CEO Incentive Contracts, Monitoring Costs, and Corporate Performance

The after-tax real wage of the average worker in the United States has fallen 13 percent in the last 20 years, while the average chief executive officer (CEO) has received a pay raise of over 300 percent.[1] This glaring contrast has sparked a flood of papers analyzing CEO compensation contracts. One of the main justifications for the extraordinary pay of top CEOs is that they receive performance-based contracts. In theory, having CEO pay depend on the performance of the firm is the optimal solution to the moral hazard problem that exists because shareholders do not observe the actions of the CEO. Because the shareholders have less information than the CEO about the actions of the CEO and how they affect the health of the firm, the CEO takes actions in his or her own best interests, which do not necessarily coincide with the best interests of shareholders. Designing compensation contracts that link CEO compensation to the performance of the firm is one way to get around this difficulty. The empirical literature, however, has found little evidence that CEO contracts provide such incentives. The compensation of CEOs appears to respond very little to the performance of their firms.

This article addresses three reasons why the previous literature may have been underestimating the response of compensation to firm performance. First, only firms where monitoring the CEO is costly should have CEO compensation that is performance-sensitive. Restricting the sample to these firms yields a 67 percent increase in the performance sensitivity of compensation contracts. Second, the parameter that measures the performance sensitivity of CEO pay is negatively correlated to performance, causing it to be underestimated in standard regressions. Finally, econometricians do not observe exactly what compensation boards use as performance measures. This mismeasurement causes estimates of the effect of corporate performance on compensation to be too low. Correcting this error shows that the elasticity of CEO pay with respect to firm performance is 10 times higher than previously believed.

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I. Theory and the Empirical Literature

The information asymmetry that exists between the shareholders and the chief executive officer of a firm is generally considered to be a classic example of a principal–agent problem. In the basic principal–agent model, the agent (the CEO) is working on behalf of the principal (the shareholders), who does not observe the actions of the agent. The compensation contract is chosen to elicit the actions by the agent that maximize the principal's utility, subject to two constraints: individual rationality (the CEO would rather take the job than not) and incentive compatibility (the action that maximizes the agent's utility also maximizes the principal's utility). Because of information constraints, the first-best solution cannot be obtained. The second-best solution is analyzed here.

The solution has two parts. First, the principal specifies a contract relating levels of compensation to various outcomes. Then, the agent chooses an action. The shareholders choose a contract, such that the action that is optimal to the CEO will also minimize the net cost of compensation. Payroll costs rise with the degree to which corporate performance affects CEO pay in the contract, because a risk-averse CEO will only accept an increase in risk if expected compensation increases. Expected performance should also increase. The solution occurs when incremental corporate performance balances the cost of higher average compensation.

In theory, having CEO pay depend on the performance of the firm is the optimal solution to the moral hazard problem that exists because shareholders do not observe the actions of the CEO.

Early empirical attempts to estimate the relationship between firm performance and CEO compensation were based on cross-sectional analyses that suffered from a serious omitted variables bias because of an inability to control for individual firm effects. In the past decade, however, a number of studies have documented a significant positive effect of corporate performance on CEO compensation, using panel data. Coughlan and Schmidt (1985), Kostiuk (1986), Murphy (1985, 1986), and Deckop (1988) find a significant response to sales, profits, stock prices, or rate of return. Antle and Smith (1986) and Gibbons and Murphy (1990) find a significant response of the real rate of return even when controlling for industry measures of success, and Gilson and Vetsuypens (1993) document sensitivity when looking specifically at firms in financial distress.

The most comprehensive study is that of Jensen and Murphy (1990). They look at a wide variety of compensation measures and control for the probability of dismissal and still show that CEO wealth increases only \$3.25 for every \$1,000 increase in shareholder wealth. When looking only at salary and bonuses, a \$1,000 increase in shareholder wealth yields only an extra 2 cents for the CEO. They compare the pay variability of CEOs with that of randomly chosen non-CEO workers and conclude that CEO compensation is not significantly more variable. While CEO compensation is statistically sensitive to measures of firm performance, the implied correlation is surprisingly small.

Jensen and Murphy suggest political forces are driving the small estimates they find. They argue that since managerial contracts are public information, they are subject to the scrutiny of employees, labor unions, consumer groups, the Congress, and the media. The press is filled with stories about executive compensation each spring (during proxy season), and lawsuits are filed against board members. Jensen and Murphy conclude that "it is natural that well-intentioned but risk-averse board members will resist innovative incentive contracts" (1990, p. 254). To support their hypothesis, they use two pieces of evidence. First, pay-performance sensitivity was higher in the 1930s when regulatory pressure was less in evidence. Second, large visible firms have a lower pay-performance sensitivity. These facts are suggestive but hardly conclusive, and they do not explain why boards would be so easily swayed to act unprofitably.

