus any factor that affects the probability of choosing full cost accounting is positively correlated with the error term in the full cost compensation function. This implies a positive correlation between the error term in the accounting choice model -u and ϵ_{fc}, or a negative correlation between u and ϵ_{fc}. Similar reasoning leads to the conclusion that u and ϵ_{se} are positively correlated.

not indicate whether the pattern of self-selection is consistent with the thesis that FC managers choose FC over SE because it maximizes their compensation. The selectivity correction factor in the SE model is negative and statistically insignificant.

One way to understand the consequences of self-selection is to evaluate the expected value of the dependent variable for the unchosen alternative (Maddala 1983, 1991). A comparison of this expected value with the amount of compensation actually received provides an ex post measure of the compensation effect associated with the accounting choice. The proportional benefit realized by each FC and SE manager from the accounting choices actually made is given as

(16)

$$\frac{e^{lnC_{fc}} - e^{E(lnC_{se}|A=1)}}{e^{E(lnC_{se}|A=1)}} = \frac{e^{lnC_{fc}}}{e^{(\hat{\beta}_{fc0ij} + \hat{\beta}_{se_1}R + \hat{\beta}_{se_2}NI_{se} + \hat{\beta}_{se_3}RA + \hat{\beta}_{se_4}K_{fc} + \hat{\beta}_{se_t} + \hat{\beta}_{se_p})}} - 1$$

(17)

$$\frac{e^{lnC_{se}} - e^{E(lnC_{fc}|A=0)}}{e^{E(lnC_{fc}|A=0)}} = \frac{e^{lnC_{se}}}{e^{(\hat{\beta}_{se0ij} + \hat{\beta}_{fc_1}R + \hat{\beta}_{fc_2}NI_{fc} + \hat{\beta}_{fc_3}RA + \hat{\beta}_{fc_4}K_{se} + \hat{\beta}_{fc_t} + \hat{\beta}_{fc_p})}} - 1$$

where

$\hat{\beta}_{fc,i}$, $\hat{\beta}_{se,i}$ = vector of estimated regression coefficients for the main and interactive effects for each of the i performance variables taken from models 1 and 2, respectively

$\hat{\beta}_{fc,0ij}$, $\hat{\beta}_{se,0ij}$ = estimated individual effect

$\hat{\beta}_{fc,t}, \hat{\beta}_{se,t}$	=	estimated time period effect
$\hat{\beta}_{fc,p}, \hat{\beta}_{se,p}$	=	estimated position effect
R	=	vector consisting of R and all R*I interaction terms
NI_{fc}, NI_{se}	=	vector consisting of NI and all NI*I interaction terms; NI of SE firms converted to FC (NI_{fc}) and NI of FC firms converted to SE (NI_{se}) by adjusting i) depreciation, depletion, and amortization expense and ii) dry-hole costs [5]
RA	=	vector consisting of RA and all RA*I interaction terms

The results show that the mean (median) value of equation 16 is .23 (.15) while the mean (median) value of equation 17 is .13 (-.05). The results suggest that, on average, both FC and SE managers earn more under the accounting

[5] FC earnings are converted to SE earnings by expensing dry-hole costs and reducing depletion expense (DDA) by the estimated amount of DDA attributable to prior dry-hole costs (the costs of drilling unsuccessful wells) that were capitalized. This amount is estimated by multiplying reported DDA by the proportion of exploration wells drilled that failed to discover reserves during the period 1988-1992. SE earnings are converted to FC earnings by adding back dry-hole costs and increasing DDA by the estimated amount of DDA attributable to prior dry-hole cost that would have been capitalized and amortized under FC. This amount is estimated by dividing reported DDA by one minus the proportion of unsuccessful exploration wells drilled by the firm during the period 1988-1992. Interestingly, the pro forma earnings numbers show that FC firms would increase their earnings on average by approximately 5% and SE firms decrease their earnings by approximately 14% were they to change accounting methods. This is consistent with the prediction by Sunder (1976) that FC earnings are less than SE earnings during periods of depressed exploration activity.

method used by their firm than they would expect to earn if their firm instead used the alternative accounting method.

To briefly summarize, the self-selection tests indicate the presence of self-selection, and the comparison of realized compensation to expected compensation reveals that managers earn more under their firms' chosen accounting method than they would expect to earn under the alternative accounting method. Both results are consistent with the notion, formalized in P13, that managers' accounting choices are influenced by the effect they expect those choices to have on their compensation. P13 can be more formally tested by estimating the structural-form accounting choice model in equation 3 and testing the statistical null that the coefficient on the explanatory variable ($\ln C_{fc}$-$\ln C_{se}$) is less than or equal to zero against the alternative hypothesis that it is greater than zero. Results from this test are reported in the following section.

Structural-Form Accounting Choice Model

The explanatory variable ($\ln C_{fc}$-$\ln C_{se}$) is operationalized by using the estimated parameters for models 1 and 2 to predict $\ln C_{fc}$ and $\ln C_{se}$ for each manager. This variable operationalizes the approximate proportional increase or decrease in expected compensation that would accompany the FC accounting choice.

The accounting choice literature does not identify the management position responsible for accounting choices; therefore, theoretical guidance as to whose measure of ($\ln \hat{C}_{fc}$-$\ln \hat{C}_{se}$) to include in the structural-form accounting choice model is not available. As an exploratory analysis, I sum the predicted values of $\ln C_{fc}$ and $\ln C_{se}$ across executives within firms and operationalize ($\ln\hat{C}_{fc}$-$\ln\hat{C}_{se}$) as the approximate proportional change in expected compensation of the management group that would accompany the FC accounting choice.

Since the data needed to convert FC (SE) earnings to SE (FC) are not available in the Arthur Andersen & Co. data base until 1988, ($\ln\hat{C}_{fc}$-$\ln\hat{C}_{se}$) is only available for 1988-1992. Accordingly, the structural-form accounting choice model is estimated by pooling annual recurring accounting choices made across 1988-1992 by the 40 firms.

