Are Energy Executives Rewarded For Luck?

Lucas W. Davis Catherine Hausman*

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Abstract

In an influential paper, Bertrand and Mullainathan (2001) show that energy executives are rewarded for high oil prices, which they term pay-for-luck. Almost twenty years later, performance-based pay as a portion of executive compensation has nearly doubled; total executive compensation has also nearly doubled; and new disclosure laws and tax rules have changed the regulatory landscape. In this paper, we examine whether their results and their interpretation continue to hold in this changing environment. We find that executive compensation at U.S. oil and gas companies is still closely tied to oil prices, indicating that executives continue to be rewarded for luck despite the increased availability of more sophisticated compensation mechanisms. This finding is robust to including time-varying controls for the firms' scale of operations, and it holds not only for total executive compensation but also for several of the separate individuals components of compensation, including bonuses. Moreover, we show there is less pay-for-luck in better-governed companies, and that pay-for-luck is asymmetric – rising with increasing oil prices more than it falls with decreasing oil prices. These patterns are more consistent with rent extraction by executives than with maximizing shareholder value.

Key Words: Pay-for-Luck, Executive Compensation, Principal-Agent Problem, Rent Extraction, Performance Pay

JEL Codes: M12, Q40, G34, J33, M52

*(Davis) University of California, Berkeley. Email: lwdavis@berkeley.edu. (Hausman) University of Michigan. Email: chausman@umich.edu. We are grateful to Severin Borenstein, Thom Covert, Todd Gerarden, Matthew Kahn, Ryan Kellogg, Daniel Raimi, Martin Schmalz, and seminar participants at Cornell, UC Berkeley, UC Davis, and Wharton for helpful comments. We have not received any financial compensation for this project, nor do we have any financial relationships that relate to this research.

1 Introduction

In an influential analysis, Bertrand and Mullainathan (2001) (hereafter B&M) test whether CEOs are rewarded for luck, that is, shocks to firm performance that are beyond the CEO's control. Their paper uses several different measures of luck, but some of the most compelling evidence comes from a case study of the oil industry, in which they show that CEO compensation, crude oil prices, and company value are strongly correlated. Using an instrumental variables analysis to isolate the variation in company value coming from oil prices, they find that CEO compensation responds just as much to changes driven by oil prices as it does to generic changes in company value.

This finding that CEOs are rewarded for luck stands in contrast to the predictions of standard principal-agent models. In simple contracting models, pay-for-performance is used to incentivize CEOs to take actions to maximize company value. However, because CEOs are risk averse, the optimal contract does not reward executives for changes in company value driven by luck (Holmstrom, 1979). Instead, companies should "filter out" oil prices and the other forms of observable luck that make contracts riskier without providing better incentives to CEOs.

In the years since B&M, executive compensation has changed in a number of important ways. There has been a dramatic increase in the use of stock options followed by a partial reversal of this trend. There was a major recession, accompanied by an increase in public scrutiny of executive compensation, and regulatory rules regarding compensation disclosure and shareholder involvement have tightened. Finally, the last decade has seen a transformation of the oil and gas industry in the United States, with the rise of hydraulic fracturing and the entry of dozens of new companies. In these changing times, and particularly in an era with a much sharper focus on pay-for-performance, are energy CEOs still paid for luck?

In this paper, we analyze executive compensation data from 80 U.S. oil and gas exploration and production companies (hereafter energy companies) for the period 1992–2016. Despite the increased availability of more sophisticated compensation mechanisms, we find that executive compensation at U.S. energy companies is still closely tied to oil prices. Like B&M, we find that executive compensation responds just as much to changes driven by oil prices as it does to generic changes in company value. In our instrumental variables specification, a ten percent increase in company value driven by oil prices leads to a two percent increase in executive compensation.

Our analysis provides valuable corroboration to B&M during a very different time period, while also expanding B&M along several dimensions. Whereas B&M examines CEOs only, we look at all types of top executives. In addition, our data are more comprehensive with more than twice as many companies, including not only the very largest U.S. companies but also many smaller, though still publicly-traded, companies. Overall, we have over 4,600 executive-year observations, compared to 827 executive-year observations in B&M. This larger sample size yields a significant improvement in statistical precision, allowing us to perform richer analyses.

First, we show that this pay-for-luck finding is robust to including time-varying controls for capital expenditures and labor. This suggests that the pattern cannot be explained by increased demand for executive effort during high-production years.

Second, we demonstrate that pay-for-luck is widespread across the different individual components of executive compensation, including not only stocks and options, but also bonuses and long-term cash incentives. This evidence is significant because it implies that the overall pattern is not driven by a mechanical relationship between stock options and market value.

Third, we find less pay-for-luck at better-governed companies. Results are consistent across three measures of firm governance, including the presence of insiders (e.g., executives or their family members) on the board of directors and the compensation committee. These results suggest that when these governing bodies have a conflict of interest, it can be easier for executives to push through lucrative compensation packages, particularly during boom times when oil prices are high.

Fourth, we show that pay-for-luck is asymmetric, with executive compensation increasing more with rising oil prices than it decreases with falling oil prices. This contrasts with a shareholder value model in which executives are paid their marginal product, for which we would expect a symmetric pattern.

Fifth, we compare dynamics for executives whose compensation is above or below the median, finding more pay-for-luck (and comparable asymmetry) among higher-paid executives. This is notable, as we explain in the paper, because it suggests that the pay-for-luck we observe is not driven by retention concerns.

Overall, we find that the evidence is more consistent with rent extraction by executives than with maximizing shareholder value. Much of the broader literature on executive compensation has aimed at reconciling these two views.[1] Under the rent extraction view, executives

[1] Surveys of this literature include Abowd and Kaplan (1999), Murphy (1999), Bebchuk and Fried (2003), Bertrand (2009), Edmans and Gabaix (2009), Murphy (2013), Edmans and Gabaix (2016), and Edmans et

have co-opted the pay-setting process, and are increasing compensation as much as possible. In contrast, under the shareholder value model, pay is set within a competitive executive market, structured in such a way that executives are properly incentivized to exert effort on behalf of the firm.

As with the rest of the literature, we are unable to explicitly rule out all shareholder value interpretations.[2] Part of the challenge, as explained by Murphy (2013), is that these two views are not mutually exclusive, with both forces impacting compensation to varying degrees across firms and over time. Our purpose is not to rule out one theory or the other. Instead, we aim to provide updated empirical facts, two decades after B&M, for an industry where enormous dollar values are at stake, and where filtering of luck is in principle easy to do.

Focusing on energy companies has several significant advantages. Most importantly, the fortunes of energy companies are highly dependent on a single, highly-salient, well-understood, widely-available, plausibly exogenous factor – the price of oil. Indeed, we find that a 10 percent rise in oil prices increases the market value of energy companies by 9.9 percent – almost a 1-for-1 relationship. As we discuss more in Section 2, these features make oil prices very different from other measures of luck that have been used in the literature.

In addition to providing an advantageous case study, the U.S. energy industry is of significant intrinsic interest. The United States is the world's largest producer of oil and natural gas. The annual value of U.S. oil and natural gas production exceeds $200 billion, and the firms in our sample had a total market value of almost half a trillion dollars in 2016. Reflecting the size of this industry, the dollar value at stake in executive pay is substantial: total compensation of all energy executives in the latter part of our sample is almost $1 billion per year.

The paper proceeds as follows. Section 2 provides background on the related literature and on the oil and gas industry. Section 3 describes our data. Sections 4 and 5 present empirical results, and Section 6 concludes.

al. (2017).

[2]See Himmelberg and Hubbard (2000); Oyer (2004); Bolton et al. (2006); Axelson and Baliga (2009); Gopalan et al. (2010); Hoffmann and Pfeil (2010); Noe and Rebello (2012); Danthine and Donaldson (2015); Chaigneau and Sahuguet (2018).

2 Background

2.1 Measuring Luck in Executive Compensation

We are not aware of any executive compensation studies other than B&M that use oil prices as a measure of luck. Instead, a substantial related literature has developed on relative performance, i.e., how an executive's own company's performance compares to that of other companies in the same industry, and how this "relative performance" affects the executive's compensation. In this literature, "luck" is measured using within-industry average performance. Just as an optimal contract should filter out the effect of oil prices, so should a contract filter out within-industry average performance. Filtering out the exogenous industry-wide ebbs and flows decreases the variance of compensation, without reducing incentives for executives to take actions to benefit the firm.

The literature testing for relative performance evaluation has found mixed evidence (Antle and Smith, 1986; Aggarwal and Samwick, 1999b; Gibbons and Murphy, 1990; Garen, 1994; Garvey and Milbourn, 2003). Typically these studies take the form of testing whether executive compensation is tied to *absolute* firm performance, which depends in part on industry-wide lucky breaks, or is tied to *relative* firm performance, which filters out observable industry-wide shocks. However, conclusions in that literature depend in large part on how the researcher defines the peer group, and for some peer comparison groups there is evidence of relative performance evaluation (Gong et al., 2011; Lewellen, 2015).[3]

Each of these two approaches for measuring luck has advantages. The main advantage of using relative performance is that this measure is available for all industries, facilitating larger-scale analyses and cross-industry comparisons. Oil prices have certain advantages too, however. Oil prices are both exogenous and highly volatile, driven by world-wide shocks.[4] An additional advantage of our focus on oil prices as a measure of luck is that we are not forced to choose a peer comparison group. A challenge in relative performance studies is

[3]Also related is the literature on benchmarking, which investigates how pay *levels* depend on peer comparisons, rather than on how pay varies with peer performance; see, e.g., Albuquerque et al. (2013); Cremers and Grinstein (2014). Other related work has focused on executive hiring and firing decisions: Jenter and Kanaan (2015) documents that industry movements (i.e. bad luck) are predictive of CEO *dismissals*, with only partial filtering of luck.

[4]Outside of the executive compensation literature, these features of oil prices have been widely noted. For example, Kline (2008) writes that oil prices "provide ample exogenous variation" and "are well measured, volatile, and difficult to forecast" (p 3). He also notes other advantages of studying the oil industry, including the importance of oil shocks to the economy as a whole. Kline (2008) uses variation in crude oil prices to study labor market dynamics. Using data from the *Current Employment Survey*, he finds that employment and wages in the U.S. oil and gas field services industry increase with crude oil prices.

that there is significant ambiguity in how the "peer group" is defined. There are questions not only about which companies to include but also about which measures to use, as well as about how to weight different observations, and how to handle entry and exit of companies. This ambiguity introduces measurement error and implies that the peer comparison group is potentially endogenous, since compensation boards have considerable flexibility in these choices. Moreover, in industries that are not perfectly competitive, executives may be able to influence competitor market value, thereby directly violating the exogeneity assumption (Aggarwal and Samwick, 1999a).

One strand of the relative performance evaluation literature tests for asymmetric pay-for-luck. Garvey and Milbourn (2006) document that executives are rewarded more for good luck than they are punished for bad, which the authors argue is consistent with rent extraction, i.e. executives having control over the pay-setting process. This argument is bolstered by their finding that both pay-for-luck and the asymmetry are stronger at firms with worse governance.[5] In contrast, Bizjak et al. (2008) argue that asymmetry in observed pay-for-luck could be the result of compensation boards using benchmarking to set wages at market reservation levels, motivated by their finding that the asymmetry appears for firms paying their CEOs below the peer group median. They also argue more generally that other observed empirical facts are consistent with executive compensation being set in a competitive environment rather than as a result of rent-seeking. Campbell and Thompson (2015) also argue that retention concerns are better able to explain asymmetric pay-for-luck than are explanations relating to rent extraction. Finally, Bell and Van Reenen (2016) examine both asymmetry and the impacts of firm governance, finding evidence of pay-for-luck in UK firms.

Another paper in the relative performance evaluation literature is Cremers and Grinstein (2014). They ask whether retention concerns can explain observed pay-for-luck, arguing that compensation practices depend on whether the pool of executives comes from within the industry or from outside industries. They write that, "in an industry with many outsider CEOs and where the overall supply of CEOs will be relatively inelastic, boards may be forced to raise their CEOs' compensation if there is a positive industry-wide shock... However, in industries with few outsider CEOs, such a competitive labor market argument would be less compelling because CEOs and top executives are beholden to the firm" (p 947). Interestingly, Cremers and Grinstein (2014) find that the oil and gas industry is one of the sectors with few outside hires. According to their logic, observed pay-for-luck in a sector like oil and gas

[5] Asymmetry and governance are further explored in Harford and Li (2007), which examines compensation following acquisitions; and in Bebchuk et al. (2010), which investigates governance and director compensation. Bebchuk and Fried (2003) summarizes additional related work on governance.

would be difficult to explain by retention concerns in a competitive labor market. We view our paper as complementary to this existing literature on asymmetry and retention concerns, in an industry context in which luck is particularly important and easy to measure.