Another possible explanation for the small performance-sensitivity estimates that previous authors have found is that the asymmetry of information between the shareholder and the CEO is not as large as assumed. Lazear (1986) shows that contingent, performance-based managerial compensation contracts are optimal only when the cost of direct moni-

[1] Crystal (1991, p. 27). Using the sample and measure of compensation used in this paper, real CEO compensation has gone up 91 percent.

toring of the agent's actions is prohibitive. When a comparatively inexpensive monitoring system is available, both CEOs and shareholders benefit from more traditional compensation systems. The ease with which stockholders monitor is related to ownership structure. When stockholders are relatively dispersed, an individual holder has neither the incentive nor the power to influence the CEO's actions. The social benefit to monitoring the CEO is much higher than the private benefit. On the other hand, when a few dominant shareholders control the company, the return to monitoring is greatly increased. If this is the case, CEO contracts should be less sensitive to performance when the ownership of the corporation is very concentrated. Monitoring and incentive contracts are substitute methods for influencing the actions of the agent.

A number of studies have documented a significant positive effect of corporate performance on CEO compensation.

Douglas and Santerre (1990), Arnould (1985), and Dyl (1988) have found an inverse relationship between the effect of shareholder concentration and CEO compensation. Because the overall cost of a compensation contract must increase with increased performance sensitivity and, thus, risk to the CEO, these results are consistent with the hypothesis that increased monitoring in highly concentrated firms leads to less sensitivity in the compensation contract.[2]

None of the above studies looks directly at the degree of performance sensitivity in CEO compensation contracts across groups with different monitoring costs. However, Kaplan (1992) investigates the sensitivity of Japanese CEO contracts relative to U.S. contracts. The Japanese corporate governance structure is generally believed to include much more direct monitoring by banks and other major shareholders. Japanese firms should therefore be less subject to the information asymmetry of the principal–agent problem, and CEO contracts should thus be less sensitive to measures of performance. Kaplan finds no significant difference between the degree of sensitivity in U.S. and Japanese compensation systems. He concludes, however, not that monitoring is an unimportant aspect of the principal–agent setup, but that the Japanese and U.S. corporate governance systems are not so different after all. Kaplan exploits neither the exogenous splitting of Japanese firms into high versus low monitoring-cost groups due to the *keiretsu* system nor the recent liberalization in Japan's corporate governance system, which may provide a natural experiment.

This article explores another way to distinguish groups with differing monitoring costs, by comparing the performance sensitivity of firms with concentrated ownership structures to that of firms with more dispersed ownership structures. The results show that they differ significantly. This evidence raises concerns that previous studies found little sensitivity because their samples included firms where a basic assumption of agency theory may have been violated.

The evidence that different groups use incentive-based compensation systems to varying degrees brings up another problematic issue. Some firms are more likely to use performance-sensitive compensation systems than others. The parameter that measures the effect of performance on compensation may also vary across time as a result of trends in compensation or the regulatory environment. As long as contract differences are unrelated to firm performance, ordinary least squares results can be used to find the average sensitivity of firms. If the heterogeneity is systematic, however, modeling the incentive parameter is necessary. This issue is taken up in Section IV.

Another potential problem with the previous empirical literature is that the performance regressor may not fit the requirements of ordinary least squares (OLS) regression. The performance measures used in this paper and others are not necessarily the same as those used by compensation committees. Econometricians can guess at the definitions used, but they will always be measuring performance with error. The solution to this problem is an instrumental variables approach.

[2] Other studies look at growth rates of firms to infer information about the ease of monitoring. They suggest that managers in high-growth firms are more likely to have inside information because high-growth firms are characterized by new products, which may have long development cycles. Bizjak, Brickley, and Coles (1993) use this assumption to look at incentive compensation and investment behavior. Kole (1991), Clinch (1991), and Gaver and Gaver (1993) look at whether firms have incentive plans, and their results are consistent with the theory that high-growth firms are more likely to have incentive contracts because they are more difficult to monitor. High-growth firms are not a very clean indicator of monitoring costs, however, because these firms may differ in many ways from other firms. For instance, firms with innovative approaches may be characterized by both high growth and incentive-based contracts without the two necessarily being linked.

This paper uses information from the input-output table of the U.S. manufacturing sector to create demand-shift instruments for 52 CEOs in the sample. The consistent estimates yield interesting results. Exogenous demand shocks cause movements in current performance measures that identify performance-sensitivity estimates 10 times as large as the OLS estimates.