The parameter estimates of the structural probit accounting choice model appear in Table 20. All variables are strongly significant with the expected signs. SIZE and choice of full cost accounting are inversely related, a finding that is consistent with the hypothesis that large firms choose more conservative accounting methods to avoid exposure to political costs. LEV is positively associated with choice of full cost accounting which is consistent with the hypothesis that firms choose income-increasing accounting methods to avoid incurring the costs associated with debt covenant violation. Both results are consistent with the results of prior studies that investigate the choice of oil and gas accounting method (Malmquist 1990, Deakin 1979).

The principal motivation for estimating the structural-form accounting choice model is to evaluate the sign and significance of the coefficient on ($\ln\hat{C}_{fc}$-$\ln\hat{C}_{se}$) as a test of P13. As expected, the estimated coefficient is statistically significant and positive in sign, a result that rejects the null hypothesis that managers do not consider the effect of accounting choice upon their expected compensation when choosing accounting methods.

In summary, three tests provide convergent evidence that managers consider the expected compensation effects when selecting accounting methods. First, the selectivity correction factor is significant in the FC group, indicating the presence of self-selection. Second, the realized compensation for managers in both groups is, on average, greater than the level of compensation the managers could expect to receive if their firm were to change accounting method. Third, firms whose management group are estimated to expect greater compensation under FC accounting than under SE accounting are more likely to use FC accounting, and firms whose management group are estimated to expect greater compensation under SE accounting than under FC accounting are more likely to use SE accounting. Taken together, these tests provide strong evidence that managers consider the expected compensation effects when selecting accounting methods. Thus, the data reject null-form P13.

CHAPTER 6

SUMMARY AND CONCLUSIONS

Findings

Compensation systems in oil and gas firms often use stock returns, earnings, and reserve additions as performance measures. This dissertation tests whether these compensation systems exploit the bias in the earnings and reserve addition performance measures in order to allocate incentives and shield executives from output risk.

Test results present strong evidence that output risk, managers' marginal productivity, and the noise characteristics of the performance measures affect the absolute weights placed on the three performance measures in compensation systems.

Test results also present evidence, although weaker, that the association between compensation and stock returns, compensation and earnings, and compensation and reserve additions varies in a pattern that is consistent with compensation systems exploiting the bias to allocate incentives and shield executives from output risk. Test results also reinforce the findings of prior research that noisy performance measures receive less weight in compensation systems than less-noisy performance measures. Unfortunately, the tests are often inconsistent across alternative operationalizations of the explanatory variables and across the two accounting groups.

The degree of risk-shielding and incentive allocation achieved by use of the biased accounting measures is assessed relative to the degree achievable in a benchmark compensation system using only stock returns as a performance measure. Under the benchmark system, the manager receives equal incentives for both production and exploration activities and is equally exposed to exploration and production risk. The assessment of risk shielding not only shows that the use of biased accounting measures appears to reduce managers' absolute level of exposure to output risk, but also shows that managers' exposure to production risk appears to be reduced relative to exploration risk when compared to the degree of exposure in a benchmark compensation system that uses only stock returns to measure managers' performance. The assessment of incentive allocation shows that the use of biased accounting measures appears to increase the level of incentives provided for the exploration activity, relative to the level provided for the production activity.

The dissertation also examines the effect of accounting choice upon managers' realized compensation and, conversely, the impact of expected compensation upon accounting method choice. The results show that, on average, the compensation of FC and SE managers is, respectively, 23% and 13% greater than what they could expect to receive if their firms were to switch accounting methods. These findings suggest that managers do not randomly adopt accounting methods but select the accounting method that maximizes expected compensation. Two additional tests support this conclusion. First, self-selection tests indicate a pattern of self-selection in the FC group. Second, the proportional change in expected compensation that would accompany the choice of FC accounting is found to be positively associated with the choice of FC accounting. The results also show that accounting decisions and compensation decisions are jointly determined.

Implications and Contributions

The findings that measurement bias in accounting performance measures is useful for risk-shielding and incentive allocation, and that accounting and compensation policies are interdependent, have several important practical and theoretical implications. First, the results underscore the importance of considering the noise and bias characteristics of accounting performance measures when designing compensation systems. Failure to consider the noise/bias in these accounting measures may produce a compensation system that suboptimally allocates incentives or that needlessly exposes executives to controllable volatility in their earnings stream. Either consequence is potentially costly.

Second, the findings suggest that the relative effectiveness of accounting performance measures to risk-shield and allocate incentives may help explain choice among alternative accounting methods. The idea that alternative accounting methods differ in their capabilities to control contracting costs and that this influences accounting choice is known as the efficiency-in-contracting theory (Holthausen 1990; Watts and Zimmerman 1990). Empirical evidence on this theory is virtually nonexistent. The findings in this study imply that compensation contracting may be a fruitful setting in which to test the efficiency-in-contracting theory using the relative incentive-allocation and risk-shielding capabilities of accounting performance measures produced under alternative accounting methods. This is discussed below in the section on future research.

Third, the results show that measurement bias in accounting numbers may be useful, a finding that is inconsistent with the conceptual framework that underpins contemporary normative accounting theory. The finding that measurement bias can be useful and is not always undesirable challenges us to rethink this accepted view.

Fourth, the study reveals the importance of refining the measure of bonus-plan effects used in accounting choice studies. Malmquist (1990) examines the determinants of accounting choice in oil and gas firms and finds that accounting-based compensation plans have no effect on the choice between SE and FC accounting. He uses a zero-one dummy variable to indicate the presence of an accounting-based compensation plan. Ball and Foster (1982) claim that zero-one dummies are inadequate to measure bonus plan effects, and Watts and Zimmerman (1990) describe this operationalization as simplistic. By directly measuring the effect of accounting choice on compensation rather than relying upon a dichotomous proxy, this dissertation is able to discover that managers choose the accounting method that maximizes expected compensation - an association between compensation systems and accounting choice undetected by Malmquist.