2.2 Industry Background

The oil and gas industry is a major force in the U.S. economy. As mentioned in the introduction, the firms in our sample had a total market value of almost half a trillion dollars in 2016. The sector is composed of both large, old firms like ConocoPhillips (which began extracting oil over one hundred years ago), and newer firms such as Anadarko Petroleum Corp (established in 1959) and Chesapeake Energy Corp (founded in 1989). While those three companies are quite large – with over 10 billion in market value each – dozens of smaller companies are also publicly traded.

The oil and gas industry has changed dramatically since the 1977 to 1994 period examined by B&M. Most importantly, the rise of hydraulic fracturing and associated innovations has substantially increased total U.S. oil and gas production. Hydraulic fracturing has been called "the biggest energy innovation since the start of the new century" (Yergin, 2011) and has had a large positive impact on the U.S. economy (Hausman and Kellogg, 2015). U.S. oil and natural gas production has increased more than 50 percent since 2008, making the United States the world's largest petroleum and natural gas producer (Energy Information Administration, 2018). Along with this growth in production, there have been dozens of new entrants into the oil and gas industry. While the new entrants tend to be smaller firms, some of the entrants have rapidly become major producers. Concho Resources, for instance, was founded in the mid-2000s but by 2016 was among the top ten publicly-traded U.S. oil and gas firms by market value.

Reflecting the size of the industry, executive compensation is substantial, with average executive compensation over the last decade at $4 million per year, and average CEO compensation over the last decade at $8 million. For CEOs, this is more than three times the average CEO compensation in the B&M sample, equal to $2.4 million in 2016 dollars.

Some top oil and gas executives have been publicly criticized for their pay. Ray Irani of Occidental Petroleum Corp was forced out after investors criticized his pay package.[6] In 2013, the shareholders of Apache rejected proposed executive compensation plans in a non-

[6]Krauss, Clifford. 3 May 2013. "Occidental Chairman Agrees to Step Down Ahead of Schedule." *New York Times*. https://www.nytimes.com/2013/05/04/business/occidental-chairman-irani-agrees-to-leave-company.html

binding say-on-pay vote. Perhaps most vivid is the professional story of the late Aubrey McClendon, cofounder of one of the largest companies in our sample, Chesapeake Energy. Through McClendon's leadership, Chesapeake rose to become a leading producer of natural gas, and McClendon was in the late 2000s one of the highest-paid CEOs in the United States. The company was, however, also plagued by questions about governance and conflict-of-interest (details provided in the Appendix), and McClendon was eventually forced out of the company.

Our analysis is complementary to descriptive studies of executive compensation in the oil and gas industry. We have reviewed, for example, industry reports on how oil and gas firms structure their pay packages.[7] These reports draw on proxy statements, in which firms are required to provide summaries of their executive pay-setting practices, and the summary reports provide a valuable complement to our regression-based analysis. One recent report (Alvarez & Marsal, 2018) notes a couple of useful facts, which together highlight the value of empirically estimating the reponsiveness of pay to market value versus to oil prices.

First, firms use a wide variety of performance metrics when setting pay. Common metrics include total production, health/safety/environmental metrics, the value of reserves, and total shareholder return (both relative and absolute). Some of these measures are correlated with oil prices while others are not. Second, most oil and gas companies use some discretion, rather than solely formulaic plans, when determining annual pay. This use of discretion is relevant because it suggests that, even if relative performance evaluation is named as a strategy in proxy statements, it is possible that the use of discretion undoes some of the relative comparison.[8] Indeed, a blog post by a compensation consultant describes just such a mechanism following the oil price crash at the end of 2015.[9]

These facts indicate that examining realized pay structures can provide a useful summary

[7] Pearl Meyer's "2016 Oil & Gas Market Review: CEO Pay and Practice Trends," available at https://www.pearlmeyer.com/2016-oil-and-gas-market-review-ceo-pay-and-practice-trends.pdf; Alvarez & Marsal's 2018 "Oil and Gas Exploration & Production (E&P) Incentive Compensation Report: Analysis of Compensation Arrangements Among the Largest U.S. E&P Companies," available at https://www.alvarezandmarsal.com/sites/default/files/article/pdf/62276_03274_tax_oil-gas_ep_incentive_comp_report_v15_pages.pdf; and similar Alvarez & Marsal reports from earlier years.

[8] This is related to the findings of Wade et al. (1997) regarding how compensation committee justify compensation decisions.

[9] The author writes "across a sample of 32 publicly-traded large E&P companies, we found that 50% applied negative discretion or subjective assessment (e.g., through an 'individual performance' component) to reduce annual incentive payouts from the formulaic outcome... This all reinforces the importance of compensation committees maintaining some degree of subjectivity or discretion in determining bonus payouts, especially during volatile commodity cycles." Source: Szabo, Jon. "Post #41: Effective Use of Discretion in Annual Incentives." Available at http://www.meridiancp.com/wp-content/uploads/Effective-Use-of-Discretion-in-Annual-Incentives.pdf

of pay structures that vary (perhaps endogenously) across firms and across time. Moreover, while the mention of relative total shareholder return as one metric points to the possibility that we might observe the filtering of industry-wide luck from executive pay, the use of multiple other performance metrics, and the possibility that the choice of metrics is itself endogenous to compensation committee goals, suggests that we may not empirically observe much filtering. Indeed, in related work, Bell and Van Reenen (2016) argues that a potential explanation for pay-for-luck is "that CEO remuneration plans are sufficiently complex that shareholders have difficulty effectively monitoring the contracts." The less able shareholders and boards of directors are able to monitor contracts, the more likely we are to see pay-for-luck and rent extraction.

3 Data

We assemble data on firm performance and executive compensation from Compustat, which collects data from firms' annual proxy statements.[10] The Compustat data span the years 1992–2016 and cover 3,664 publicly-traded firms, including all of the S&P 1500. The panel is unbalanced because of mergers, acquisitions, entry, etc.[11] We focus on oil and gas exploration and production firms, of which there are 80 in the Compustat data. Names of each company, along with mean compensation and mean market value, are provided in the Appendix (Table A2). These firms, defined by NAICS code 211111, are engaged in "the exploration, development and/or the production of petroleum or natural gas." Oil and gas exploration is delineated separately from firms engaged primarily in other oil and gas activities, such as support activities for oil and gas (drilling on a contract basis) and petroleum refining.[12] Whereas crude oil prices have a clear and direct impact on production companies, the relationship is less clear for these other types of oil and gas companies. Refinery mark-ups, for example, can either increase or decrease with crude oil prices (Borenstein and Kellogg, 2014; Muehlegger and Sweeney, 2017).

[10] B&M use two different CEO compensation datasets, neither with data available past 1994. Their oil results leverage a dataset of CEO compensation from the 51 largest U.S. oil companies between 1977 and 1994, for a total of 827 executive-by-year observations. Their market-wide results use a dataset of CEO compensation from Yermack (1995).

[11] We examined new entrants into the sample and exits from the sample. New entrants tended to coincide with initial public offerings, spin-offs, and S&P 1500 listings; exits tended to coincide with acquisitions by other firms.

[12] For a complete list of NAICS codes with descriptions see https://www.census.gov/cgi-bin/sssd/naics/naicsrch. Note that the "supermajors" Chevron and ExxonMobil, as well as other vertically-integrated companies like Valero and Western Refining, are in NAICS Code 324110 "refining," and thus are excluded from this analysis.

In principle, one could perform similar analyses on other types of energy companies, such as natural gas transmission and distribution firms, or electric utilities.[13] We instead focus on oil and gas extraction, because an exogenous measure of luck is readily available both to us and to executive compensation boards: the crude oil price we describe above. As described above, oil prices are driven by worldwide supply and demand shocks; natural gas prices, in contrast, can be substantially impacted by U.S. supply conditions, as described in detail in Hausman and Kellogg (2015). Also, these other energy firms in our data are a heterogeneous mix of gas-only, electric-only, and gas- and electric utilities; and of competitive producers and price-regulated utilities. These different types of firms are affected quite differently by energy price shocks, limiting both power and generalizability.

Conceptually, pay-for-luck could be assessed in any competitive commodity market in which output prices are variable and exogenous. We considered coal producers, for example. While coal is traded worldwide and thus has a fairly exogenous price, coal prices are much less variable than oil prices, limiting statistical power. Moreover, while we have 80 oil and gas companies, there are only eight coal mining companies in our data. Another possibility would be companies engaged in gold or silver mining, but there are only nine and two companies, respectively, in these sectors. In addition, we considered agricultural commodities but there are only four companies in our data engaged in corn, poultry, or cotton production, and other agricultural companies (e.g. Monsanto) tend to be broader conglomerates with many different lines of business. In short, none of these other commodity markets have nearly as many companies as does oil and gas.

For each firm, we observe financial measures on an annual basis, including total market value, total book value, net income, total assets, the return on equity, the return on assets, the number of employees, and capital expenditures.[14] Each firm also reports executive compensation for its five highest ranked employees.[15] Altogether, we observe 934 individual executives at energy firms. As mentioned above, total compensation of all oil and gas executives in the latter part of our sample is almost $1 billion per year, and it peaked at $1.1 billion in 2008.[16]

[13] Related work on utilities includes Joskow et al. (1993) and Joskow et al. (1996), which examine political pressure and executive pay at regulated utilities.

[14] Market value is essentially the year-end stock price times the number of shares. Book value is the stockholders' equity from the balance sheet, with adjustments for deferred taxes, investment tax credits, and preferred stock. The return on equity is the income to common equity ratio, multiplied by 100. The return on assets is the income to assets ratio, multiplied by 100.

[15] Some firms report compensation for more than five executives, but we limit the sample to the top five in each firm-year.

[16] The average per year for 2007 to 2016 is $900 million, reflecting mean compensation of $4 million annually for around 225 executives.

For each executive, in addition to total compensation we observe its components: salary, stocks and stock options, bonuses, long-term incentives, and other compensation (such as benefits and perquisites). The value of stocks and options is the grant-date fair value of stock/options awarded. The reporting format for some of the individual components of compensation changes in 2006, as we describe in the Appendix. We also observe whether the executive is the CEO.

We merge in crude oil prices from the Energy Information Administration. We use the West Texas Intermediate (WTI) price; this is the standard benchmark price for U.S. crude and it closely follows other international crude prices.[17,18] We focus primarily on December oil prices, since market value is measured at year-end; however we also examine annual average prices.[19]

As we discuss later in more detail, we have three measures of firm governance. The first is the proportion of executives that are not on the board of directors; we construct this variable from Compustat data. Second, from Institutional Shareholder Services (ISS) we have the proportion of board members that are not insiders (e.g., employees or family members of employees). Also from ISS, we have the proportion of compensation committee members that are not insiders.

To control for macroeconomic conditions, we use real GDP and the unemployment rate from FRED. Finally, we deflate all prices using the CPI - All Urban Consumers: All Items Less Energy, from FRED.

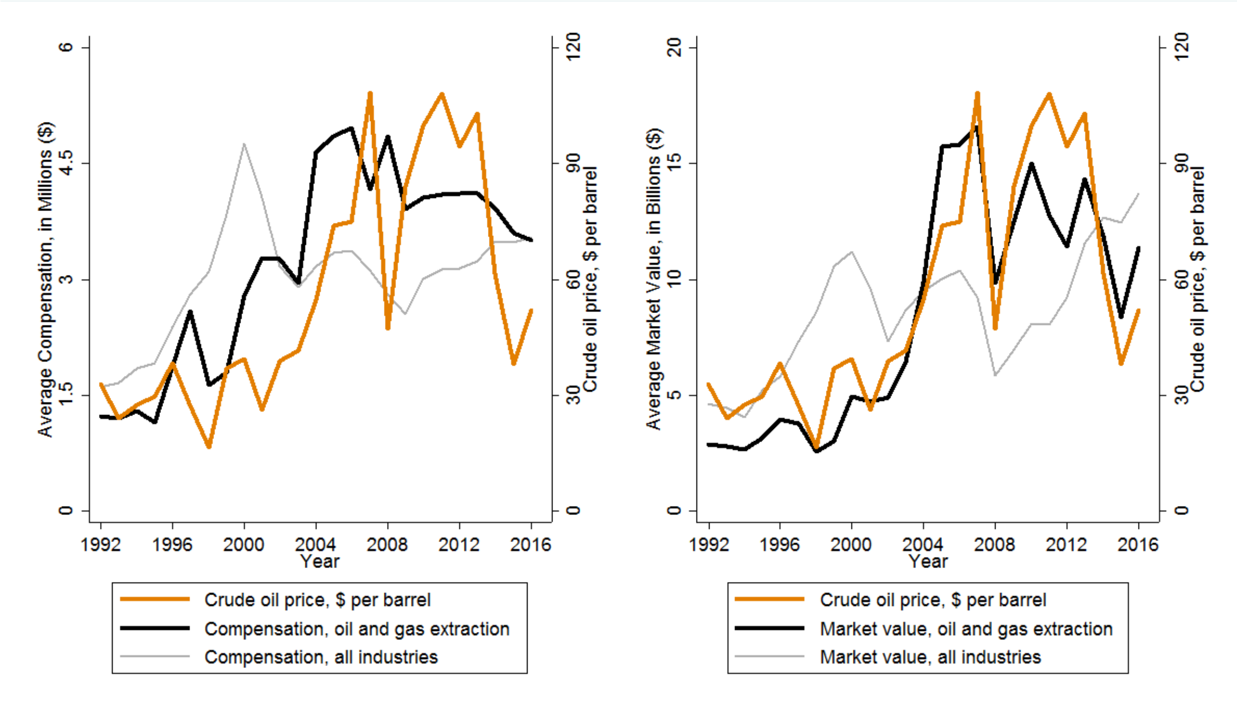
We show summary statistics in the Appendix (Table A3). Average annual compensation in our sample is just over $3 million, with about half coming from stocks and stock options. Market value has missing observations, making up around 7 percent of the sample; these missing values are concentrated in firms not listed on a major S&P index and in firm-year observations just prior to a firm's IPO. Across several variables, mean and median values differ because of skew, so we log transform most variables in the specifications that follow. The difference between mean and median values is especially pronounced for the return on assets and return on equity variables; the negative mean values are driven by a handful of outliers. When we use these return variables, we trim both upper and lower outliers.