The next section explains the data to be used. Section III investigates the role of monitoring costs. Section IV examines the heterogeneity in the sensitivity parameter. Measurement error of the performance variable is handled in Section V. Some brief conclusions are drawn in the final section.

II. The Data

The basic data set is an unbalanced panel that combines compensation and performance measures from two sources. The compensation data were gathered from the annual *Forbes* magazine CEO salary lists. The data comprise roughly 400 CEOs each year for the period 1972 to 1989. The variables include salaries and bonuses, deferred compensation earned for a given fiscal year but paid out later, and director's fees. SIC codes and the name of the CEO were also obtained from this source. For the 1980–89 period, information is also available on stock awards, fringe benefits, accruals to pensions, and the value of cash or stock of exercised options. However, the second group of variables does not capture the ex ante value of stock options and therefore is not accurately measuring compensation. Only the first group of variables is used in this study. In the first part of the study, whether the CEO is a major shareholder is considered part of the monitoring costs classification, so that CEO holdings are not ignored. In the second part, not enough observations are present to restrict the analysis to only the 1980–89 period. For this reason, even if the second group of variables were accurate, it would be unusable.

This study compares the performance sensitivity of firms with concentrated ownership structures to that of firms with more dispersed ownership structures and finds that they differ significantly.

The data on firm performance are taken from Compustat for fiscal years 1971 to 1989, based on the 1991 industrial and historical research files. The Compustat data were matched with the *Forbes* data by company name and any uncertainties were double-checked in Moody's Industrial and Financial News Reports. For companies with name changes, a complete history was documented to see if *Forbes* information was consistent with data from Compustat. The performance variables in this paper are total shareholder return, sales, and the stock price. Total shareholder return is a market measure, the annual return per share of common stock. The numerator is dividends and capital gains and the denominator is the previous year's closing price. Sales are taken directly from Compustat and the stock price is the closing price. These values have all been adjusted to reflect stock splits and stock dividends during the year.

The data on shareholder concentration and CEO share holdings were taken from the Corporate Data Exchange (CDE). The CDE publishes stock ownership directories that include shareholder concentration at the 5, 10, 15, and 20 shareholder levels. In addition, the CDE Stock Ownership Directory also includes the names of all the major shareholders of the companies it profiles. These were matched with the names of the CEOs from the *Forbes* data. The CDE publishes directories on the *Fortune 500* companies as well as the transportation, banking and finance, energy, and agribusiness industries.

III. Ownership Concentration

If monitoring costs are low, both the principal and the agent prefer a contract that is not contingent on performance. This section explores whether the contingency of the contract varies across groups with different monitoring costs. When shareholders are relatively dispersed, monitoring of the CEO is more costly to individual shareholders. Firms with low shareholder concentration are defined as those where the share of the stock held by the top five shareholders is below the five-shareholder concentration level for the median firm. A family complex—defined as all known family members and family-controlled trusts, foundations, and corporations—is classified as a single holder. While this classification can identify firms

Table 1
Summary Statistics by Monitoring Class

	Mean	Standard Deviation	Number of Observations
Total Sample			
Salary and Bonus ($)	517,500	406,208	11,430
Shareholder Return (%)	9.98	35.8	10,933
Assets ($)	1,189,888	2,199,729	9,195
CEO Tenure (years)	8.1	7.2	12,471
Low Shareholder Concentrations			
Salary and Bonus ($)	605,897	304,028	3,001
Shareholder Return (%)	9.31	31.9	3,040
Assets ($)	1,945,671	2,597,699	2,296
CEO Tenure (years)	6.8	5.6	3,298
CEO Not a Shareholder			
Salary and Bonus ($)	617,654	324,266	1,525
Shareholder Return (%)	9.33	30.6	1,531
Assets ($)	2,063,116	2,655,897	1,156
CEO Tenure (years)	6.7	4.6	1,588

with dispersed shareholders, CEOs may still be major shareholders in these firms. For example, in 1980 the top five shareholders of Teledyne held only 16.2 percent of the stock, making it a relatively unconcentrated ownership structure. Forty percent of that, however, was held by the CEO. Teledyne suffered less, therefore, from an informational asymmetry between its top five shareholders and its CEO. To take care of these cases, only firms that have both low shareholder concentration *and* a CEO who is not a major stockholder are classified as high-monitoring-cost firms.