Fifth, the study relaxes the frequently-made assumption that the factors explaining accounting choice are exogenous. Watts and Zimmerman (1990) argue that managers select packages of accounting, financial, and organizational policies, and they challenge researchers to empirically test whether accounting policy is simultaneously determined along with these other important corporate policies. This study responds to that challenge and presents the first empirical evidence that compensation decisions and accounting choice are interdependent. The results imply that model estimates and related statistical inferences in prior accounting choice studies, which uniformly assume compensation to be an exogenous explanatory variable, may be less reliable than previously thought.

Future Research

Nearly all extant studies of accounting choice test opportunism-based hypotheses rather than efficiency-based hypotheses. The notion that efficiency considerations motivate accounting choice is plausible and deserves rigorous testing. The research design used in this study was not intended, and thus was unable, to determine whether the association found between the expected compensation differential and accounting choice is attributable to efficiency or opportunism. The compensation differential ($\ln C_{fc}$-$\ln C_{se}$) reported in this study is large (23 percent, on average, for FC managers). If accounting choice were entirely motivated by opportunism, this compensation differential would represent a lower-bound estimate of contracting costs. [6] It seems very unlikely that contracting costs are on the order of 23% of a manager's annual pay; consequently, the association between expected compensation and accounting choice reported in this study may be due to efficiency rather than opportunism. Evaluating the explanatory power of the opportunism theory versus the efficiency-in-contracting theory remains an important objective in accounting research. The research setting and design used in this dissertation could be extended to directly probe the relative explanatory power of hypotheses motivated by both theories. Thus, one avenue for future work is to measure the relative capability of full cost and successful efforts accounting to risk-shield and to allocate incentives and to assess whether these relative capabilities help explain accounting choice.

Second, almost all of the evidence supporting the risk-shielding and incentive- allocation hypotheses came from the FC group and not the SE group. This inspires the question of why SE firms appear less likely than FC firms to exploit accounting measurement bias in compensation systems. Future research could attempt to answer this question.

Third, the estimated stock return elasticity is very small and negative in sign for both the FC and SE groups. This implies that managers are penalized

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[6] Because it is costly to restructure compensation arrangements following all opportunistic choices, there will exist some optimal level of opportunistic accounting choice that is permitted to occur. The magnitude of contracting costs determines that level. Thus, contracting costs create an upper bound on the magnitude of wealth that managers can transfer from shareholders by opportunistic accounting choices; conversely, the magnitude of the wealth transfer is a lower-bound estimate of contracting costs.

for increasing shareholder wealth, a finding difficult to satisfactorily explain by theory or by intuition. Thus, this anomaly warrants further study in future research.

Finally, and as discussed in greater detail below, the study is subject to a number of the usual limitations that plague empirical research. Future researchers might test the theory using an experimental setting. This approach would facilitate a stronger test of the theory because the theoretical constructs could be more precisely measured and manipulated at controlled levels. The task of designing an accounting-based compensation contract could be incorporated within a computer program relatively easily and could be administered within an experimental-market setting or individually.

Limitations

Several factors reduce the internal and external validity of the study. First, there were substantial structural changes in the oil and gas industry during the 1980s causing a number of mergers and other changes in reporting entities. The selection criteria effectively eliminate all firms undergoing significant restructuring so that the results may not be generalizable.

Second, many of the firms meeting the selection criteria are integrated firms. One would expect that firms concentrating exclusively on oil and gas exploration and production would be more concerned with managing exploration and production risk than integrated firms. Consequently, a second effect of the selection criteria is to bias against the hypotheses, producing a less powerful test of the theory.

Third, the nonlinear restriction tests are sensitive to the ways in which the noise, risk, and productivity variables are operationalized. Several factors could account for this, including measurement error and the inherent limitations of the test itself. Measurement error is possible if each operationalization captures a only a limited dimension of the underlying theoretical construct. However, this is somewhat unlikely because the principal and alternative operationalizations are highly correlated (ranging from .65 to .90).

The nonlinear restriction test is limited because it is biased toward rejecting the null if one or more coefficients are imprecisely estimated. The estimated variance of the nonlinear restriction function is computed from the variance of each coefficient and the covariance among all coefficients; consequently, a single coefficient with an extremely large estimated variance biases against rejecting the null hypothesis. If the coefficient estimate varies widely between the principal and alternative operationalization, the imprecisely estimated coefficient could cause the nonlinear restriction test results to change.

The nonlinear restriction test is also sensitive to small variations in coefficient estimates between tests. The nonlinear test computes the variance of the nonlinear restriction function from a linear approximation to that function. Because the expected value of a nonlinear function is not equal to the function of the expected value, the test is only valid asymptotically. Slightly different coefficient estimates between tests could produce very different linear approximations and, therefore, different estimated variances.

Finally, the study was unable to discriminate between an opportunism-based or an efficiency-based explanation for the association between $\ln C_{fc}$-$\ln C_{se}$ and accounting choice. As discussed above, this is an important issue that should be addressed by future research.

APPENDIX

TABLES

Table 1.-- Summary of sample

Description	FC firms	SE firms	Total
Executives	99	123	222
Firms	18	22	40
Executive-years	527	624	1151
Firm-years	144	176	320

FC firms	SE firms
Apache Corporatation	Amerada Hess Corporation
Coastal Corporation	Amoco Corporation
Columbia Gas System	Ashland Oil, Inc.
Consolidated Natural Gas Enserch	Atlantic Richfield Company
Corporation	Beard Oil Company
Forest Oil Corporation	Chevron Corporation
First Mississippi Corporation	Equitable Resources, Inc.
Howell Corporation	Equity Oil Company
MDU Resources Group, Inc.	Exxon Corporation
National Fuel Gas Company	Global Natural Resources, Inc.
Nicor, Inc.	Helmerich & Payne
Pacific Enterprises	Kerr-McGee
Patrick Petroleum Company	Louisiana Land and Exploration
Plains Resources, Inc.	Maynard Oil Company
Questar Corporation	Mobil Corporation
Southern Union Company	Montana Power Company
Southwestern Energy Company	Murphy Oil Corporation
Swift Energy	Noble Affiliates, Inc.
	Occidental Petroleum Corp.
	Oneok, Inc.
	Phillips Petroleum Company
	Texaco, Inc.