[17]We also collect data on the Brent crude oil price, which diverged somewhat from the WTI price over our time period. Our main results are very similar using the Brent price.

[18]For supplementary analysis, we also collect natural gas prices at Henry Hub, a major pipeline hub in Louisiana and the official delivery location for most U.S. natural gas futures contracts.

[19]A firm could of course have a fiscal year ending in a month other than December; however, in our sample 97 percent of all fiscal years end in December.

Figure 1: Energy Company Executive Compensation, Market Value, and Oil Prices



Note: This figure plots the average executive compensation (left panel) and the average year-end market value (right panel) for firms in Compustat. In each panel, the thick black line is for 80 oil and gas firms and the thin grey line for all other firms in Compustat. Executive compensation is averaged across the top five executives at each firm. Crude oil prices (West Texas Intermediate light sweet crude) are plotted in orange. All values are in 2016 dollars, using the CPI-All Urban Less Energy.

Before presenting the details of our empirical analysis, we present descriptive evidence on the positive correlation between executive compensation, oil prices, and market value. The time-series plots in Figure 1 show that executive compensation and market value at energy firms closely follow the pattern for crude oil prices during the period 1992–2016. The left-hand panel shows the national average compensation for energy executives (thick black line) versus executives in all other industries (thin grey line).[20] It is immediately apparent that compensation at energy firms is highly correlated with the crude oil price (thick orange line). Asymmetry also appears in this figure: compensation tracks *upward* movements of oil prices more closely than *downward* movements. Firm market value is, of course, closely tied to oil prices (without asymmetry), as shown in the right-hand panel. Also apparent in the right-hand panel is the highly variable nature of market value for oil and gas firms. Figure 1 does not provide conclusive evidence of pay-for-luck but it does motivate the regression analyses that follow, showing that this is an industry closely tied to oil prices.

[20]The data are for an unbalanced panel, as described below; the figure looks very similar if firm fixed effects are removed to correct for compositional changes.

4 Main Results

4.1 Pay for Performance

We begin by measuring pay for performance for U.S. energy executives. That is, we measure the extent to which executive compensation varies with the value of the firm. We estimate the following:

$$ln(C_{i,t,p}) = \alpha + \beta_1 \cdot ln(V_{i,t}) + X_{i,t,p}\Theta + \varepsilon_{i,t,p}, \tag{1}$$

where $C_{i,t,p}$ is compensation at firm i in year t for executive p, V is market value, and X is a vector of controls.[21] Time-series controls (to account for macroeconomic conditions) include GDP growth, unemployment, and a linear trend. Firm fixed effects aid with precision and account for compositional changes. A CEO dummy also aids with precision. Standard errors are two-way clustered by firm (to allow for correlation across individuals and across years within a firm) and by year (to allow for correlation across firms within a year).

Results, shown in Column 1 of Table 1 indeed show a positive coefficient. The coefficient is 0.29, statistically significant at the one percent level, indicating that for every 10 percent increase in market value, executive compensation rises by almost 3 percent.[22] This specification is analogous to Column 3 of Table 1 in B&M. The magnitude we estimate is somewhat smaller than what is estimated by B&M; their coefficient is 0.38.

The coefficient of 0.29 is economically significant. From 2000 to 2010, the average market value of firms in our sample rose by 84 log points, or $10 billion in real terms. At the same time, executive compensation rose 52 log points, or $1.5 million per executive. The coefficient on market value indicates that compensation would be expected to rise over 20 log points, accounting for around half of the total increase over this time period. Moreover, recall that total compensation includes stocks and options, which we value using the grant-date value. The *exercised* value, i.e. realized pay, will be even more closely tied to the firm's stock price and therefore market value.

Regressions of this form are typically interpreted as measuring pay-for-performance. But, of

[21] When we take the log of compensation, we add $1 to any zero values; this affects only one observation. The right-hand side variable, market value, has no zero or negative values. In the Appendix we show that results are similar for alternative measures of firm performance, including book value, the return on equity, and the return on assets.

[22] Aggarwal and Samwick (1999b) interact market value with a measure of the variance in firm returns, thus allowing heterogeneity in pay-for-performance across the variance of returns. When we estimate an augmented regression with this feature (Appendix Table A4), results are largely unchanged, with a similar slope estimate on the value of the firm and a small and statistically insignificant slope on the interaction term.

Table 1: Are Energy Executives Paid for Luck?

	(1) OLS	(2) IV	(3) OLS
Log market value	0.29***	0.19***	
	(0.04)	(0.05)	
Log crude oil price			0.19***
			(0.06)
First-stage F-statistic		90.61	
Observations	4,673	4,673	4,673
Within R^2	0.52	0.51	0.46

Note: This table reports estimates and standard errors from three separate regressions. The dependent variable in all regressions is log total annual compensation. All regressions include company effects, macroeconomic variables (national GDP growth rate and unemployment rate) and a linear trend, as well as an indicator for whether the executive is the CEO. In Column 2 we instrument for log market value with log crude oil prices. Compensation, market value, and oil prices are normalized to 2016 dollars. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

course, this causal interpretation requires the standard assumptions on exogeneity of market value. For instance, one needs to assume there is no reverse causality; this would be violated if a firm's compensation decisions impact market value. In the following subsection we turn to an instrumental variables framework to relax this assumption.

4.2 Pay for Luck

Next, we examine the extent to which this link between compensation and market value is a result of pay-for-performance versus pay-for-luck. We follow B&M and use an instrumental variable to isolate the variation in market value that is attributable to changes in oil prices. Specifically, we estimate the following:

$$ln(C_{i,t,p}) = \alpha + \beta_2 \cdot \widehat{ln(V_{i,t})} + X_{i,t,p}\Theta + \varepsilon_{i,t,p}, \tag{2}$$

where $\widehat{ln(V)}$ is the predicted log market value, from a regression of log market value on log oil price:

$$ln(V_{i,t}) = \alpha + \delta \cdot ln(O_t) + X_{i,t}\Theta + \varepsilon_{i,t}. \tag{3}$$

Here O is the December crude oil price.[23] We focus on oil, rather than natural gas prices, to be consistent with B&M. Also, as described above, natural gas prices are much more heavily influenced by the activities of U.S. firms.

The first stage results are shown in the Appendix (Table A5). The coefficient on the oil price has the expected sign and is statistically different from zero at the one percent level. The coefficient of 0.99 indicates that for every 10 percent change in oil prices, market value at the average energy firm increases by 9.9 percent. Oil prices are a tremendous driver of value for these firms.

The IV estimates are shown in Column 2 of Table 1.[24] When we instrument for market value using oil prices, we estimate a coefficient on market value of 0.19, statistically significant at the one percent level. For every 10 percent increase in market value driven by an increase in oil prices, executive compensation rises by 1.9 percent. The coefficient is not statistically different from 0.29 (the coefficient in Column 1), indicating that we cannot reject that compensation responds just as much to changes in market value due to oil prices as it does to generic changes in market value.

Our estimate is consistent with B&M, but much more precisely estimated. In particular, our standard error is less than one-third the magnitude (0.05 compared to 0.17) of their analogous estimate (Column 4 of Table 1 of their paper). This increased statistical power reflects our larger sample size and somewhat longer time frame. We also have about 20 percent more variation in oil prices as measured by the standard deviation of the log real price. We also have more precision than B&M in specifications using accounting rates of return as the measure of firm value (Table A6). Our point estimate is smaller than B&M (0.19 compared to 0.35). However, when using annual average oil prices, rather than December prices, we estimate a coefficient of 0.31, more comparable to the B&M estimate (see Appendix, Table A6).

The instrument serves two purposes here. As described above, the OLS specification cannot be interpreted causally if there is any endogeneity in market value. Because oil prices are determined by exogenous, international factors, a causal interpretation is now possible. Second, the regression isolates the variation in market value that is driven by luck, rather than executive performance. That is, even after isolating only the variation in market value

[23] For simplicity, we use the same α, $X\Theta$, and ε notation in all equations; obviously the actual estimated values vary across equations. In general, most of our specifications are run at the individual executive level, but the p subscript is dropped from equation 3 as all variables in that equation are at the firm level.

[24] The table also reports the first-stage instrument F-statistic, specifically the Kleibergen-Paap statistic that accounts for the clustered standard errors. The value of 90.61 indicates that we do not have a weak instruments problem.

that is driven by exogenous changes to oil prices—beyond the control of the executive—we estimate an economically significant impact on compensation.

Recognizing that oil price movements add noise without reflecting executive skill, boards should filter out this variation from compensation. Thus the coefficient on market value in this IV framework would be zero under an optimal contract. Not only is the coefficient statistically different from zero, but the fact that it is not statistically different from 0.29, the OLS coefficient in Column 1, suggests that little or no filtering of oil prices is done. We return to this question of the *extent* of filtering in Section 5.5.

Finally, we show in Column 3 of Table 1 the estimates from an alternative regression, in which we regress compensation directly on oil prices:

$$ln(C_{i,t,p}) = \alpha + \psi \cdot ln(O_t) + X_{i,t,p}\Theta + \varepsilon_{i,t,p}. \tag{4}$$

The coefficient on the oil price is 0.19, statistically significant at the one percent level. This implies that for a 10 percent rise in oil prices, executive compensation rises by 1.9 percent. This is an economically significant amount. The mean absolute year-on-year change in oil prices over this period was 30 log points. Thus in a typical year, energy executives saw their compensation vary by 6 log points because of the oil price change, or $180,000 at the mean pay level. Moreover, from 2013 to 2015, oil prices fell by 100 log points (60 percent)—implying a drop in annual compensation of over $500,000 per executive. Recall that executive *wealth* would drop even more, since the value of stocks held also dropped.

4.3 An Alternative Interpretation

B&M interpret their IV estimate as evidence of pay-for-luck that is consistent with rent extraction on the part of executives. But under some conditions this pattern could be explained under a simple model of firm profit maximization. When oil prices go up, firms want to produce more—so firms will choose to buy more of all inputs (capital, labor, and executives), in order to produce and sell more oil. That is, it is important to consider whether these results could alternatively be explained as increased demand for executive effort.

In the simplest version of this explanation, the firm will choose to buy "more" executives, or equivalently, pay their executives more to work more hours, whenever oil prices are high. In this subsection we test whether results change when we control for labor and capital inputs. A firm will maximize profit by choosing inputs to equate the marginal rate of technical substitution with the input price ratio. That is, the firm equates the marginal product per

Table 2: Separating Luck from Effort

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV
Log market value	0.19***	0.15**	0.14**	0.13**	0.11**
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Log employees		0.17***		0.10***	0.10***
		(0.04)		(0.03)	(0.03)
Log capital expenditures			0.16***	0.12***	0.06
			(0.05)	(0.04)	(0.07)
Log employees, squared					0.00
					(0.01)
Log capital expenditures, squared					0.01
					(0.01)
First-stage F-statistic	90.61	89.23	72.51	76.15	84.51
Observations	4,673	4,623	4,603	4,553	4,553
Within R^2	0.51	0.52	0.51	0.52	0.52

Note: This table reports estimates and standard errors from five separate IV regressions, identical to Column 2 of Table 1, but with additional labor and capital control variables. Thus, the dependent variable in all regressions is log total annual compensation. Compensation, market value, oil prices, and capital expenditures are normalized to 2016 dollars. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

dollar for each input. When the production technology is, for example, Cobb-Douglas or CES, then the marginal rate of technical substitution does not depend on output prices, so whether the price of oil is \$20, \$100, or \$200 per barrel, the firm will still choose the same ratio of inputs. This implies that after controlling for labor and capital, the demand for executives should not depend on oil prices.