Some summary statistics about the various sample groups are given in Table 1. Firms with high monitoring costs appear to be somewhat larger than other firms and pay their CEOs more. This is not particularly surprising, since firms where it is easy for the owners to monitor the management tend to be small, family-held firms. High-monitoring-cost firms also have slightly lower performance as measured by total shareholder return. The relative number of observations between the high-monitoring-cost firms and the total sample do not indicate the share of all firms that have high monitoring costs, because information on both shareholder concentration and CEO shares were available for only one-third of the entire sample.[3]

The specification of the compensation equation used in this section is similar to that used by others.[4]

$$\Delta C_{it} = \beta TSR_{it} + \eta_{it} \qquad (1)$$

ΔC is the first difference of compensation and TSR is real total shareholder return. Compensation is first-differenced because its level is non-stationary, but the same is not true of shareholder return. By its very nature, shareholder return is not in levels. Equation (1) is similar to a regression of compensation on shareholder wealth that has been differenced. First-differencing is one way to deal with the omitted variables that differ across CEO and firm but do not vary across time.[5] Since this equation is not technically completely first-differenced, it was also run including a dummy variable for each CEO, and the hypothesis that the intercept is the same for all cross-sectional units was not rejected.[6] Year dummies were included in all the regressions to control for business cycle effects and stock price movements that are common to all firms.[7]

The results from equation (1) are given in Table 2. The first column shows that compensation is significantly positively related to total shareholder return. When the total shareholder return is 10 percent, a CEO receives on average $8,300 more per year. The significant intercept in this regression indicates that a firm with a zero return would increase the pay of its CEO by $24,700, while a firm with a 10 percent return would increase the pay of its CEO by $33,000. For the CEO with the mean compensation, this amounts to a 4.7 percent real increase in pay as opposed to a 6.4 percent increase: a difference of 1.7 percentage points. These magnitudes are similar to those found by previous authors.

The first column of Table 2, however, includes firms where monitoring costs may be very low and performance-sensitive contracts may be unnecessary.

[3] Since shareholder concentration is defined as being below the median, 50 percent of the firms with shareholder concentration data are low-concentration firms. Of the firms that have available shareholder data in the CDE, 48 percent of their CEOs were not shareholders.

[4] Murphy (1986) and Abowd (1990) are two examples.

[5] Another reason to control for fixed effects is because in levels the relationship may merely be capturing the fact that some firms attract higher-quality CEOs than others and they are paid what they are worth. Since this ability to attract high-quality CEOs presumably does not change over time, it is a fixed effect for each firm and first-differencing takes care of it.

[6] Regressing the level of compensation on total shareholder return as well as CEO and year dummies did not qualitatively alter the basic results, either.

[7] The fact that they are significant indicates that CEOs are being compensated to some extent for movements outside their control. This is not terribly surprising, since CEO compensation—like that of other workers—should depend on the tightness of the labor market to some extent.

Table 2
CEO Compensation and Monitoring Costs

	Δ (Salary and Bonus)			
Shareholder Return	.83 (12.7)	.84 (7.56)	.70 (4.80)	.76 (5.65)
Low Shareholder Concentration		.35 (2.27)		
CEO Not a Shareholder			.55 (2.41)	
High Monitoring Costs				.63 (2.30)
Year Dummies	Yes	Yes	Yes	Yes
Constant	24.7 (2.86)	12.4 (.941)	−18.6 (−.671)	−18.6 (−.670)
Number of Observations	9,879	5,605	3,312	3,312

Note: t-statistics in parentheses.

Columns 2, 3, and 4 include interactive terms to test for differences in the performance sensitivity across groups.[8] In column 2, total shareholder return is interacted with a dummy for low shareholder concentration.[9] The significance of the variable shows that firms with low concentration have a sensitivity parameter that is 0.35 higher than the total sample. This indicates that lumping these firms in with the rest of the sample masks the fact that high monitoring costs yield more performance-sensitive compensation. In column 3, the interactive term is between total shareholder return and a dummy that equals one when the CEO is not a major stockholder of the firm. These firms have a performance sensitivity that is 0.55 higher than the rest of the sample.[10]

The strictest definition of high monitoring costs is in column 4. Shareholder return is interacted with a dummy for firms that have both low shareholder concentration and a CEO who is not a major shareholder. In this case, the high-monitoring-costs group has a sensitivity parameter that is 0.63 higher than the others, for a total sensitivity of 1.39. That high monitoring costs are associated with more performance-sensitive compensation is consistent with the theory that contingent contracts and monitoring are substitutes. According to this regression, there is no increase in real CEO pay for a total shareholder return that is equal to zero. A 10 percent shareholder return, however, yields an extra $13,900 for the CEO. For the average CEO, this is an increase of 2.1 percent.