Table 2.-- Descriptive statistics on firms					
	Method	Mean	Median	Q1[a]	Q3[a]
Market value of common equity in millions of dollars	FC SE	1,182.84 7,747.06	455.83 1,477.88	227.16 665.40	2,031.34 14,827.00
Book value of long-term debt as a fraction of market value of common equity	FC SE	.96 .55	.63 .43	.42 .19	.85 .75
Oil and gas exploration expenditures as a fraction of market value of common equity	FC SE	.05 .05	.03 .04	.01 .02	.05 .06
Discounted present value of oil and gas reserves as a fraction of market value of common equity plus long-term debt	FC SE	.39 .49	.23 .42	.13 .28	.61 .54
Oil and gas sales as a fraction of total sales	FC SE	.28 .35	.10 .25	.05 .15	.40 .51

[a]Q1 and Q3 denote quartile 1 and quartile 3, respectively

Table 3.--Sample firms as proportion of population

	Group	Sample 1985-1992	Population 1985-1992[a]	Prop. of pop.[c]
Exploration expenditures in thousands of dollars	FC	2,597,944	11,436,453	.227
	SE	47,356,880	102,088,666	.464
	All	49,954,824	113,525,119	.440
Oil and gas production in thousands of barrel-of-oil equivalent units[b]	FC	1,040,058	4,328,226	.240
	SE	29,536,144	58,641,107	.504
	All	30,576,202	62,969,333	.485

Note: Measures summed across the period 1985-1992 to produce sample and population totals

[a]Population defined as publicly-held oil and gas firms on Arthur Andersen Reserve Disclosures Database

[b]Gas production converted to barrel-of-oil equivalent (BOE) units at the rate 6 Mcf gas=1 Bbl oil.

[c]Proportion of population represented by sample.

Table 4. Descriptive statistics on performance measures

Variable	Method	Mean	Median	Quartile 1	Quartile 3
R[a]	FC	.1115	.0838	-.0357	.2616
	SE	.2072	.1674	.0273	.3022
NI[b]	FC	.0845	.0916	.0538	.1165
	SE	.1198	.0970	.0370	.1459
RA[c]	FC	.1181	.0775	.0524	.1988
	SE	.0630	.0377	.0195	.0950

[a]Monthly stock returns compounded over 12-month period beginning in month 1 of fiscal year through month 12 of fiscal year $(Price_t - Price_{t-1} + Dividends)/Price_{t-1}$

[b]Earnings before extraordinary items scaled by beginning market value of equity

[c]Oil and gas reserve additions scaled by beginning oil and gas reserve stock

Table 5.-- Summary statistics on parameters estimated in equation 4 [a]

Parameter	Group	Mean	Median	Quartile 1	Quartile 3
$\hat{\alpha}_{1j}$	FC SE	.0299 -.0699	.0973 -.0714	-.0861 -.2807	.1499 .0998
$\hat{\alpha}_{2j}$	FC SE	.9016 .9723	.9140 1.0199	.4586 .6957	1.2676 1.2607
I_{1j} [b]	FC SE	.0097 .0100	.0089 .0101	.0064 .0073	.0118 .0119

[a] Equation 4 is $R_{jt} = \alpha_j + \alpha_{1j}R_{mt} + \alpha_{2j}R_{it} + S_{jt}$

[b] $I_{1j} = \hat{\alpha}_{1j}^2 var(R_M) + \hat{\alpha}_{2j}^2 var(R_I) + 2\hat{\alpha}_{1j}\hat{\alpha}_{2j}cov(R_I,R_M)$

Table 6.-- Summary statistics on parameters estimated in equation 5 [a]

Parameter	Group	Mean	Median	Quartile 1	Quartile 3
$\hat{\alpha}_{1j}$	FC SE	.0811 .0294	.0791 .0197	.0196 -.0405	.1868 .1566
$var_j(\eta_{jt})$	FC SE	.0122 .0086	.0070 .0042	.0030 .0023	.0151 .0107

[a] Equation 5 is $NI_{jt} = \alpha_{0j} + \alpha_{1j}S_{jt} + \eta_{jt}$

Table 7.-- Summary statistics on I_3

Variable	Group	Mean	Median	Quartile 1	Quartile 3
I_{3j} [a]	FC SE	.0268 .0047	.0068 .0016	.0036 .0008	.0162 .0050

[a] $I_{3j} = Var(Revisions_{jt}/Reserves_{jt-1})$. Revisions defined as the change in the estimate of the beginning-of-year volume of oil and gas reserves in BOE units. Reserves defined as beginning of year volume of oil and gas reserves in BOE units.

Table 8.-- Summary statistics on parameters estimated in equations 6 and 7 [a]

Parameter	Group	Mean	Median	Quartile 1	Quartile 3
$\hat{\alpha}_{xj}$	FC	.2818	.2173	.1411	.4318
	SE	.2065	.1837	.1417	.2247
$var_j(\eta_{x,jt})$	FC	.0109	.0056	.0015	.0219
	SE	.0027	.0016	.0003	.2247
$\hat{\alpha}_{pj}$	FC	10.2634	10.2209	9.7307	11.3597
	SE	7.8114	7.8001	6.6393	8.7797
$var_j(\eta_{p,jt})$	FC	.1218	.0564	.0263	.1106
	SE	.0651	.0461	.0278	.0774

[a] Equation 6 is $RA_{jt} = \alpha_{xj}EXPL_{jt} + \eta_{x,jt}$ and Equation 7 is $NETREV_{jt} = \alpha_{pjt}EU + \eta_{p,jt}$. RA is reserve additions measured in thousands of BOE units, EXPL is exploration expenditures in thousands of dollars, NETREV is oil and gas revenues less direct lifting costs, EU is production volume in thousands of BOE units, and all variables scaled by beginning of year reserves measured in thousands of BOE units.