We thus estimate a series of alternative specifications for our baseline IV regression in which we control for labor and capital inputs. Specifically, we include log employee counts and the log of capital expenditures as control variables. We also show a version with quadratic functions of these variables. Results are shown in Table 2. Column 1 of this table re-creates our main specification from before, that is, Column 2 of Table 1. Columns 2 and 3 add the labor and capital controls one-at-a-time. We see that each of these cuts the coefficient on log market value by about 20 to 30 percent, with the capital control having a bigger impact on the market value coefficient. When we include both capital and labor controls, the coefficient on log market value drops to 0.13. A quadratic version (Column 5) drops the market value coefficient a bit further.

Part of what we above termed pay-for-luck thus appears to be explained by firms choosing to buy more of *all* inputs when oil prices rise. Intuitively, more executive effort is needed to manage more employees and more capital investment decisions. However, a positive coefficient on instrumented log market value remains. Even controlling for other inputs, energy executives see their pay rise by 1.3 percent for every 10 percent rise in oil-price induced changes to market value. This evidence is hard to reconcile with a neoclassical model with a Cobb-Douglas or CES production function and is suggestive of rent extraction.

Below, we consider additional tests of shareholder value versus rent extraction. Throughout, we proceed with the more conservative specification that controls for capital and labor.

4.4 Robustness to Alternative Specifications

In the Appendix, we show robustness of these main results to a variety of additional alternative specifications. First, because the identifying variation in our measure of luck is time-series variation, we consider specifications of the regression of compensation on oil prices (Column 3 of Table 1) that use various alternative comparison groups. In these we can examine the *differential* impact of oil prices on compensation in energy companies relative to other industries. These comparisons are designed to assess whether our macroeconomic controls are sufficient. We use manufacturing as a comparison group, then services. We also estimate a specification that includes *all* firms in Compustat, with a separate coefficient on the oil price for each industry. We find an impact of oil prices on compensation for oil and gas extraction firms and not for the comparison groups (Table A7).

We also report estimates (Table A8) from a wide variety of alternative specifications for our IV specification. We evaluate the robustness of this specification as it provides the most direct, causal test of whether executives are paid for luck. To be conservative, we focus on the specification that controls for capital and labor. We first show that the results do not rely on the macro-economic controls that we use. Next we show that results with person fixed effects are very similar to the main results. This specification is reassuring because it suggests the results are not driven by compositional changes.[25]

Results are also very similar using various subsets of the data: limiting the sample to firms on the S&P 1500; limiting the sample to a balanced panel; defining the oil and gas sector with SIC sector definitions; weighting by a time-invariant measure of firm size (assets); limiting the sample to CEOs; dropping CEOs; or using all executives reported in Compustat rather than just the top five.

[25]Interestingly, the executives our sample tend to remain in the energy business their entire career. In particular, for this subsect of executives 93 percent of all person-year observations are for energy companies. This is notable because it implies that the pay-for-luck result is not driven by movement of executives between energy and non-energy companies, for example, with highly productive executives moving into the industry during high oil price periods.

Finally, we show that results are also very similar for alternative variable definitions: an alternative total compensation measure reported in Compustat; using Brent oil prices rather than WTI oil prices; or including the log of natural gas prices as an additional instrument. Thus, overall, our main finding that energy executives are paid for luck is very robust across alternative specifications.

5 Additional Results

5.1 Components of Pay

We next test for pay-for-luck across the different components of executive compensation. These different components are of significant interest because of secular trends in compensation practices, and because particular components are better suited for filtering out pay-for-luck. For example, pay-for-luck might be mechanically explained by the rise of stocks and stock options as a major form of compensation. Nationwide, the use of stocks and stock options expanded dramatically through the 1990s, then plateaued.[26] Their growth in the energy sector continued for longer than in other sectors, and as a result, energy relies more heavily on these forms of compensation than other sectors, as can be seen in Figure 2. In 2016, the average energy executive received over seventy percent of compensation from components other than salary.

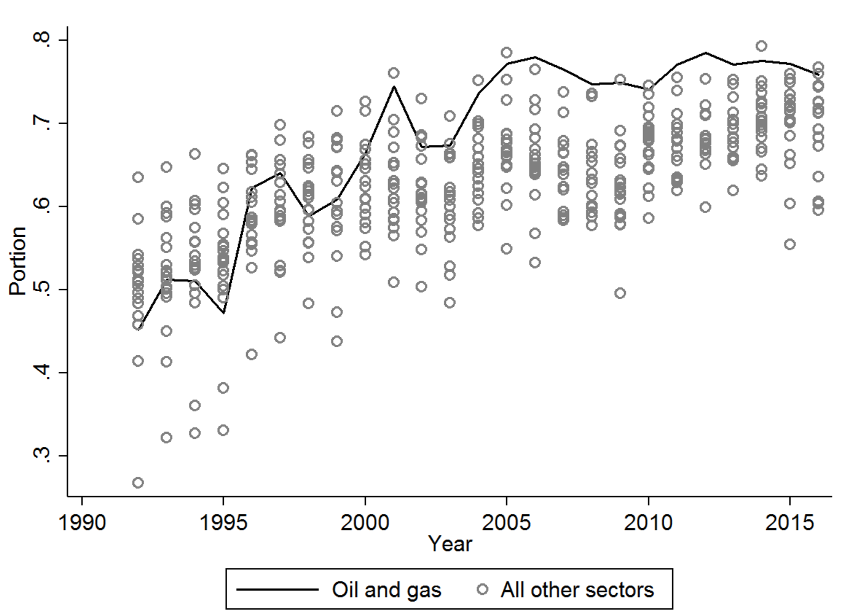
We break total compensation down into five categories: salaries, stocks and stock options, bonuses, long-term incentive programs, and other pay (such as benefits). We regress each component on market value, instrumented with the oil price.[27] We use the same set of controls as in the primary results shown in Column 4 of Table 2, including capital and labor. We also add a dummy to account for changes in the way Compustat reports these variables after 2006 (details in the Appendix).

Results are shown in Table 3. Salary (Column 1) does not reflect pay-for-luck. If anything, salary appears to decrease with increases in market value driven by oil prices, but the co-

[26]One of the reasons nationwide for the rise in the use of stocks and options was legislation in 1993 that limited tax deductions to the first $1 million of salary (Rose and Wolfram, 2002). In the Appendix, we show with histograms that this appears to be somewhat binding for CEO pay, although not for other executive pay. We also show in the Appendix (Table A8) that pay-for-luck appears to be approximately equally prevalent with CEOs and other executives, so this tax rule does not appear to be a primary driver of our results.

[27]All five components of pay have some observations equal to zero. We have dropped these from our log regressions, so these results are conditional on a non-zero value. In the Appendix (Table A9), we run the regressions in levels, including zeroes, and results are qualitatively similar.

Figure 2: Non-Salary Portion of Pay



Note: This figure plots, by sector, the average portion of compensation coming from bonuses, stock and options awards, and other non-salary components of pay. Each sector is defined by a two-digit NAICS code; sector 21 has been broken down into "Oil & Gas Extraction" versus other firms in sector 21, including mining and quarrying and support activities for oil and gas. One outlier for sector 71 has been dropped.

efficient is close to zero and only marginally statistically significant. Stocks and options (Column 2) are positively impacted by firm performance. When crude oil prices cause market value to rise by 10 percent, the value of stocks and options granted to executives rises by 0.8 percent. That this coefficient is somewhat small and not statistically significant is perhaps surprising. However, we measure the value of stocks and options at the time they are granted, i.e. ex-ante not ex-post, so we've removed most of the mechanical positive correlation between realized pay and oil prices. Moreover, in the Appendix (Table A10), we show that this appears to be at least in part because the value of stocks and options is tied more closely to *annual average* oil prices than to the December price that we use in our main specifications. This is intuitive if, for instance, these are granted earlier in the year, since their value is computed at the time they are granted. In our sample, several years saw enough within-year variability in oil prices for the December and annual average prices to differ by at least 25 percent.[28]

Thus in one sense, this rise of stocks and options makes the impact of oil prices on executive compensation not surprising, at least mechanically. However, the intuition regarding

[28]Another possible explanation for the small coefficient for stocks and options is heterogeneity in the way firms compute the grant-date fair value of stocks and options, detailed in Coles et al. (2014).

Table 3: For Which Components of Pay Is There Pay-for-Luck?

	(1) IV Salary	(2) IV Stocks & options	(3) IV Bonuses	(4) IV Other incentives	(5) IV Other pay
Log market value	-0.05*	0.08	0.59***	0.56***	0.21**
	(0.02)	(0.09)	(0.17)	(0.15)	(0.10)
First-stage F-statistic	84.39	101.78	56.67	175.36	84.33
Observations	4,546	3,934	3,083	1,729	4,443
Within R^2	0.34	0.48	0.27	0.38	0.14

Note: This table reports results from five separate IV regressions. The regressions are identical to Column 4 of Table 2, but with alternative dependent variables: each of five components of executive pay (logged). Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

filtering of observable luck, described above, makes it apparent why the use of this form of compensation is actually counterintuitive for the energy sector. Compensation boards *choose* to reward executives with stocks and options, rather than only with cash incentives based on performance. Given the extent to which market value, and therefore the value of stocks and options, is tied to exogenous factors like the crude oil price, the choice in this sector to have half of executive compensation come from stocks and options (see Table A3) runs counter to a simple theory of optimal filtering.

Columns 3-5 examine bonuses, other incentives, and other pay. Together, these make up around 30 percent of pay (see Table A3). When crude oil prices move market value by 10 percent, bonuses (Column 3) rise by 5.9 percent and other incentives by 5.6 percent, both statistically significant at the one percent level. This is consistent with the metrics that firms report using when setting pay: one recent industry report noted that common metrics for annual bonus payments are production and the value of reserves, both of which are positively correlated with oil prices; and that a common metric for long-term incentive payments is total shareholder return (Alvarez & Marsal, 2018). While that report notes that some firms use a mix of relative and absolute total shareholder return, our results suggest that the relative comparison fails to filter luck driven by oil prices.

For none of these latter components (Columns 3-5) do we reject the null that compensation responds just as much to changes driven by oil prices as it does to generic changes in company value. That is, we fail to reject that the IV estimates are identical to point estimates from analogous OLS regressions, shown in the Appendix (Table A11). And overall, we see that the main results (that total compensation is driven in large part by luck) are not simply a mechanical result stemming from stock and option awards. Indeed, the strongest evidence of pay-for-luck comes from bonuses and other incentives, the categories for which filtering would be most natural.

5.2 Governance

We next follow B&M in examining how pay-for-luck varies with firm governance. As pointed out in B&M, firms with high-quality leadership from the board should be better able to prevent executives from co-opting the pay process, suggesting that "we should expect more pay for luck in the poorly governed firms" (p 918). Whereas B&M test governance using mean industry performance as a measure of luck, our analysis is the first to test the effect of governance on pay-for-luck using oil prices.

We leverage three indicators of firm governance. First, from the Compustat data, we observe whether each of the firm's top-five executives also sits on the board of directors. We construct a variable equal to the proportion of the top five executives that do not sit on the board. Higher levels of this measure thus indicate better governance in that executives are less able to co-opt the board and its pay-setting process. The mean in our sample is 0.64. That is, on average about two-thirds of the top-five executives do not sit on the board. Table A3 includes descriptive statistics for all our governance measures.

Second, from ISS data, we observe whether each of the firm's board members has any sort of insider status, for instance because the member is an employee or the close relative of an employee. From this, we construct a variable equal to the proportion of the board members that are not insiders. Again, a higher value indicates a higher level of governance. The mean in our sample is 0.75.[29] Thus on average about three-quarters of board members are not insiders.

Third, also from ISS data, we observe whether the members of the compensation committee are insiders. All of the firms in our data have compensation committees, typically with around four members. We construct a variable equal to the proportion of the committee members that are not insiders. The mean in our sample is 0.95. This mean reflects a lower proportion in the first part of our sample (0.80 for 1999-2002), and a mean of essentially 1 in the latter part – reforms by NASDAQ, the NYSE, and the SEC have mandated independence of compensation committee members in recent years.

[29] Missing values arise both because the ISS data do not cover the years 1992-1996, and because they do not cover the smallest firms in our sample. The compensation committee variables are further limited, covering 1999-2016.

For each of the three measures, we focus on a time-invariant measure, equal to the mean value observed across all years for each firm. The primary reason we use time-invariant measures is that the ISS data do not cover the full sample, and we thus we lose a large number of observations if we use a time-varying measure.