While restricting the sample to those firms that fit the assumptions of the standard principal–agent problem increases the sensitivity parameter by 67 percent, the resulting increase in CEO compensation due to changes in performance does not change the basic results of previous studies that conclude that performance sensitivity is not as high as would be expected. This section has proved, however, that the sensitivity parameter can differ in systematic ways across groups, a difficulty taken up in more detail in the next section.

IV. Heterogeneity

Section III discussed how the degree of contingency in compensation contracts can vary across groups. It may also vary across time. This heterogeneity is a problem only if the incentive parameter (pay-performance sensitivity) is correlated to the regressor (performance). Given that the groups in the previous section that had higher pay-performance sensitivity also had lower performance, this may be the case. Certain firms may be more likely to adopt incentive-based plans, and firms may be more likely to change their compensation schemes when performance changes. The heterogeneity in the incentive parameter can be modeled as:

$$C_{it} = \beta_{it} P_{it} + \xi_{it} \qquad (2)$$

where C is the compensation measure, P is the firm performance measure, β is the incentive parameter, and ξ is the error term. Since most studies are concerned with the average degree of performance sensitivity, they test:

$$C_{it} = \beta P_{it} + \eta_{it} \qquad (3)$$

Assuming equation (2) is the true equation, η is a function of the regressor,

$$\eta_{it} = (\beta_{it} - \beta) P_{it} + \xi_{it} \qquad (4)$$

[8] These columns have fewer observations because information on concentration and major share holdings was unavailable for some firms.

[9] The comparable results obtained when the definition of low concentration is modified to be all firms whose 15-shareholder concentration is below the median are shown in columns 1 and 2 of Table 4, below. The result from low concentration in this case becomes less significant but still has the same sign and magnitude.

[10] When the CEO is a major shareholder, salary and bonus is less sensitive, but total compensation may not be. Whether a CEO's shares are considered compensation or a reduction in monitoring costs is merely a difference in definitions.

Table 3
CEO Compensation, Monitoring Costs, and Heterogeneity

	Δ (Salary and Bonus)			
Shareholder Return	1.06 (13.3)	1.07 (8.11)	.89 (4.94)	.95 (5.69)
(Shareholder Return)^2	−.002 (−4.98)	−.002 (−3.23)	−.001 (−1.78)	−.001 (−1.96)
Low Concentration		.30 (1.89)		
CEO Not a Shareholder			.45 (1.93)	
High Monitoring Costs				.55 (1.98)
Year Dummies	Yes	Yes	Yes	Yes
Constant	22.6 (2.60)	10.3 (.783)	−20.7 (−.745)	−20.9 (−.753)
Number of Observations	9879	5605	3312	3312

Note: t-statistics in parentheses.

Table 4
15-Shareholder Concentration Ratio

	Δ (Salary and Bonus)			
Shareholder Return	.87 (7.48)	.77 (5.74)	1.11 (8.16)	.97 (5.82)
(Shareholder Return)^2			−.002 (−3.36)	−.001 (−2.4)
Low Concentration	.23 (1.49)		.19 (1.23)	
High Monitoring Costs		.55 (1.97)		.47 (1.64)
Year Dummies	Yes	Yes	Yes	Yes
Constant	13.3 (1.01)	−18.2 (−.655)	11.0 (.832)	−20.6 (−.742)
Number of Observations	5,605	3,312	5,605	3,312

Note: t-statistics in parentheses.

As long as P_{it} and β_{it} are uncorrelated, ordinary least squares will continue to yield consistent estimates. However, if β_{it} and P_{it} are correlated, OLS estimates and even instrumental variable estimates are inconsistent. One way to deal with the problem is to model β_{it} as a linear function of P_{it}.

$$\beta_{it} = \beta_0 + \beta_1 P_{it} \qquad (5)$$

Plugging this into equation (2) yields:

$$C_{it} = \beta_0 P_{it} + \beta_1 P_{it}^2 + \xi_{it} \qquad (6)$$

Adding the squared performance term allows β to vary with the performance of a firm.

The results from adding squared performance terms to the regressions are shown in Table 3. The coefficient on total shareholder return is again positive and significant, but now it is even higher. The squared performance term is significantly negative, though small. These results indicate that the performance-sensitivity parameter was biased downward before because it decreases with performance. The interactive terms continue to be positive and significant; however, both the estimates and the t-statistics on these terms are somewhat smaller than they were in Table 2.[11] This suggests that some of the effect attributed to high monitoring costs may have been due to the link between high monitoring costs and low performance, given that performance varies inversely with pay-performance sensitivity.

Column 4 of Table 3 implies that while a firm with a zero return will increase its CEO's pay by nothing, a firm with a 10 percent return will increase CEO pay by $14,900 (= $9,500 + $5,500 − $100). For the average CEO, this is only a 2.9 percent increase. So while there is evidence that allowing for the heterogeneity in the sensitivity parameter increases the overall response of compensation to performance, it is not enough to greatly alter the results.