Table 9. - Comparison of principal and alternative operationalization of explanatory variables

		Principal operationalization				Alternative operationalization			
Variable	Group	Mean	Median	Quartile 1	Quartile 3	Mean	Median	Quartile 1	Quartile 3
I_{1j}	FC	.0097	.0089	.0064	.0018	.197	.0900	.0460	.1935
	SE	.0100	.0101	.0073	.0119	.118	.1040	.0610	.1667
I_{2j}	FC	.0122	.0070	.0030	.0151	.0181	.0103	.0043	.0197
	SE	.0086	.0042	.0023	.0107	.0868	.0054	.0034	.0103
I_{3j}	FC	.0268	.0068	.0036	.0162	n/a [a]	n/a	n/a	n/a
	SE	.0047	.0016	.0008	.0050				
I_{4j}	FC	.0109	.0056	.0015	.0219	120.5041	10.8803	4.4645	56.7287
	SE	.0027	.0016	.0003	.2247	58.3477	15.7005	8.7769	26.5268
I_{5j}	FC	.1218	.0564	.0263	.1106	18.0313	9.3911	4.7786	21.9271
	SE	.0651	.0461	.0278	.0774	30.0867	18.4385	11.3782	26.1285
I_{6j}	FC	.2818	.2173	.1411	.4318	.2495	.1688	.1022	.4001
	SE	.2065	.1837	.1417	.2247	.1925	.1455	.1268	.2597
I_{7j}	FC	10.2634	10.2209	9.7307	11.3597	11.3935	11.1902	10.3823	12.9848
	SE	7.8114	7.8001	6.6393	8.7797	10.4619	10.3594	8.7678	11.1442

Note: Alternative operationalization of variables used to test the robustness of the principal test results to different ways of measuring the explanatory variables.

[a]No feasible alternative operationalization of I_3

Table 10.-- Parameters estimated in the reduced-form accounting choice model

	Principal		Robustness	
Variable	Coefficient	χ^2 stat.	Coefficient	χ^2 stat.
INTERCEPT	.7432	3.58	-1.2937	10.20***
R	7.2191	4.98**	1.9889	0.35
NI	-33.4709	11.61***	-19.0814	3.49*
RA	-257.2491	20.75***	-48.9093	9.17***
RAD	-145.4244	21.82***	-20.9302	8.14***
R*I1	118.0556	.49	-3.0615	.09
R*I2	-65.1539	.42	24.6370	15.79***
R*I3	12.6975	.24	-2.5459	.01
R*I4	-49.8067	.11	-.0044	.22
R*I5	-5.6536	1.55	.0270	.35
R*I6	-3.6734	1.02	-3.3693	.96
R*I7	-.5579	4.49**	-.0274	.01
NI*I1	475.9063	1.85	62.3939	6.68***
NI*I2	399.6687	4.01**	-10.1121	.03
NI*I3	147.6133	5.51**	71.3522	.97
NI*I4	399.5463	1.20	.0033	.04
NI*I5	24.3023	2.05	-.2361	4.53**
NI*I6	10.5660	.65	8.0160	.48
NI*I7	1.2048	3.95**	.8979	.68
RA*I1	12,730.4591	19.81***	-122.8924	6.32**
RA*I2	-820.9445	2.13	-398.0418	2.10
RA*I3	469.2095	9.74***	341.5489	4.36**
RA*I4	3,960.2072	13.75***	.1096	3.11*
RA*I5	110.6886	16.77***	-.1223	.67
RA*I6	91.3280	9.96***	29.0356	1.86
RA*I7	13.3769	16.25***	6.2579	12.82***
SIZE	-.0000	.67	-.0000	5.48**
LEV	.1788	3.15*	2.4272	27.91***

Note: Significance at the .10, .05, and .01 levels denoted by *, **, and *** , respectively.

Table 11.--Least squares estimates of coefficients in equation 1 (FC group)

Variable	Principal tests: OLS coefficient estimate	Principal tests: t-statistic OLS	Principal tests: t-statistic Froot	Robustness test: OLS coefficient estimate	Robustness test: t-statistic OLS	Robustness test: t-statistic Froot
R	-.394	-2.66***	-2.64***	-.240	-1.64	-1.44
NI	4.077	6.11***	5.83***	2.418	2.73***	2.60***
RA	1.163	1.90*	2.26**	1.273	1.81*	1.71*
RAD	-2.381	-4.87***	-4.98***	.145	.27	.25
R*I1	-4.279	-.60	-.65	-.267	-1.50	-1.53
R*I2	-1.067	-.33	-.37	.198	.13	.14
R*I3	1.724	2.78***	2.79***	2.321	3.81***	3.98***
R*I4	-.000	-.00	-.00	.000	.58	.60
R*I5	.099	.65	.65	.001	.86	1.03
R*I6	.059	.44	.44	-.018	-.15	-.17
R*I7	.028	2.46**	2.38**	.012	1.02	.97
NI*I1	1.331	.05	.04	-.057	-.09	-.09
NI*I2	4.972	.64	.50	-5.724	-1.02	-1.01
NI*I3	-4.309	-1.60	-1.43	-5.915	-2.24**	-2.26**
NI*I4	-13.844	-1.53	-1.11	.000	.69	.70
NI*I5	1.764	2.65***	2.19**	.006	1.12	1.33
NI*I6	-1.554	-2.81***	-1.88*	.267	.55	.61
NI*I7	-.301	-4.80***	-3.71***	-.149	-2.17**	-2.28**
RA*I1	216.703	4.49***	4.29***	-1.077	-1.28	-1.45
RA*I2	-32.604	-2.09**	-2.29**	-20.196	-1.93*	-1.91*
RA*I3	-8.753	-2.61***	-2.62***	1.684	.57	.56
RA*I4	-14.836	-1.79*	-2.13**	-.000	-.53	-.54
RA*I5	-1.978	-2.54**	-2.79***	.000	.17	.20
RA*I6	-3.715	-4.76***	-4.92***	-2.582	-2.74***	-2.46**
RA*I7	-.047	-.82	-.94	-.002	-.02	-.03
K	.096	2.52**	2.71***	-.021	-.91	-.82