We do not make a direct *causal* claim regarding any of the three measures; we cannot make such a claim since we do not have exogenous variation in governance quality. Rather, we interpret these measures as indicative of the kind of firm that is more likely to have governance problems. This could be because, for instance, having an insider on the compensation committee directly leads to a higher probability of committee capture. However, it could also be because the kind of firm that is willing to place insiders on the compensation committee is more likely to experience various other issues with poor governance.

We estimate a series of regressions in which we augment our standard IV specification with an *interaction* of market value with each governance measure.[30] The coefficient on this interaction thus tells us how pay-for-luck differs for better-governed firms. We display 2SLS results, matching the previous pay-for-luck specification, Column 4 of Table 2.[31] We have two first-stage equations: we instrument for both the log market value and for the interaction of market value with the governance indicator. Our two instruments are log oil prices and the interaction of log oil prices with the governance measure. We estimate the impact of governance on both pay-for-luck in total compensation, and on pay-for-luck in bonuses and non-stock incentives. We examine bonuses and non-stock incentives because this is the component of pay over which boards are likely to have the most discretion, and because our analysis earlier showed significant pay-for-luck in this category.

Results are shown in Table 4. The first-stage instrument F-statistics range from 33 to 60, indicating that we do not have a weak instruments problem. Across all six specifications, the interaction of market value and the governance indicator has a negative sign, indicating less pay-for-luck at better-governed firms. Results are statistically significant in some, but not all, of the specifications.

The magnitudes are suggestive of an economically significant effect across all columns. For instance, removing one of the top five executives from the board removes 8 percent of the pay-for-luck effect in Column 1 and 11 percent of the pay-for-luck effect in Column 4.[32]

[30] B&M use other measures, such as the presence of large shareholders on the board and the interaction of this variable with CEO tenure. For our sample, there is very little variation in the presence of large shareholders on the board: the average firm has only 0.03 large shareholders on the board. B&M also use the number of board members, but in our sample that is highly correlated with firm size.

[31] We also show OLS results in Appendix Table A12.

[32] Removing one of the top five executives decreases the "portion not on the board" by 20 percentage

Table 4: Does Good Governance Reduce Pay-for-Luck?

	(1) 2SLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
	Panel A: All Compensation			Panel B: Bonuses and Cash Incentives		
Log market value	0.17	0.44*	0.66**	0.96***	1.37***	1.47**
	(0.20)	(0.23)	(0.30)	(0.22)	(0.36)	(0.62)
Log market value X Proportion top-five executives not on board	-0.07			-0.55		
	(0.27)			(0.35)		
Log market value X Proportion board members non-insiders		-0.46			-1.09**	
		(0.28)			(0.44)	
Log market value X Proportion compensation committee non-insiders			-0.59**			-0.96
			(0.28)			(0.65)
First-stage F-statistic	33.26	38.07	43.41	43.35	58.97	59.77
Observations	4,553	3,406	3,377	4,117	3,133	3,114
Within R^2	0.52	0.56	0.55	0.43	0.50	0.49

Note: This table reports estimates and standard errors from six separate 2SLS regressions. The dependent variable in Columns 1–3 is log total annual compensation; and log bonuses and non-stock incentives in Columns 4–6. In all columns, we have two first stage equations: we instrument for log market value and the governance interaction with both log crude oil prices, and with log oil price interacted with the governance measure. All regressions include the same controls as in Column 4 of Table 2, including capital and labor. Columns 4–6 additionally include a dummy for data reporting changes beginning in 2006. The sample size varies across columns because of differential data availability across the different governance measures. Compensation, market value, and oil prices are normalized to 2016 dollars. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Similarly, in Columns 2 and 5, replacing one insider from a nine-member board removes 11 percent of the pay-for-luck effect on total compensation and 9 percent of the effect for bonuses and cash incentives.[33] Removing one insider from the compensation committee has an even larger proportional effect: removing one insider from the compensation committee removes 22 percent of the impact of market value on total compensation and 17 percent of the impact of market value of bonuses and incentives (Columns 3 and 6).

Governance especially matters for bonuses and cash incentives. These are the components of pay that are most discretionary and thus most easily manipulated, and thus this pattern of more pay-for-luck in poorly governed firms is consistent with rent extraction. We also show, using OLS estimates (see Appendix Table A12), that executive compensation in well-governed firms is less tied overall to market value, consistent with these firms using more nuanced forms of pay-for-performance.

One might be concerned that these governance results are driven by other differences in

points, and $-0.07 \cdot 0.20 = -0.014$, or 8 percent of the log market value effect on total compensation of 0.17 if all executives are on the board.

[33] Removing one insider decreases the "portion non-insiders" by 11.1 percentage points, and $-0.46 \cdot 0.111 = -0.05$, or 11 percent of the log market value effect on total compensation of 0.44 if all board members are insiders.

Table 5: Does Good Governance Reduce Pay-for-Luck for CEOs?

	(1) 2SLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
	Panel A: All Compensation			Panel B: Bonuses and Cash Incentives		
Log market value	0.11	0.70**	0.60	1.43***	2.13***	3.03***
	(0.28)	(0.27)	(0.52)	(0.34)	(0.49)	(0.97)
Log market value X Proportion top-five executives not on board	0.05			-1.10**		
	(0.38)			(0.48)		
Log market value X Proportion board members non-insiders		-0.78*			-2.01***	
		(0.41)			(0.69)	
Log market value X Proportion compensation committee non-insiders			-0.50			-2.53**
			(0.55)			(1.05)
First-stage F-statistic	29.02	36.56	38.74	36.06	52.28	53.30
Observations	853	652	646	774	599	596
Within R^2	0.48	0.53	0.52	0.36	0.40	0.38

Note: This table is identical to Table 4, but the sample is limited to CEOs. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

firms that are correlated with the board composition measures that we have used here. For instance, board composition might be correlated with firm size. To explore this possibility, we estimate alternative specifications (see Appendix Table A13) that control for firm size. Specifically, we include interactions of the market value and oil price variables with a time-invariant measure of firm size, average log employees over our sample period. The coefficients on the governance variables are generally robust to this additional control, suggesting that heterogeneity along this dimension is not driving the governance results.

Finally, we examine the relationship between governance and compensation paid to CEOs. We run the same regressions as in Table 4, but we limit the sample to the CEO of each firm. Results are shown in Table 5. We again find economically large and statistically precise impacts of governance on pay-for-luck, with strikingly large impacts for bonuses and cash incentives. Overall, the governance results as a whole point to less pay-for-luck in better-governed firms. This is hard to reconcile with a model of shareholder value and seems more consistent with rent extraction.

5.3 Asymmetry

Another approach to potentially distinguish between rent extraction and shareholder value is to test for asymmetry. In particular, we next explore whether pay-for-luck is equal when the firm's market value is rising versus falling. Under a shareholder value model in which

Table 6: Is Pay-for-Luck Asymmetric?

	(1) OLS	(2) OLS	(3) 2SLS
Log market value, if rising	0.28***		
	(0.04)		
Log market value, if falling	0.21***		
	(0.04)		
Log oil price, if rising		0.20***	
		(0.07)	
Log oil price, if falling		0.06	
		(0.06)	
Log market value, if oil price rising			0.29***
			(0.10)
Log market value, if oil price falling			0.18*
			(0.10)
p-value, rising versus falling	0.004	0.006	0.067
First-stage F-statistic			17.92
Observations	4,357	4,357	4,357
Within R^2	0.53	0.51	0.52

Note: This table reports estimates and standard errors from three separate regressions. The dependent variable in all regressions is log total annual compensation. We also report the p-value for a test of equality of the "if rising" versus "if falling" coefficients. All regressions include the same controls as in Column 4 of Table 2. Column 1 also includes (not shown) a dummy variable to indicate whether market value is rising; Columns 2 and 3 include a dummy variable to indicate whether oil prices are rising. Column 3 has two first stage equations: "log market value, if oil price rising" and "log market value, if oil price falling" are instrumented with "log oil price, if oil price rising" and "log oil price, if oil price falling." Compensation, market value, and oil prices are normalized to 2016 dollars. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

executives are paid their marginal product, we would expect the pattern to be approximately symmetric. In contrast, under a rent extraction model we would expect executives to always be extracting as much as possible from the firm, potentially resulting in more pay-for-luck at times when oil prices are rising.

To explore this possibility, we estimate augmented versions of our standard specifications, separating the coefficients on market value and oil prices into two coefficients each. We construct an indicator variable equal to one if market value is higher (in real terms) than the previous year. We then interact the log of market value with both this indicator variable and with one minus this indicator variable. The regression thus tells us whether the sensitivity of executive pay to firm performance is the same when the firm's value is rising versus falling. Results are shown in Table 6. We estimate an economically large and statistically significant difference across the two coefficients. In Column (1), the sensitivity of pay to market value is around one third higher when the firm's value is rising (in real terms).

Similarly, we construct an indicator variable for whether oil prices are rising or falling, then include interactions of this indicator variable with the log oil price. Results are shown in Column 2 of Table 6.[34] We again estimate an economically and statistically significant difference: pay is more than *three times* as sensitive to luck when luck is improving, i.e. when oil prices are rising.

Finally, we estimate a 2SLS version, in which log market value is interacted with the oil price rising/falling dummy. Thus we have two first stage equations, in which our instruments are log crude oil prices if oil prices are rising, and log crude oil prices if oil prices are falling.[35] Results, in Column 3, again indicate an asymmetric pay-for-luck effect, with the estimate about 50 percent larger for increases than decreases.

This asymmetry is suggestive of rent extraction, consistent with executives having co-opted the compensation process and increasing their pay when the firm is earning windfall profits. The OLS results in Column 1 are particularly striking, because they indicate that the impact of market value is not explained by a contract in which executive pay is a simple linear function of market value. That we see asymmetry in Column 1 is more consistent with discretion being used to increase pay when times are good.[36]

In contrast, it is hard to reconcile this evidence with a simple shareholder value model. Instead, to generate an asymmetric pattern like this with a shareholder value model would require some kind of additional mechanism layered on top. For example, if there is something about capacity investments which means that decisions about capacity expansions are more important than decisions about capacity reductions, that could generate the asymmetric pattern observed here. While we cannot rule out this possibility, it is becoming harder and harder to reconcile the evidence with a shareholder value model. This evidence of asymmetry – like the previous governance results – appears to point away from a shareholder value model.

[34]Note that the number of observations drops because we do not observe market value in 1991, and thus we are unable to construct the "rising/falling" dummy for market value in 1992.

[35]Ideally, we would estimate a 2SLS versions where the indicator variable were for *market value* rising or falling, using three first-stage equations (i.e., instrumenting with the oil price rising indicator variable). However, we find that we lose first stage power when we have three endogenous variables. Thus we interact the market value variable with the oil price rising/falling indicator variable directly.

[36]Mechanically, this could arise through the use of bonuses that are bounded below at zero. This is still consistent with the rent extraction interpretation, however, since the use of such bonuses is a choice by compensation committees. Asymmetry could also arise if bonus criteria change when oil prices are low. There is some anecdotal evidence to support this. A recent article describes how bonus criteria at Comstock Resources changed over time, from quantitative metrics in years with high oil prices to qualitative metrics (e.g. "leadership development" and "execution of strategic plan") in years with falling oil prices. Source: Denning, Liam. "A Tiny Gas Firm's Big Lesson on Bosses' Pay." 4 June 2018. *Bloomberg Opinion*, https://www.bloomberg.com/view/articles/2018-06-04/comstock-resources-a-lesson-on-oil-gas-executive-pay.

Table 7: Above and Below Median

	(1) OLS Below median	(2) OLS Above median
Log oil price, if rising	0.18*	0.34***
	(0.10)	(0.07)
Log oil price, if falling	0.03	0.21***
	(0.06)	(0.05)
p-value, rising versus falling	0.047	0.021
Observations	1,576	1,723
Within R^2	0.41	0.50

Note: This table reports estimates and standard errors from two least squares regressions. The specification is identical to Column 2 in Table 6, but with the sample split by whether the executive's pay is below (Column 1) or above (Column 2) the peer group median in the prior year. Thus the dependent variable is log total annual compensation. Compensation, market value, and oil prices are normalized to 2016 dollars. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

5.4 Above and Below Median

We next examine whether pay-for-luck differs for executives with compensation levels above and below the median. Results are shown in Table 7. For these regressions, we split the sample according to whether the executive's pay in the previous year was above or below median compensation for the firm's peer group, where peer group is defined by firm size with four categories.[37] We have also examined results not using size groupings, and the results are similar.

The results show oil prices matter for both groups of executives. However, sensitivity to oil prices is much stronger for executives paid above their peer group median. This is consistent with rent extraction, with this group of executives having been more likely to have co-opted the pay setting process, resulting in less filtering of observable luck. For both groups of executives there is clear evidence of asymmetry – with compensation increasing more with rising oil prices than it decreases with falling oil prices.