V. Measurement Error

The first two issues addressed in this article, monitoring costs and heterogeneity, have yielded significant differences that were not very large. This section takes up the issue of measurement error, with more interesting results.

The assumption that the econometrician can accurately measure the performance variable being used by the compensation board is crucial for the consistency of the estimates. Consider the basic equation that is usually specified:

[11] The comparable results obtained when the definition of low concentration is modified to be all firms whose 15-shareholder concentration is below the median are shown in columns 3 and 4 of Table 4.

$$C = P^*\beta + \eta \quad (7)$$

where P^* is the measure used by the compensation board. The performance measure used by the econometrician, P, is the true measure plus some error:

$$P = P^* + \epsilon \quad (8)$$

Equation (7) becomes:

$$C = (P - \epsilon)\beta + \eta = P\beta + (\eta - \epsilon\beta) \quad (9)$$

Running a regression on the performance measure with error causes the regressor to be correlated to the error term. Standard ordinary least squares estimates of β are underestimating the true value.

The solution to the measurement error problem is to find an instrumental variable that is correlated to the true performance measure that compensation committees use, but is not correlated to the error term in equation (8).

Instruments

The instruments used in this analysis are obtained using the methodology of Shea (1993). Shea uses information from the input-output tables to choose variables that should be correlated with demand shocks to a particular industry. Output of sector j is a good demand-shifter for sector i if sector j demands a large share of sector i's output, but sector i and other sectors closely related to it comprise a small share of the production costs to sector j. The first condition is to ensure that output of sector j is relevant for identifying demand shocks. The second condition is to minimize the possible sensitivity of the output of sector j to price variations in sector i.

Shea (1991) shows that the asymptotic bias in the instrumental variable estimates of the supply elasticity obtained using the input-output approach to select instruments is decreasing, in the ratio of the demand share of sector j, DS, to the cost share of sector i, CS. For a given ratio, increases in DS increase the correlation between the final and intermediate outputs. Using Monte Carlo simulations, Shea shows that, over a certain range, the increased correlation improves the small-sample properties of his estimates. Variables with high DS/CS ratios are therefore good exogenous demand shocks.

To minimize the influence of common supply shocks between sector i and sector j, industries within the same 2-digit SIC code are not eligible to be used as instruments. The same restriction is also true for industries that are subject to the same supply shocks: apparel and textiles, primary and fabricated metals, and machinery and electrical machinery. The entire list of industries that have good demand shifters according to the above criteria is given in Shea (1992). Many industries have more than one candidate instrument. In those cases, the instrument that maximized DS/CS was chosen.

The correlation between industry j and industry i may still be caused by responses to the business cycle. If the instrument candidate moves closely with the business cycle, it may not represent exogenous shocks to sector i, because sector i's cost variables may respond to the business cycle as well. To minimize the possibility that the correlation between sector j and sector i is driven by the business cycle, instruments were further screened and only those variables that maintained a positive correlation to the regressor, controlling for aggregate manufacturing price and production movements, were included as instruments.

Shea develops instruments for 2-, 3-, and 4-digit industries, while the variables in this paper are firm-level. Under the assumption that firms have input-output structures that are similar to the industries to which they belong, Shea's instruments work here as well. For firms with 4-digit SIC codes that did not have instruments, the 2- and 3-digit SIC instruments were not used because, at the level of aggregation closest to firm level, the DS/CS level was not high enough and either exogeneity or instrument relevance would have been sacrificed.

Results

The specification in this section differs from that of Section III in a number of ways. While total shareholder return is a good way to measure performance of the firm, it is not easily instrumented for. The demand-shifting instruments described in the previous subsection are best for performance measures that stress current performance of the firm. So for this section, performance is split into two variables: sales, to measure the current performance of the firm; and the stock price, to measure expectations of the firm's future performance. The equation to be estimated is:

$$\Delta \log C_{it} = \beta_1 \Delta \log SA_{it} + \beta_2 \Delta \log ST_{it} + \eta_{it} \quad (10)$$

SA represents sales and ST represents the stock price. Unlike total shareholder return, sales and the stock price do not take on negative values and are not stationary. This equation, therefore, is first-differenced

Firms and Their Instruments

Name of CEO's Company	Instrument
Armstrong Cork	New construction
Carborundum	New construction
Certainteed	New construction
Georgia-Pacific	New construction
Great Northern Nekoosa	Animal fats and other food products
Hoerner Waldorf	Animal fats and other food products
Inland Container	Animal fats and other food products
International Paper	Animal fats and other food products
Johns-Mansville	New construction
Lafarge	New construction
Longview Fibre	Animal fats and other food products
Louisiana-Pacific	New construction
Masonite	New construction
Mead	Animal fats and other food products
Norton	New construction
Olinkraft	Animal fats and other food products
Owens-Corning	New construction
Parker Hannifin	Federal defense spending
Square D	New construction
Sundstrand	Federal defense spending
Textron	Federal defense spending
United States Gypsum	New construction
Weyerhaeuser	Animal fats and other food products

and can be represented in logs. The constant is insignificant throughout this section.