Table 11.--Least squares estimates of coefficients in equation 1 (FC group)

	Principal tests			Robustness test		
		t-statistic			t-statistic	
Variable	OLS coefficient estimate	OLS	Froot	OLS coefficient estimate	OLS	Froot
Period86	-.030	-1.06	-.98	-.003	-.08	-.06
Period87	.107	3.92***	3.20***	.128	4.43***	3.29***
Period88	.193	7.16***	6.05***	.216	7.22***	5.35***
Period89	.371	12.92***	11.38***	.368	11.27***	9.41***
Period90	.397	14.76***	13.62***	.415	13.71***	10.44***
Period91	.497	17.35***	15.62***	.508	16.27***	12.73***
Period92	.564	19.40***	16.85***	.576	17.07***	11.54***
CEO	.157	2.63***	3.17***	.145	2.25**	2.69***
COB	.190	2.13**	2.35**	.193	2.00**	2.35**
BOTH	-.134	-1.55	-1.48	-.125	-1.31	-1.34

Note: Adjusted R^2 of the principal and robustness models was .969 and .965, respectively. The standard error of the principal and robustness models was .012 and .013, respectively.

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level

Table 12.-- Least squares estimates of coefficients in equation 2 (SE group)

Variable	Principal			Robustness		
	OLS coefficient estimate	t-statistic		OLS coefficient estimate	t-statistic	
		OLS	Froot		OLS	Froot
R	-.241	-1.077	-.755	-.170	-.803	-.659
NI	.201	.153	.129	-2.727	-2.684***	-2.857***
RA	-.242	-.175	-.166	-1.577	-1.249	-1.199
RAD	-.603	-.797	-.731	1.342	1.719*	1.314
R*I1	1.933	.194	.121	.097	.204	.144
R*I2	-6.307	-1.917*	-1.477	.214	.375	.304
R*I3	-2.563	-.286	-.191	-20.510	-2.252**	-1.565
R*I4	44.122	3.498***	2.203**	-.000	-.089	-.069
R*I5	-.565	-.576	-.365	.003	2.279**	1.977**
R*I6	-.236	-.282	-.187	1.239	2.394**	1.605
R*I7	.027	1.313	.946	-.011	-.503	-.493
NI*I1	171.031	4.005***	3.445***	2.242	.912	.798
NI*I2	27.481	2.816***	1.695*	9.124	6.854***	6.353***
NI*I3	97.937	2.733***	1.931*	155.810	2.761***	2.478***
NI*I4	-80.301	-1.410	-.880	-.025	-6.849***	-5.569***
NI*I5	-15.384	-3.360***	-2.329**	-.040	-5.536***	-5.737***
NI*I6	-9.327	-2.767***	-1.871*	-8.050	-3.046***	-2.296***
NI*I7	.118	1.233	.982	.521	4.225***	5.109***
RA*I1	109.385	1.332	1.231	-11.248	-3.153***	-3.009***
RA*I2	19.103	1.039	.993	6.782	1.999**	1.773*
RA*I3	131.989	2.351**	2.499**	149.405	2.170**	1.869*
RA*I4	-224.322	-2.795***	-2.321**	-.011	-1.405	-1.247
RA*I5	1.759	.349	.322	-.026	-3.422***	-3.411***
RA*I6	-.070	-.020	-.018	-6.454	-2.053**	-1.549
RA*I7	.033	.204	.205	.431	3.210***	3.341***
K	-.049	-1.240	-.988	.033	1.215	1.080

Table 12.-- Least squares estimates of coefficients in equation 2 (SE group)

	Principal			Robustness		
		t-statistic			t-statistic	
Variable	OLS coefficient estimate	OLS	Froot	OLS coefficient estimate	OLS	Froot
Period86	.017	.693	.519	.014	.580	.405
Period87	.069	3.178***	2.323**	.070	3.055***	2.187**
Period88	.183	8.577***	6.714***	.210	9.383***	6.675***
Period89	.285	11.871***	7.526***	.310	12.320***	7.801***
Period90	.358	15.105***	9.617***	.377	15.744***	9.559***
Period91	.427	17.872***	11.926***	.448	18.788***	12.960***
Period92	.463	18.254***	12.450***	.478	17.663***	11.478***
CEO	.313	7.758***	5.827***	.264	6.734***	5.381***
COB	.248	3.059***	4.340***	.349	4.983***	5.575***
BOTH	-.337	-3.782***	-3.981***	.397	-5.147***	-5.446***

Note: Adjusted R^2 of the principal and robustness models was .987 and .986, respectively. The standard error of the principal and robustness models was .0100 and .0103, respectively.