This evidence of asymmetry both above and below the median differs from Bizjak et al. (2008), which finds that pay-for-luck is driven by CEOs with pay *below* the peer group median. Their context is somewhat different as their study uses industry returns as a measure of luck, rather than oil prices, but their discussion is nonetheless quite relevant. In particular, they argue that their evidence is consistent with "competitive benchmarking being used for

[37]Firm size is defined by the firm's average asset value over the sample period.

retention motives" (p 164), rather than rent extraction: "under [the rent extraction story], the asymmetry in pay to luck should be most prevalent in the group of highly paid CEOs because these are the ones who have likely captured the pay process" (p 165).

5.5 Discussion: Measuring the Extent of Filtering

Before we conclude we want to return to our original motivation and perform a back-of-the-envelope calculation aimed at helping to put our main results in context. One of the reasons pay-for-luck is interesting is that it stands in contrast to the predictions of standard principal-agent models. Executives are risk averse, so companies should filter out oil prices and other observable measures of luck to make contracts less risky. Our findings show that companies are paying for luck (Table 2), and thus not completely filtering out oil prices. However, are companies doing partial filtering? To what *extent* are companies filtering out oil prices?

To assess this magnitude we follow Holmstrom and Milgrom (1987), who derive the optimal compensation contract under assumptions about the executive's risk aversion and assumptions on the process controlled by the executive. This model, and the literature using it (such as B&M and Aggarwal and Samwick (1999b)), abstract away from the potential impact of luck on executive marginal product. Using the notation in Aggarwal and Samwick (1999b), the compensation contract is $w = \alpha_0 + \alpha_1 \pi + \alpha_2 \theta$, i.e. compensation w is a linear function of firm performance π and observable luck θ. The optimal weight on observable luck θ is negative; i.e., in the optimal contract, luck is filtered out.

Aggarwal and Samwick (1999b) show that in the optimal contract the weights on firm performance and observable luck have the ratio $\frac{\alpha_2^*}{\alpha_1^*} = -\beta$, where β is the coefficient from a regression of firm performance on luck. That is, the more firm performance is driven by observable luck, the greater the relative (negative) weight that should be put on luck in the optimal contract. It is worth noting that their model assumes that the executive is risk averse, but that this ratio does not depend on the exact *level* of risk aversion.

We can examine the extent to which firms filter by calculating the ratio $\frac{\alpha_2}{\alpha_1}$ at the theoretical optimum versus in practice. The optimal ratio is simply 0.99, the first-stage coefficient in Table A5 – the contribution of luck to firm performance.[38] To calculate the *actual* ratio used by the typical firm, we estimate a regression with log compensation as the dependent variable and both log market value and log oil prices as explanatory variables. Full results

[38]The specification in Table A5 includes additional controls, but we show in the Appendix (Table A15) that the 0.99 estimate is not sensitive to the controls.

are given in Table A14. When we include the same controls as in Table 1, we estimate a coefficient on log market value of 0.31 and a coefficient on log oil price of -0.12.[39] The ratio of the coefficients is $\frac{\alpha_2}{\alpha_1} = -0.12/0.31 = -0.4$.

Thus in practice compensation practices are such that firms put a negative weight on oil prices that is only 0.4 times the weight put on firm performance. In contrast, the optimal contract would instead put a negative weight on oil prices that is essentially identical to the weight on firm performance. That is, for this back-of-the-envelope calculation, which abstracts away from executive marginal product effects, we see only 40 percent of the optimal level of filtering being done in practice. Not only do we not find complete filtering, but it appears that about 60 percent of observable luck is not filtered. U.S. oil and gas firms compensate their executives in a way that falls well short of this theoretical optimum.

6 Conclusion

Our analysis of pay-for-luck in the U.S. oil and natural gas industry over 1992–2016 provides strong evidence that executives are paid for luck. In our IV specification, a 10 percent increase in firm value driven by oil prices leads to a 1.9 percent increase in total executive compensation. The bulk of this pay-for-luck effect – a 1.3 percent increase – remains even after controlling for capital and labor. Across specifications, we cannot rule out that executive compensation responds just as much to changes in firm value driven by oil prices as it does to generic changes in firm value.

Moreover, our analysis supports the following additional conclusions. First, pay-for-luck is pervasive across different components of pay. Bonuses and other incentives appear to exhibit the most pay-for-luck, despite the fact that it would be relatively easy to adjust these components to filter out observable luck. Second, we find significantly less pay-for-luck in better-governed firms. Results are similar across measures of governance, and robust to controlling for firm size. Third, pay-for-luck is asymmetric. Executive compensation rises more during oil price increases than it falls during oil price decreases. Fourth, sensitivity to oil prices is much stronger for higher-paid executives, with asymmetric effects which are about twice as large as effects for lower-paid executives.

How can this pattern of pronounced pay-for-luck survive in equilibrium? If oil executives are

[39] In the Appendix, we consider two sets of robustness checks. First, results are robust to including additional measures of firm performance; see Table A16. Next, we consider a related specification used in Garvey and Milbourn (2003). Table A17 shows that their regression yields results that are equivalent to a non-linear combination of the parameters that we estimate.

overpaid when oil prices are high, relative to what a profit-maximizing firm would choose, why are outside hires not able to arbitrage away this difference? Our discussion of the Cremers and Grinstein (2014) argument provides one potential explanation. The U.S. oil and gas industry has few outsider executives, perhaps because of industry-specific human capital. In this context, it would be difficult for an outsider to arbitrage away any executive rents.

Here is an industry for which the fortunes depend to a large degree on luck. Everyone in this industry understands that oil prices are highly variable and completely out of the control of executives. So it is particularly striking that we do not see compensation practices designed to insulate executives from this volatility. By our estimates, companies are doing only about 40 percent as much filtering as they should be.

Why? Is it that oil executives are not risk averse? This seems implausible. The industry historically attracted adventure-seekers, but today's oil and gas executives are more likely to be finance and engineering experts. And for typical risk aversion parameters, Lambert et al. (1991) and Hall and Murphy (2002) show that uncertainty can significantly reduce the value of executive compensation. Moreover, we show there is relatively little movement of oil and gas executives across industries, so this provides little insurance against bad shocks.

It seems more likely that rent extraction is occurring. The governance and asymmetry results point to this, as do the additional results showing more sensitivity to oil prices for higher-paid executives. Executive compensation has become more complicated than ever. While in theory these more sophisticated mechanisms make it easier to filter out luck, in practice they also serve to obfuscate. If one thought executives had co-opted the process and were extracting as much rent as possible, one would expect to see results much like ours.

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Online Appendix: Are Energy Executives Rewarded For Luck?

Lucas Davis and Catherine Hausman

An Illustrative Example

During the last three decades one of the most influential, and highly compensated oil and gas executives in the United States was Aubrey McClendon, the cofounder of Chesapeake Energy. His professional story provides an illustrative example about what oil and gas executives do and how they add value to companies, but also about how executive compensation is set, and how conflicts of interest can easily arise with board-of-directors.

A history major at Duke University, Aubrey McClendon cofounded Chesapeake Energy in 1989. The company would go public in 1993, and during the 1990s focus on land leasing and drilling for oil and gas in Oklahoma, Texas, and, less successfully, Louisiana.

Chesapeake is one of about 130 publicly-traded U.S. oil and gas producers sometimes called the "independents." Whereas the "majors" (e.g. Shell, ExxonMobil, BP) are large integrated companies active along the entire petroleum supply chain (including giant offshore and international projects, operating refineries, and even retail), the independents are companies focused almost entirely on onshore domestic oil and gas production.[40] Independents are less corporate, and more dynamic; the natural descendants to the entrepreneurial "wildcats" that have long operated in U.S. onshore oil and gas drilling.

In what would end up being a remarkably prescient move, McClendon steered Chesapeake in the early 2000s sharply toward unconventional drilling for natural gas. McClendon didn't invent hydraulic fracturing, indeed he wasn't an engineer at all, but he was one of hydraulic fracturing's most vocal early proponents, and McClendon was uniquely skilled at convincing Wall Street to finance Chesapeake's aggressive push in this direction. As Russell Gold described in the *Wall Street Journal*, "He didn't just see the energy boom coming. He helped create it." (Gold, 2016).

Between 2004 and 2011, Chesapeake drilled more wells than any other company in the world. For much of the 2000s, these investments were extremely profitable. U.S. natural gas prices were above $6 per thousand cubic feet between 2005-2008, and Chesapeake made a fortune.

[40] On nasdaq.com, 130 U.S. "Oil & Gas Production" firms are listed as traded on either NASDAQ, NYSE, or AMEX. Another 17 U.S. companies are listed as "Integrated Oil Companies."

In 2005, Fortune magazine named McClendon one of the best-performing U.S. executives, and Chesapeake's stock price surged from $2 in 2000, to above $40 in 2008.

Alas, the 2008 market crash was not good for McClendon or Chesapeake. The stock price for Chesapeake crashed back to below $20, leading to margin calls that erased almost all of McClendon's $2 billion personal fortune. Aware of McClendon's great personal losses, the Board of Directors chose that moment to give McClendon a new five-year contract and a $75 million retention bonus (Gold, 2014), making McClendon in 2008 the second highest-paid U.S. executive in any industry.

McClendon appears in our data receiving $112M total compensation in 2008. This is a strikingly high level of executive compensation; it is in the top 0.1 percent of all executive-firm-year observations in the broader dataset, including not only oil and gas but all industries. It is also striking because Chesapeake, while a major oil and gas producer, was not even in the top 200 most valuable companies for 2008.

At Chesapeake's shareholder meeting in 2008 one long-time investor put it like this, "*Your greed and your ego took over, and you bet the farm that your success would continue. So, your two billion dollar fortune was not enough; you wanted more. But this time your hand got stuck in the cookie jar, and you couldn't let go until your own cookies were taken in the process. And after your embarrassing losses, but with a carefully picked and extremely well-compensated board of directors, Chesapeake shareholder funds were partially used to cover your losses.*"

McClendon responded directly to the investor, "*I've worked one hundred hours a week, at least since 1989 building this company So I'm sorry that you find me as egocentric and greedy. But I'll tell you there's not a harder-working guy out there who thinks every day about how to create shareholder value.*" Both quotes from Gold (2014).

The fallout over the 2008 compensation package was the culmination of many years of questionable arrangements between McClendon and Chesapeake's Board of Directors. Several of the members of the board were longtime friends of McClendon (Shiffman et al., 2012), and board members were rewarded with large salaries, use of corporate aircraft, and other generous perks. Financial conflicts-of-interest were common. For example, back in the 1990s, several members of the board-of-directors made personal loans to McClendon, an unusual arrangement that raises clear conflict-of-interest concerns.

McClendon would lead Chesapeake for another five years, but would never quite get past these concerns about the independence of the board. Finally, with mounting concerns about corporate governance, McClendon stepped down as chairman of Chesapeake in 2012, and was forced out of the company entirely in April 2013. Then in March 2016, McClendon was indicted, charged by a Federal grand jury with colluding with another company to manipulate prices for land leases. The following day McClendon died in a single-vehicle accident when the Chevrolet Tahoe he was driving ran straight into a bridge at 60 miles per hour, killing him instantly.