The sample to be used in the two-stage least squares regressions is much smaller than that used thus far. Many industries for which CEO data are available simply did not have good exogenous demand shifters. The list of 23 firms included in the smaller sample is shown in the box, along with the instruments used. Summary statistics comparing the two samples are given in Table 5. Sales and the stock price are slightly higher in the large sample but not significantly so. The compensation variable is very similar across the two samples; however, the standard deviations of both sales and the stock price differ strongly across the groups. In the case of the stock price, this is because only manufacturing industries are included in the small sample. The manufacturing sector as a whole has a stock price standard deviation of 25.3. The difference in the variability of sales is apparently driven by a long upper tail. Excluding only the top 1 percent (which does not include any firms with instruments) brings the standard deviation down to $3,680,087. Excluding the top 5 percent brings it down to the standard deviation of the small sample.

Table 5
Summary Statistics

	Mean	Standard Deviation	Number of Observations
Large Sample			
Stock Price ($)	31.4	123.9	12,502
Sales ($)	3,133,936	6,736,477	9,918
Salary and Bonus ($)	517,499	406,207	11,430
Small Sample			
Stock Price ($)	28.2	16.9	309
Sales ($)	2,410,491	1,769,393	309
Salary and Bonus ($)	545,631	339,151	283

While contemporaneous demand shocks are good exogenous instruments for sales, the stock price will be best instrumented for by expected future demand shocks. Information on expectations is difficult to come by, but assuming that the market sometimes correctly anticipates demand shocks, leads of the instruments used for sales can be used to instrument for the stock price. The first-stage regression results are given in Table 6. Demand shocks should be correlated to sales, but the magnitude of the correlation will be determined by the slope of the supply curve. Future demand shocks should be correlated to the current stock price, but the accuracy of expectations and the supply curve will determine the extent. The $\overline{R}^2$ given in the last row indicates that sales is better instrumented for than the stock price. Includ-

Table 6
First-Stage Regression Results

	Δ log (Sales)	Δ log (Stock Price)	Δ log (Salary + Bonus)
Δ log (Demand Shock)	.48 (3.05)	−.35 (−.79)	.95 (.95)
Δ log (Demand Shock) (+1)	.10 (.62)	.65 (1.48)	.67 (1.20)
Year Dummies	Yes	Yes	Yes
Number of Observations	252	252	228
$\overline{R}^2$	.46	.33	.10

Note: t-statistics in parentheses.

Table 7
CEO Compensation, Performance, and Measurement Error

	Δ log (Salary and Bonus)								
	Large Sample			Small Sample					
	OLS	OLS	OLS	OLS	OLS	OLS	Instrumental Variables (IV)		
Δlog (Sales)	.26 (15.6)	.23 (40.0)	.22 (12.9)	.42 (2.02)	.48 (2.97)	.35 (1.63)	2.44 (2.03)	1.16 (2.61)	2.52 (2.05)
Δlog (Stock Price)		.12 (16.2)	.15 (16.5)		.07 (1.10)	.12 (1.56)		.56 (2.14)	.42 (.36)
Year Dummies	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Number of Observations	9,847	9,847	9,847	253	253	253	253	228	228

Note: t-statistics in parentheses.

ing more leads of the instruments did not improve the fit.

The results from the OLS regressions on the large sample are given in the first three columns of Table 7. In column 3, an elasticity of compensation with respect to sales of 0.22 is consistent with what the previous literature has found. The compensation-stock price elasticity of 0.15 is also quite familiar. Columns 1 and 2 show the results from regressions run omitting the stock price variable and year dummies, respectively. While both are significant and should be included, leaving them out gives some indication of what happens to the coefficient on sales when they are removed.

Before turning to the instrumental variable results, it is worth looking at the ordinary least squares results from the smaller sample, given in columns 4, 5, and 6 of Table 7. The huge reduction in observations causes a decrease in significance, but the point estimates of the parameters are not greatly changed.