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level

Table 13.--Likelihood ratio test of residual independence

Group	Mean $\hat{\rho}_{ijk}$	Mean t statistic	Z statistic
FC	.38	2.38	22.13***
SE	.48	2.50	26.13***

H_0: Residuals among executives are uncorrelated within firms

$\hat{\rho}_{ijk}$ = estimated correlation of residuals between executive i and executive j within firm k

$\hat{\rho}_{ijk}*(n-2)^{1/2}/(1-\hat{\rho}_{ij})^{1/2}$ is a t variate with n-2 df

The sum of the standardized estimated t-statistics for $\hat{\rho}_{ijk}$ is normally distributed and is used to test the null hypothesis that the residuals are independent across executives within firms:

$$Z=\frac{1}{\sqrt{M}}\sum_{K}\sum_{i=1}^{N}\sum_{j=i+1}^{N}\frac{t_{ijk}}{L_{ijk}/(L_{ijk}-2)}$$

where

t_{ijk} = t-statistic for $\hat{\rho}_{ij}$ in firm k
L_{ijk} = number of pairwise residuals between executive i and j in firm k
M = total number of pairwise correlation coefficients summed across all firms
N = number of executives in firm
K = number of firms

Table 14.--Test of linear restrictions imposed on coefficients in model 1 (FC group)

Coefficient restrictions	Principal test		Robustness tests	
	F-test	Wald test	F-test	Wald test
	F stat.	χ^2 stat.	F stat.	χ^2 stat.
LR1: All coefficients=0	117.50***	975.88***	104.88***	672.81***
LR2: Coefficients on all performance measures and interaction terms = 0	6.65***	304.83***	4.67***	200.84***
LR3: $R=R*I_1=R*I_2=R*I_3=R*I_4=R*I_5=R*I_6=R*I_7=0$	3.41***	37.05***	3.20***	29.05***
LR4: $NI=NI*I_1=NI*I_2=NI*I_3=NI*I_4=NI*I_5=NI*I_6=NI*I_7=0$	9.68***	93.18***	6.04***	75.43***
LR5: $RA=RAD=RA*I_1=RA*I_2=RA*I_3=RA*I_4=RA*I_5=RA*I_6=RA*I_7=0$	4.43***	61.61***	3.39***	37.09***
LR6: $R*I_1=NI*I_1=RA*I_1=0$	3.60**	20.71***	2.07	8.01**
LR7: $R*I_2=NI*I_2=RA*I_2=0$	2.18*	10.11**	1.66	5.28
LR8: $R*I_3=NI*I_3=RA*I_3=0$	3.47**	13.90***	5.52***	16.15***
LR9: $R*I_4=NI*I_4=RA*I_4=0$	2.34*	7.32*	.61	2.13
LR10: $R*I_5=NI*I_5=RA*I_5=0$	4.25***	13.52***	1.75	6.68*
LR11: $R*I_6=NI*I_6=RA*I_6=0$	6.79***	25.59***	2.81**	7.04*
LR12: $R*I_7=NI*I_7=RA*I_7=0$	6.43***	16.91***	1.76	5.55

Note : Tests conducted by imposing zero-value restrictions on the coefficients of the above variables in equation 1. F-test computed using OLS covariance matrix and Wald test computed using Froot heteroskedastic and cross-sectionally correlated consistent covariance matrix.

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level

Table 15.--Test of linear restrictions imposed on coefficients in model 2 (SE group)

	Principal test		Robustness test	
	F-test	Wald test	F-test	Wald test
Coefficient restrictions	F Stat.	χ^2 Stat.	F Stat.	χ^2 Stat.
LR1: All coefficients=0	294.93***	2477.39***	290.60***	6500.17***
LR2: Coefficients on all performance measures and interaction terms = 0	13.28***	816.20***	12.97***	3395.15***
LR3: $R=R*I_1=R*I_2=R*I_3=R*I_4=R*I_5=R*I_6=R*I_7=0$	6.94***	119.96***	8.71***	498.99***
LR4: $NI=NI*I_1=NI*I_2=NI*I_3=NI*I_4=NI*I_5=NI*I_6=NI*I_7=0$	9.17***	90.33***	10.42***	109.26***
LR5: $RA=RAD=RA*I_1=RA*I_2=RA*I_3=RA*I_4=RA*I_5=RA*I_6=RA*I_7=0$	7.95***	123.40***	7.47***	233.55***
LR6: $R*I_1=NI*I_1=RA*I_1=0$	8.23***	21.89***	3.53**	9.18**
LR7: $R*I_2=NI*I_2=RA*I_2=0$	3.39**	6.93**	18.89***	46.60***
LR8: $R*I_3=NI*I_3=RA*I_3=0$	5.09***	16.48***	6.16***	12.88***
LR9: $R*I_4=NI*I_4=RA*I_4=0$	6.81***	14.81***	17.22***	33.70***
LR10: $R*I_5=NI*I_5=RA*I_5=0$	5.30***	8.46**	15.91***	58.14***
LR11: $R*I_6=NI*I_6=RA*I_6=0$	3.54**	6.03	7.38***	9.29**
LR12: $R*I_7=NI*I_7=RA*I_7=0$	2.28*	8.93**	11.43***	59.83***

Note : Tests conducted by imposing zero-value restrictions on the coefficients of the above variables in equation 2. F-test computed using OLS covariance matrix and Wald test computed using Froot heteroskedastic and cross-sectionally correlated consistent covariance matrix.

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level

Table 16.--W(NI),W(R), and W(RA) estimated from equations 1 and 2

		Estimated weight[a]	
	Group	Principal	Robustness
$W(NI)=\beta_2+\sum\beta_{2k}*I_k$	FC	.5947	.7446
	SE	.5599	.9043
$W(R)=\beta_1+\sum\beta_{1k}*I_k$	FC	-.0945	-.1041
	SE	-.0366	-.0759
$W(RA)=\beta_3+\sum\beta_{3k}*I_k$	FC	.7885	.5579
	SE	.9604	.7329
W(NI)/W(R)	FC	-6.2915	-7.1514
	SE	-15.3019	-11.9121
W(RA)/W(R)	FC	-8.3416	-5.3577
	SE	-26.2480	-9.6544

[a]Weights estimated using median values for each I_k from Table 9 and estimated values of β_{ik} from Tables 11 and 12

Table 17.--Test of predictions about W(NI)/W(R) [a]