Data

As we describe in the paper, our analyses are based on executive compensation data from Compustat. These data have been widely used and are described in detail elsewhere:

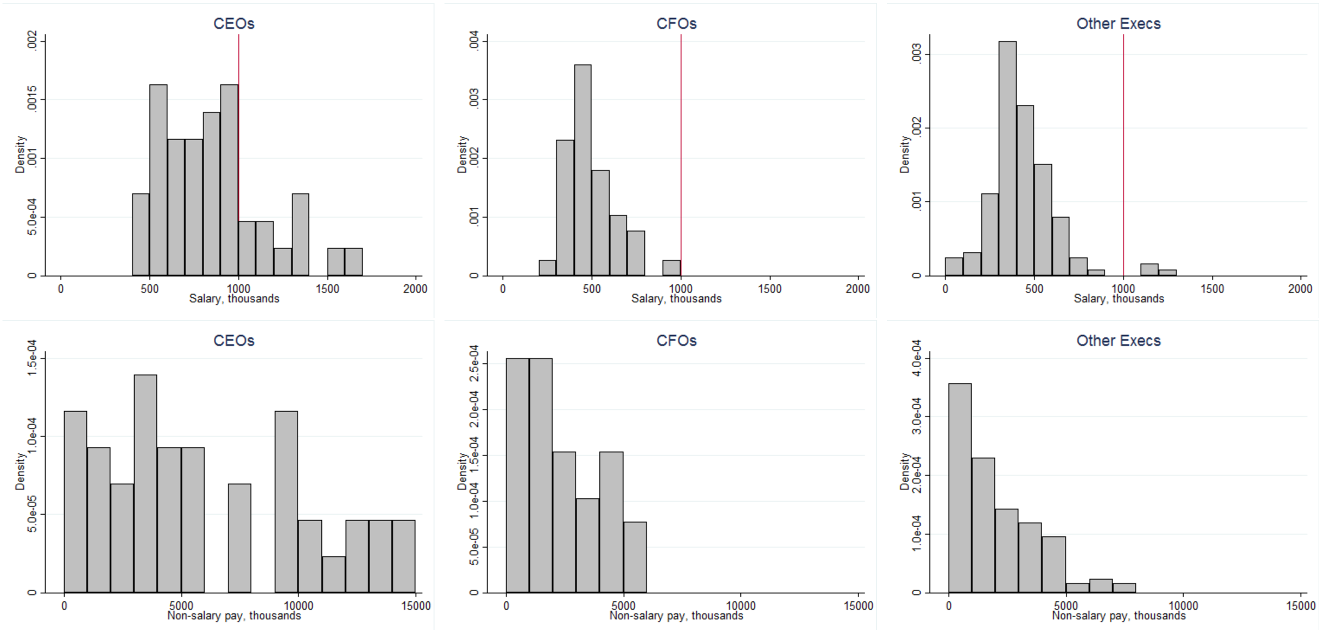
- Gine, Mireia. "WRDS E-Learning Session" [Pdf of slides]. 18 September 2009. Available at https://wrds-web.wharton.upenn.edu/wrds/E-Learning/_000Course%20Materials/ExecutiveCompensationChanges.pdf.cfm?.
- "ExecuComp Data Definitions in Alphabetical Order." https://wrds-web.wharton.upenn.edu/wrds/support/Data/_001Manuals%20and%20Overviews/_001Compustat/_007Execucomp/_005ExecuComp%20Data%20Definitions.cfm. Accessed 5 June 2018.
- "RiskMetrics Directors Definitions." https://wrds-web.wharton.upenn.edu/wrds/support/Data/_001Manuals%20and%20Overviews/_037ISS%20(formerly%20RiskMetrics)/ISS %20(formerly%20RiskMetrics)%20Directors%20Definitions.cfm

The Compustat data include S&P 1500 firms, as well as other firms. Some of the additional firms included were at one time on the S&P 1500; they continue to be included in Compustat as long as they are still trading.

Beginning in 2006, reporting for some of the variables changes. This was driven by regulatory requirements on what firms report in their annual proxy statements. The tdc1 variable, total compensation, has good continuity across time, albeit with some changes to its subcomponents.

The variables we use are listed and defined in Table A1.

Figure A1: Impact of the $1 Million Deduction Limit



Note: This figure shows histograms of nominal executive pay in 2016 for CEOs, CFOs, and other executives. The top row shows salary pay and the bottom row shows non-salary pay, in thousands of dollars. In the top row, a vertical red line at $1 million (the deduction limit) is shown.

Table A1: Variables Used

Variable	Compustat name(s)	Notes
Total compensation	tdc1	"Total Compensation."
Salary	salary	"The dollar value of the base salary earned by the named executive officer during the fiscal year."
Bonus	bonus	"The dollar value of a bonus earned by the named executive officer during the fiscal year."
Stocks and options	rstkgrnt, option_awards_blk_value, stock_awards_fv, option_awards_fv	We sum across the stock variable and the options variables in Compustat. Prior to 2006, we use **rstkgrnt** ("The value of restricted stock granted during the year (determined as of the date of the grant).") + **option_awards_blk_value** ("The aggregate value of stock options granted to the executive during the year as valued using Standard & Poor's Black-Scholes methodology.") After 2006 we use **stock_awards_fv** ("Fair value of all stock awards during the year as detailed in the Plan Based Awards table. Valuation is based upon the grant-date fair value as detailed in FAS 123R.") + **option_awards_fv** ("Fair value of all options awarded during the year as detailed in the Plan Based Awards table. Valuation is based upon the grant-date fair value as detailed in FAS 123R.")
Incentives	ltip, noneq_incent	Prior to 2006, we use **ltip** ("This is the amount paid out to the executive under the company's long-term incentive plan. These plans measure company performance over a period of more than one year (generally three years)."). After 2006 we use **noneq_incent** ("Value of amounts earned during the year pursuant to non-equity incentive plans. The amount is disclosed in the year that the performance criteria was satisfied and the compensation was earned.") As described in Hopkins and Lazonick (2016), some elements of "bonus" moved to "noneq_incent" in 2006. Also, "ltip" in some cases includes stock units, which are excluded from "noneq_incent." Since our pay-for-luck results are comparable across the various non-salary components of pay, and since we include a dummy for the reporting changes, we are reassured that these changes do not explain our pay-for-luck results.
Other compensation	othann, allothtot, defer_rpt_as_comp_tot, othcomp	Prior to 2006, we use **othann** ("The dollar value of other annual compensation not properly categorized as salary or bonus. This includes items such as: Perquisites and other personal benefits ... Tax reimbursements ...") + **allothtot** ("This is the amount listed under 'All Other Compensation' in the Summary Compensation Table. This is compensation that does not belong under other columns, which includes items such as: Severance payments, Debt forgiveness, ... Payment for unused vacation, Tax reimbursements, Signing bonuses..."). After 2006, we use **defer_rpt_as_comp_tot** ("Amount of deferred compensation earnings that were reported as compensation in the Summary Compensation Table.") + **othcomp** ("Other compensation received by the executive including perquisites and other personal benefits, termination or change-in-control payments, contributions to defined contribution plans (e.g. 401K plans), life insurance premiums, gross-ups and other tax reimbursements, discounted share purchases etc.")
Market value	mktval	"The Close Price for the fiscal year multiplied by the company's Common Shares Outstanding."
Book value	seq, txdb, itcb, pstkrv, pstkl, pstk	We use **seq+txdb+itcb-pstkrv**: the sum of "Stockholders Equity," "Deferred Taxes," and "Investment Tax Credit," subtracting "Preferred Stock." Where **pstkrv** is missing, we use **pstkl** or **pstk**. This constructed book value has a correlation of 0.996 with **seq**.
Net income	ni	"Net Income (After EI and DO)."
Assets	assets	"Total Assets"
Return on assets	roa	"Return on Assets"
Return on equity	roeper	"Return on Equity"
Employees	empl	"Employees (## Thous)"
Capital expenditures	capx	"Capital Expenditures"
Executives not on the board	execdir	We take the average across the top five executives of one minus **execdir**, "Flag to indicate that the executive served as director during the year."
Board members not insiders	classification	We use the portion of the board members with **classification**, "Independent Outsiders (I)." Thus excluded categories are "Insiders / Employees (E)" and "Affiliated Outsiders / Linked (L)." We use the same variable, along with the variables **comp_membership** and **comp_chair**, to identify compensation committee members that are not insiders. The compensation committee fields are complete only beginning in 1999.

Note: All variables are from Compustat, with the exception of "Board members not insiders," which is constructed using Institutional Shareholder Services (ISS) data.

Table A2: Company List

Company	Total executive-by-year observations	Mean compensation, millions	Market value, billions
ANADARKO PETROLEUM CORP	145	6.59	21.63
APACHE CORP	142	4.32	17.47
APPROACH RESOURCES INC	49	1.60	0.48
BARRETT RESOURCES CORP	42	0.93	1.30
BILL BARRETT CORP	53	1.79	1.26
BONANZA CREEK ENERGY INC	44	1.41	0.85
BROWN (TOM) INC	36	1.44	1.17
BURLINGTON RESOURCES INC	64	3.96	10.94
CABOT OIL & GAS CORP	128	1.91	3.81
CALIFORNIA RESOURCES CORP	19	3.88	1.34
CALLON PETROLEUM CO/DE	53	1.45	0.50
CARRIZO OIL & GAS INC	52	1.37	1.53
CHESAPEAKE ENERGY CORP	78	11.54	13.66
CIMAREX ENERGY CO	80	3.39	5.51
COMSTOCK RESOURCES INC	57	2.90	1.13
CONCHO RESOURCES INC	56	3.74	9.15
CONOCOPHILLIPS	147	7.97	62.39
CONTANGO OIL & GAS CO	52	1.30	0.70
DENBURY RESOURCES INC	78	2.60	4.07
DEVON ENERGY CORP	133	4.23	18.12
ENCORE ACQUISITION CO	20	2.00	2.05
ENERGEN CORP	127	1.45	2.41
EOG RESOURCES INC	124	4.44	19.54
EVERGREEN RESOURCES	19	1.46	0.94
FOREST OIL CORP -OLD	91	2.08	2.25
FREEPORT MCMRN OIL&GAS -REDH	50	7.63	
GEORESOURCES INC	25	0.35	0.37
GULFPORT ENERGY CORP	40	1.66	2.62
HARVEST NATURAL RESOURCES	130	1.05	0.33
HESS CORP	132	5.27	13.84
HS RESOURCES INC	44	0.66	0.40
KCS ENERGY INC	56	0.76	0.38
KERR-MCGEE CORP	71	2.33	6.04
KEY PRODUCTION CO INC	22	0.54	0.28
LOUIS DREYFUS NAT GAS CORP	20	1.22	1.43
MARATHON OIL CORP	132	4.75	17.54
MARINER ENERGY INC	21	3.50	1.70
MATADOR RESOURCES CO	36	1.50	1.52
MURPHY OIL CORP	132	2.72	7.22
NEWFIELD EXPLORATION CO	128	2.47	4.13
NOBLE ENERGY INC	129	2.87	8.52
NORTHERN OIL & GAS INC	42	2.73	0.75
NUEVO ENERGY CO	32	1.63	0.44
OCCIDENTAL PETROLEUM CORP	133	11.72	38.31
OCEAN ENERGY INC	52	2.25	2.17
ORYX ENERGY CO	31	1.09	2.91
PATINA OIL & GAS CORP	35	2.04	1.23
PDC ENERGY INC	80	1.76	1.20
PENN VIRGINIA CORP	73	1.30	0.73
PENNZENERGY CO	46	1.26	3.32
PETROHAWK ENERGY CORP	28	2.46	
PETROQUEST ENERGY INC	56	1.48	0.39
PIONEER NATURAL RESOURCES CO	140	3.00	6.98
PLAINS RESOURCES INC	62	1.64	0.37
POGO PRODUCING CO	80	1.54	2.06
PRIMA ENERGY CORP	25	0.64	0.38
QEP RESOURCES INC	45	3.00	5.00
QUICKSILVER RESOURCES INC	63	2.15	2.10
RANGE RESOURCES CORP	56	4.82	8.64
RANGER OIL LTD	39	0.51	0.98
REMINGTON OIL&GAS CP -CL B	68	0.57	0.39
REX ENERGY CORP	55	0.93	0.45
ROSETTA RESOURCES INC	45	2.03	1.77
SANTA FE SNYDER CORP	39	1.34	1.50
SILVERBOW RESOURCES INC	100	1.26	0.43
SM ENERGY CO	135	1.58	1.73
SNYDER OIL CORP	30	0.94	0.68
SOUTHWESTERN ENERGY CO	135	2.28	5.72
SPINNAKER EXPLORATION CO	12	1.20	1.34
SRC ENERGY INC	34	0.82	0.81
STONE ENERGY CORP	109	1.27	0.72
UNION PACIFIC RESOURCES GRP	28	3.36	7.15
UNIT CORP	93	1.23	1.72
UNITED MERIDIAN CORP	24	0.83	1.08
UNOCAL CORP	73	2.30	12.01
VASTAR RESOURCES INC	23	1.28	5.38
VINTAGE PETROLEUM INC	77	0.79	1.04
WISER OIL CO	53	0.45	0.13
WPX ENERGY INC	45	3.14	2.71
XTO ENERGY INC	94	11.34	8.42

Note: Compensation and market value are the mean values across all years in the sample. All variables have been normalized to reflect year 2016 dollars using the CPI-All Urban Less Energy.

Table A3: Summary Statistics

	N	Mean	Std. Dev.	Median
Executives:				
Total compensation, $000	5,045	3,258	5,959	1,639
Salary, $000	5,045	497	330	396
Bonuses, $000	5,045	402	1,935	130
Stock and option awards, $000	5,045	1,815	3,660	717
Other incentives, $000	5,045	333	1,190	0
Other, $000	5,045	211	2,173	40
CEO	5,045	0.19	0.39	0.00
Firms, financials:				
Market value, $000,000	4,679	8,486	15,950	2,587
Book value, $000,000	4,791	5,785	12,334	1,449
Net income, $000,000	5,039	267	2,110	58
Assets, $000,000	5,039	10,377	20,986	2,983
Return on assets	5,039	-0.54	25.88	3.41
Return on equity	4,888	-5.95	138.10	8.44
Employees, thousands	4,977	2.86	6.04	0.66
Capital expenditures, $000,000	4,969	1,608	2,724	627
Firms, governance:				
Executives not on the board	5,045	0.64	0.12	0.67
Board members not insiders	3,597	0.75	0.11	0.77
Compensation committee not insiders	3,568	0.95	0.08	0.99

Note: A unit of observation is an executive in a firm in a year. The sample includes the top five executives at oil and gas extraction companies (NAICS 211111) during the period 1992-2016, a total of 934 different executives at 80 different companies (unbalanced). The return on assets (equity) is the income to assets (equity) ratio, multiplied by 100. All governance measures are time-invariant: the simple mean for a firm across years. All variables have been normalized to reflect year 2016 dollars using the CPI-All Urban Less Energy.