The last column of Table 7 shows the results obtained from using two-stage, least-squares estimation on equation (10) including year dummies. One result is a huge increase in the performance sensitivity estimate on sales. Holding the stock price constant, a 10 percent increase in sales now yields a 25 percent increase in the compensation of the CEO. This result is 10 times as large as the estimates found here and in other studies.[12] The coefficient on the stock price is insignificant, however. This result may be due to the fact that the instruments are not as good for expected future performance as they are for current performance. The standard error is too large to say anything about the stock price measure. Including or excluding it, however, does not alter the large jump in the parameter on sales.

The results indicate that previous empirical studies were underestimating the performance-sensitivity parameter. Although with just one performance variable, measurement error is known to bias the variable downward, with more than one regressor the sign of the bias is unknown and must be discovered empirically.

In Table 8, squared terms of both performance variables are included. The heterogeneity that was evident in Table 3 is no longer apparent. The squared terms are insignificant throughout. Their inclusion has two effects: The coefficient on stock price is insignificant in the small sample, and everything is insignificant when both year dummies and instrumental variables are used.[13] Excluding year dummies, the instrumental variable estimate of the coefficient on sales (Table 8, column 6) is not significantly different from its counterpart in Table 7 (column 8). However, it also is only significantly different from zero with 85 percent confidence. The conclusion obtained from Table 8 is that the heterogeneity that is a problem when performance is measured by total shareholder return does not emerge when performance is measured by sales and the stock price.

[12] Studies that look at the cumulative response rather than the contemporaneous response of pay to performance also find higher estimates. See Boschen and Smith (1995) and Joskow and Rose (1994).

[13] These regressions also include the squares of the instruments as additional instruments.

Table 8
CEO Compensation and the Heterogeneity of Performance Measures

	Δ log (Salary and Bonus)					
	Large Sample		Small Sample			
	OLS	OLS	OLS	OLS	IV	IV
Δlog (Sales)	.22	.23	.28	.45	5.38	.97
	(12.3)	(13.4)	(1.25)	(2.71)	(.237)	(1.51)
(Δlog (Sales))^2	.01	−.01	.88	.64	−42.2	−3.99
	(.20)	(−.17)	(.94)	(.72)	(−.19)	(−.34)
Δlog (Stock Price)	.12	.10	.12	.12	−3.97	−1.81
	(5.05)	(4.01)	(.50)	(.51)	(−.48)	(−.36)
(Δlog (Stock Price))^2	.00	.00	.00	−.00	.63	.36
	(1.10)	(.94)	(.02)	(−.24)	(.57)	(.49)
Year Dummies	Yes	No	Yes	No	Yes	No
Number of Observations	9,847	9,847	253	253	228	228

Note: t-statistics in parentheses.

VI. Conclusions

This paper has highlighted three problems with the earlier literature on CEO compensation. First, many samples include firms that may not fit the basic assumption of the principal–agent model, that monitoring costs must be prohibitively high. Focusing only on the high-monitoring-cost firms yields a parameter that is higher, but not high enough to make the results consistent with agency theory. Second, firms with low performance may be more likely to change their CEO incentive structure. Other firms may change CEO contracts in response to trends in compensation or the regulatory environment. Controlling for changes in the incentive parameters that vary with firm performance shows that previous results were biased downward, but not by a large enough magnitude to change the qualitative results.

Third, mismeasurement of performance has been largely ignored until now. Using exogenous demand instruments, this study yields the result that previous estimates have been biased downward. CEO contracts are apparently much more sensitive to the performance of the firm than has been previously thought. This result is more in line with the principal–agent theory, which proposes that CEOs who are difficult to monitor should have a higher compensation elasticity with respect to performance than the average worker does.

The study, however, has several shortcomings. Complete measures of compensation, including stock awards and options, fringe benefits, and pension accruals, would add to the instrumental variable analysis. Combining the analyses in the first and second parts of the article would also be desirable. In this study, the small number of firms with good instruments prevents the instrumental variable technique used in Section V from being used only on those firms with high monitoring costs. Further research should also identify good instruments for the stock price or total shareholder wealth, in order to generate results that are more comparable to the previous literature.

Despite these problems, the finding remains that performance of the firm has a very large effect on CEO compensation. By rewarding CEOs for increased performance, shareholders align the interests of the CEO with their own and ensure that the CEO is choosing actions that optimize performance for both. Incentive-based contracts are costly, however, and only worth the increase in compensation if aligning the CEO's interests with the shareholders' yields a substantial subsequent increase in shareholders' wealth. Higher firm performance resulting from the incentive contracts of CEOs has not yet been demonstrated, and further research is needed before CEO pay packages can be justified on the grounds that they are performance-based.

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