Prediction	Group	Effect on W(NI)/W(R): Predicted sign of $f(\beta)$	Estimated sign: P [b]	Estimated sign: R [b]	Z Value [c]: Principal	Z Value [c]: Robustness
P10	FC	$\beta_{21}W(R)-W(NI)\beta_{11} > 0$	+	+	.53	1.82**
	SE	$\beta_{21}W(R)-W(NI)\beta_{11} > 0$	-	-	-.69	-.48
P9	FC	$\beta_{22}W(R)-W(NI)\beta_{12} < 0$	+	+	.10	.55
	SE	$\beta_{22}W(R)-W(NI)\beta_{12} < 0$	+	-	.79	-1.27
P6	FC	$\beta_{24}W(R)-W(NI)\beta_{14} > 0$	+	-	1.27	-1.05
	SE	$\beta_{24}W(R)-W(NI)\beta_{14} > 0$	-	+	-1.49	1.20
P5	FC	$\beta_{25}W(R)-W(NI)\beta_{15} < 0$	-	-	-2.02**	-1.74**
	SE	$\beta_{25}W(R)-W(NI)\beta_{15} < 0$	+	+	.56	.17
P2	FC	$\beta_{26}W(R)-W(NI)\beta_{16} < 0$	+	-	1.42	-.17
	SE	$\beta_{26}W(R)-W(NI)\beta_{16} < 0$	+	-	.43	-1.05
P1	FC	$\beta_{27}W(R)-W(NI)\beta_{17} > 0$	+	+	1.04	.66
	SE	$\beta_{27}W(R)-W(NI)\beta_{17} > 0$	-	-	-.94	-1.15

[a] Test: For each I_k, H_0: $f(\beta)=0$ tested against the alternative hypothesis that the $f(\beta)$ is either >0 or <0, depending upon the predicted sign

[b] P denotes principal test; R denotes robustness test

[c] Test statistic is $z = f(\beta)/\mathrm{Var}[f(\beta)]$ where $f(\beta) = \beta_{2k}W(R)-W(NI)\beta_{1k}$ and $\mathrm{Var}[f(\beta)]=[\partial f(\beta)/\partial\beta]'\mathrm{Var}[\hat{\beta}-\beta][\partial f(\beta)/\partial\beta]$. The covariance matrix used is Froot's. W(R) and W(NI) are evaluated using the median values of I_1-I_7.

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level

Table 18. Test of predictions about W(RA/W(R) [a]

Prediction	Group	Effect on W(RA)/W(R): Predicted sign of $f(\beta)$	Estimated Sign: P [b]	Estimated Sign: R [b]	Z Value [c]: Principal	Z Value [c]: Robustness
P12	FC	$\beta_{21}W(R)-W(RA)\beta_{31} > 0$	-	+	-1.51	2.36***
	SE	$\beta_{21}W(R)-W(RA)\beta_{31} > 0$	-	+	-.40	.83
P11	FC	$\beta_{22}W(R)-W(RA)\beta_{32} < 0$	-	-	1.12	-2.46***
	SE	$\beta_{22}W(R)-W(RA)\beta_{32} < 0$	-	+	-.12	.29
P7	FC	$\beta_{24}W(R)-W(RA)\beta_{34} < 0$	+	-	.61	-.05
	SE	$\beta_{24}W(R)-W(RA)\beta_{34} < 0$	-	+	-1.79**	.55
P8	FC	$\beta_{25}W(R)-W(RA)\beta_{35} > 0$	+	-	.69	-1.00
	SE	$\beta_{25}W(R)-W(RA)\beta_{35} > 0$	+	-	.32	-.15
P3	FC	$\beta_{26}W(R)-W(RA)\beta_{36} > 0$	+	+	2.15**	1.97**
	SE	$\beta_{26}W(R)-W(RA)\beta_{36} > 0$	+	-	.19	-.67
P4	FC	$\beta_{27}W(R)-W(RA)\beta_{37} < 0$	-	-	-1.68**	-.68
	SE	$\beta_{27}W(R)-W(RA)\beta_{37} < 0$	-	-	-.97	-1.03

[a]Test: for each I_k, H_0: $f(\beta)=0$ tested against the alternative hypothesis that the $f(\beta)$ is either >0 or <0, depending upon the predicted sign.

[b]P denotes principal test; R denotes robustness test.

[c]Test statistic is $z = f(\beta)/\mathrm{Var}[f(\beta)]$ where $f(\beta)=\beta_{2k}W(R)-W(RA)\beta_{1k}$ and $\mathrm{Var}[f(\beta)] = [\partial f(\beta)/\partial\beta]'\mathrm{Var}[\hat{\beta}-\beta][\partial f(\beta)/\partial\beta]$. The covariance matrix used is Froot's. W(R) and W(RA) evaluated using the median values of I_1-I_7.

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level

Table 19.--Proportion of expected compensation explained by performance measures in equations 1 and 2

	Group	Mean	Median	Quartile 1	Quartile 3
Prop [a]	FC SE	.012 .055	.036 .059	-.077 .008	.103 .113

[a] Prop = $1-(e^{\ln\hat{C}\beta x}/e^{\ln C})$ where $\ln\hat{C}_{ijt}$ is the fitted value from the model, β is a vector of estimated coefficients, and X is a vector of explanatory variables.

Table 20.--Estimate of parameters in structural-form accounting choice model (equation 3) [a]

Variable	Expected sign	Coefficient	χ^2 test statistic
Intercept	?	.1805	1.78
SIZE	-	-.0001	12.91***
LEV	+	.1900	4.31**
$(\ln\hat{C}_{fc}-\ln\hat{C}_{se})$	+	4.5839	9.51***

[a] Test statistic for likelihood ratio test that all coefficients are equal to zero is χ^2=52.219***

* Significant at the .10 level
** Significant at the .05 level
*** Significant at the .01 level

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