Table A4: Pay for Performance: Robustness to Including Variance of Returns

	(1)
Log market value	0.23***
	(0.05)
Log market value X CDF(Variance of returns)	0.02
	(0.07)
CDF(Variance of returns)	-0.36
	(0.56)
Observations	3,979
Within R^2	0.52

Note: This table recreates the results from Column 1 of Table 1, adding as explanatory variables the CDF of the variance of firm returns, and the interaction between that and log market value. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A5: First Stage: The Effect of Oil Prices on Market Value

	(1) Log market value
Log crude oil price	0.99***
	(0.10)
Observations	4,673
Within R^2	0.52

Note: This table reports results from a regression of log market value on log crude oil prices, i.e. the first stage regression for Column 2 of Table 1. Consistent with the main regression (Table 1), we estimate this first stage at the executive-by-year level, even though the variable of interest varies only at the firm-by-year level. The regression includes the same controls as in the main regression. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A6: Pay for Luck: Robustness to Alternative Measures of Firm Value

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log market value	0.29***	0.19***	0.31***									
	(0.04)	(0.05)	(0.09)									
Log book value				0.28***	0.28***	0.28***						
				(0.04)	(0.08)	(0.05)						
ROE							0.17***	0.39**	0.52***			
							(0.05)	(0.16)	(0.18)			
ROA										0.62***	1.13**	1.61***
										(0.19)	(0.43)	(0.55)
First-stage F-statistic		90.61	15.04		22.71	55.54		14.33	17.95		14.11	14.18
Observations	4,673	4,673	4,673	4,304	4,304	4,304	4,547	4,547	4,547	4,673	4,673	4,673
Within R^2	0.52	0.51	0.52	0.51	0.51	0.51	0.47	0.46	0.45	0.46	0.46	0.44

Note: This table reports estimates and standard errors from 4 separate OLS and 8 separate IV estimates, aimed at assessing the robustness of the results across alternative specifications. Column 1 recreates the OLS results from Table 1, which uses market value as the firm performance measure. Column 2 recreates the results from Column 2 of Table 1, which uses market value as the firm performance measure and the December oil price as the instrument. Columns 3-12 use alternative measures of firm performance, and either OLS specifications (Columns 4, 7, 10), IV specifications using the December oil price (Columns 5, 8, 11), or IV specifications using the annual average oil price (columns 3, 6, 9, 12). *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A7: The Effect of Oil Prices on Executive Compensation, Other Industries

	(1)	(2)	(3)	(4)
Log crude oil price	0.19***			
	(0.06)			
Log oil price X I(oilgasextract)		0.19***	0.19***	0.19***
		(0.06)	(0.06)	(0.06)
Log oil price X I(other manufacturing)		0.01		0.01
		(0.04)		(0.04)
Log oil price X I(services)			0.04	0.03
			(0.04)	(0.04)
Log oil price X I(oilgassupport)				0.03
				(0.11)
Log oil price X I(refining)				0.15
				(0.11)
Log oil price X I(chemicals)				0.05
				(0.05)
Log oil price X I(utilities)				0.13**
				(0.06)
Log oil price X I(other industries)				0.05
				(0.09)
Observations	4,673	86,499	106,010	211,563
Within R^2	0.46	0.32	0.25	0.29

Note: Column 1 is identical to Column 3 of Table 1, including as controls a CEO indicator, a linear trend, the GDP growth rate, the unemployment rate, and firm fixed effects (controls not shown for space). Column 2 compares oil and gas results to non-energy related manufacturing, by including sector-specific oil price coefficients and sector-specific macroeconomic controls (the trend, GDP growth rate, and unemployment rate). Column 3 similarly compares oil and gas to services. Column 4 similarly compares oil and gas to all industries. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A8: Additional Robustness: Pay for Luck

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Log market value	0.13**	0.12**	0.11*	0.10	0.27***	0.15**	0.33**	0.15*	0.13**	0.13**	0.48***	0.12**	0.08
	(0.05)	(0.06)	(0.05)	(0.07)	(0.08)	(0.05)	(0.12)	(0.08)	(0.06)	(0.06)	(0.09)	(0.05)	(0.05)
First-stage F-statistic	76.15	39.43	85.91	50.64	61.91	75.06	157.74	75.92	75.61	72.78	74.61	56.24	52.45
Observations	4,553	4,553	4,380	2,702	1,912	4,289	4,553	853	3,696	4,920	5,307	4,553	3,791
Within R^2	0.52	0.52	0.46	0.60	0.65	0.51	0.56	0.48	0.39	0.43	0.45	0.52	0.46

Note: This table reports estimates and standard errors from 13 separate IV estimates, aimed at assessing the robustness of the results across alternative specifications. Unless stated otherwise, all columns include controls for a linear trend, GDP growth, the national unemployment rate, the firm's capital expenditures and number of employees, and a CEO dummy. Column 1 replicates Table 2, Column 4. Column 2 does not control for cyclicality. Column 3 includes person effects. Column 4 limits the sample to firms on the S&P 1500. Column 5 limits the sample to a balanced panel. Column 6 uses SIC sector definitions, rather than NAICS definitions. Column 7 weights by time-invariant firm size (assets). Column 8 limits to CEOs. Column 9 limits to non-CEOs. Column 10 uses all reported executives, rather than the top 5. Column 11 uses TDC2 rather than TDC1; this alternative compensation variable from Compustat uses the value of options exercised, rather than options granted. Column 12 uses Brent rather than WTI. Column 13 adds the log of the natural gas price as a second instrument. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A9: Components of Pay, In Levels

	(1) Salary	(2) Stocks & options	(3) Bonuses	(4) Other incentives	(5) Other pay
Log market value	-21.58	394.65	342.38**	308.34**	-38.94
	(13.89)	(358.45)	(155.98)	(141.43)	(87.95)
First-stage F-statistic	84.75	84.75	84.75	84.75	84.75
Observations	4,554	4,554	4,554	4,554	4,554

Note: This table matches Table 3, but the left-hand side variables are in levels rather than logs, to allow for zeroes. Mean values of the dependent variables are provided in Table A3. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A10: Components of Pay, Using Annual Average Oil Price

	(1) Salary	(2) Stocks & options	(3) Bonuses	(4) Other incentives	(5) Other pay
Log crude oil price, annual average	-0.02	0.17**	0.14	0.35**	0.30
	(0.03)	(0.08)	(0.11)	(0.13)	(0.22)
Log crude oil price, December	-0.03	-0.02	0.38***	0.40***	0.02
	(0.02)	(0.09)	(0.07)	(0.11)	(0.08)
Observations	4,546	3,934	3,083	1,729	4,443

Note: This table matches Table A11, but including both the annual average oil price and the December price. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A11: Components of Pay, OLS

	(1) Salary	(2) Stocks & options	(3) Bonuses	(4) Other incentives	(5) Other pay
Log market value	0.01	0.25***	0.39***	0.49***	0.06
	(0.02)	(0.07)	(0.07)	(0.11)	(0.05)
Observations	4,546	3,934	3,083	1,729	4,443

Note: This table matches Table 3, but with OLS specifications rather than IV. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A12: Governance, OLS

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: All Compensation			Panel B: Bonuses & Cash Incent.		
Log market value	0.47**	0.68***	0.61*	0.61***	1.12***	1.20**
	(0.17)	(0.16)	(0.35)	(0.21)	(0.18)	(0.46)
Log market value X Portion not on board	-0.39			-0.37		
	(0.24)			(0.31)		
Log market value X Portion non-insiders		-0.62***			-0.99***	
		(0.20)			(0.23)	
Log market value X Portion compensation committee non-insiders			-0.41			-0.85*
			(0.35)			(0.49)
Observations	4,553	3,406	3,377	4,117	3,133	3,114
Within R^2	0.52	0.56	0.56	0.45	0.51	0.50

Note: This table matches Table 4 in the main text, but using OLS rather than 2SLS. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A13: Governance Results are Robust to Controlling for Size

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: All Compensation			Panel B: Bonuses & Cash Incent.		
Log market value	0.17	0.44*	0.68**	1.07***	1.37***	1.48**
	(0.21)	(0.23)	(0.31)	(0.22)	(0.36)	(0.57)
Log market value X Portion not on board	-0.07			-0.71**		
	(0.30)			(0.34)		
Log market value X Portion non-insiders		-0.45			-1.09**	
		(0.29)			(0.44)	
Log market value X Portion compensation committee non-insiders			-0.61**			-0.97
			(0.29)			(0.61)
Log market value X Log employees	-0.00	-0.04	-0.09	-0.46	0.05	-0.04
	(0.20)	(0.17)	(0.16)	(0.55)	(0.40)	(0.40)
First-stage F-statistic	9.76	25.28	24.13	20.68	47.82	42.35
Observations	4,553	3,406	3,377	4,117	3,133	3,114
Within R^2	0.52	0.56	0.55	0.43	0.50	0.49

Note: This Table matches Table 4, but with an additional regressor to allow for heterogeneity by size. In addition to the governance interactions included in Table 4, interactions with a time-invariant measures of size (log employees) is included. The size variable has been re-scaled to have a standard deviation of a magnitude comparable to the governance variables. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A14: Coefficients for Filtering Test

	(1) OLS
Log market value	0.31***
	(0.04)
Log crude oil price	-0.12**
	(0.06)
Observations	4,673
Within R^2	0.52

Note: This table is identical to Columns 1 and 3 of Table 1, but including both market value and oil prices as explanatory variables in the same regression. The dependent variable is log total annual compensation. Controls include company effects, macroeconomic variables (national GDP growth rate and unemployment rate) and a linear trend, as well as an indicator for whether the executive is the CEO. Compensation, market value, and oil prices are normalized to 2016 dollars. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A15: Robustness of First Stage, for Optimal Filter

	(1)	(2)	(3)	(4)
Log crude oil price	0.99***	0.99***	0.93***	1.33***
	(0.10)	(0.10)	(0.11)	(0.12)
Observations	4,674	967	4,674	4,674
Within R^2	0.52	0.50	0.51	0.44

Note: The dependent variable is log market value. Column 1 is identical to Table A5. Column 2 runs the regression at the firm, rather than executive, level. Column 3 includes only firm effects and a linear trend as controls. Column 4 includes only firm effects as controls. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A16: Robustness of Filtering Test

	(1)	(2)	(3)	(4)
Log crude oil price	-0.12**	-0.09	-0.10	-0.00
	(0.06)	(0.06)	(0.07)	(0.08)
Log market value	0.31***	0.23***	0.21***	0.19***
	(0.04)	(0.04)	(0.05)	(0.04)
Log book value			0.02	0.03
			(0.06)	(0.06)
Log assets			0.18***	0.19***
			(0.06)	(0.06)
Return on equity			-0.06	-0.05
			(0.13)	(0.12)
Return on assets			0.15	0.02
			(0.39)	(0.39)
Trend (national)	0.05***	0.04***	0.03***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)
GDP growth rate (national)	-0.77	-0.96	-0.41	-0.50
	(1.50)	(1.25)	(1.28)	(1.53)
Unemployment rate (national)	0.00	-0.00	0.00	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
Log employees		0.09***		
		(0.03)		
Log capital expenditures		0.07*		
		(0.03)		
CEO indicator	0.88***	0.88***	0.88***	0.88***
	(0.04)	(0.04)	(0.04)	(0.04)
Observations	4,673	4,553	4,299	4,299
Within R^2	0.52	0.52	0.53	0.53

Note: Column 1 is identical to Table A14. Column 2 adds labor and capital controls. Column 3 adds additional measures of firm value. Column 4 adds additional measures of firm value and uses the annual average oil price. *** Statistically significant at the 1% level; ** 5% level; * 10% level.

Table A17: Luck and Skill Variables Specification

	(1) OLS
Luck	0.19***
	(0.05)
Skill	0.31***
	(0.04)
Trend (national)	0.05***
	(0.01)
GDP growth rate (national)	-1.15
	(1.57)
Unemployment rate (national)	-0.00
	(0.01)
CEO indicator	0.88***
	(0.04)
Observations	4,673
Within R^2	0.52

Note: This table reports estimates and standard errors from a regressions of log total compensation on Luck and Skill, as defined in Garvey and Milbourn (2003). Compensation, market value, and oil prices are normalized to 2016 dollars. Standard errors are two-way clustered by firm and by year. *** Statistically significant at the 1% level; ** 5% level; * 10% level.