# What Death Can Tell:
# Are Executives Paid for Their Contributions to Firm Value?*

Bang Dang Nguyen
University of Cambridge, Judge School of Business
b.nguyen@jbs.cam.ac.uk

Kasper Meisner Nielsen
Hong Kong University of Science and Technology
nielsen@ust.hk

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**Abstract**

An efficient managerial labor market should compensate executives according to their contribution to shareholder value. We provide novel empirical evidence about the relationship between executive pay and managerial contribution to value by exploiting the exogenous variation resulting from stock price reactions to sudden deaths. We find, first, that the managerial labor market is characterized by positive sorting: managers with high contributions to value obtain higher pay. We find, second, that executives appear, on average, to retain about 80% of the value they create. Overall, our results are informative about the workings of the managerial labor market.

**Keywords:** Executive Compensation, Managerial Ability, Sudden Death, Corporate Governance, Value of Top Executive

**JEL Classifications:** G3, G30

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Few topics in financial economics rival executive compensation in the degree of interest they elicit from academia, media, policymakers, and the general public. How should firms determine top executive compensation? Is executive pay related to executives' contribution to firm value? Are CEOs' contributions to shareholder value sufficient to offset their pay? Despite a rich literature on the subject, these important questions remain open avenues for research. Using the stock price reaction to sudden deaths, this paper examines the relationship between executive pay and contribution to shareholder value. We find that the managerial labor market is characterized by positive sorting: managers with high contributions to value obtain higher pay. We estimate that executives retain about 80% of their contribution.

Theories of wage determination for top executives would commonly suggest that the level of pay be set via a bargaining process between the manager and the firm. The equilibrium pay level must satisfy both parties' participation constraints and allow a split of quasi-rents from the relationship according to the relative bargaining power of the participants (Lazear and Rosen, 1981; Rosen 1992).

The growing literature on executive compensation does not, however, provide empirical evidence about whether and to what extent top executives' pay levels are set as a function of their contributions to firm value. One obvious explanation for this lack of insight is that executives' contribution to firm value is empirically hard to observe, let alone identify. We use stock price reactions to exogenous (albeit tragic) events—sudden deaths of executives—to identify executives' contributions to firm value, and examine the relationship between contribution and pay. If the managerial labor market is efficient, we expect positive sorting between managerial contribution and compensation. That is, managers with high contributions to shareholder value should receive higher compensation. Our methodology extends a line of investigation found in Johnson et al. (1985) and Hayes and Schaefer (1999), who use sudden deaths to identify managerial contribution to firm value. Although several recent papers make use of the event of sudden death, no prior studies use the methodology to test whether executives are paid for their contribution to value along the lines we propose.

We collect data on the events of the sudden deaths of 149 executives in the U.S. between 1991 and 2008. From stock price reactions to sudden deaths of executives, we estimate the value of their continued service and regress it on the ratio of total annual compensation to market capitalization under the current employment contract. The intuition behind this approach is that the stock price reaction to sudden deaths equals the expected value of the deceased executive's contribution net of compensation had he not died. Under optimal contracting, executives' compensation should be a function of their contribution to firm value. Thus, we expect positive sorting between executive contribution to firm value and compensation. Our investigation is then extended to study how rent from the firm-manager relationship is shared between executives and shareholders. From the estimated relationship between the contribution and pay, we obtain an estimate of the fraction of total rent from the firm-manager relationship that is paid out to executives as compensation.

Our analysis reveals that the managerial labor market is characterized by positive sorting between managers' contribution to value and their pay. In particular, we find a negative and significant relationship between the stock price reaction to sudden deaths and the deceased executive's total compensation measured as a fraction of firm value. Thus, executives who receive a large compensation are more valuable to shareholders. We also estimate how value created by the firm-manager relationship is shared between executives and shareholders. Results indicate that an average executive keeps approximately 80% of the value she creates. While we focus on top executives, we note that the results are identical for the subsample of CEOs.

Our paper contributes to the literature on executive compensation along several lines. First, to the best of our knowledge, this paper is the first to investigate the extent to which top executives are paid according to their contributions to shareholder value. Our approach differs from Jensen and Murphy (1990) and the pay-to-performance sensitivity literature in that we focus on the relationship between compensation and executive contributions to value. Second, our evidence for how rent from the firm-manager relationship is split between executives and shareholders is informative for the discussion on the workings of executive compensation. Third, we contribute to a growing body of literature on the value of executives by examining the link between value and compensation. Last, because our sample is random, our results can be generalized to the managerial labor market. One potential caveat with our approach is that we rely on market perceptions of managerial contributions to value. To the extent that market perception differs from true value, our contribution is to show that managers are paid for their perceived contribution to shareholder value. In that case boards pay more to CEOs who they think are better.

The paper proceeds as follows. Section I provides a survey of prior literature on executive compensation. Section II details our identification strategy. Section III describes the data. Section IV presents the results. Section V provides further evidence for the interpretation. Section VI reports robustness checks. Section VII concludes.

## I. Prior literature on executive compensation

In theory, executive pay should be designed by the board to maximize shareholder value. Optimal contracting assumes that boards bargain at arm's length with executives over their pay. However, executive compensation remains a controversial topic, as some empirical evidence appears to contradict theoretical predictions of optimal contracting. Prior literature has discussed the level and structure of executive pay intensively, resulting in three dominant views.

The first strand of literature studies the pay-to-performance sensitivity. Jensen and Murphy (1990) show that CEO wealth is only weakly related to firm performance. An increase of one thousand dollars in firm value leads to an average increase in CEO wealth of only three dollars. Subsequent literature provides abundant evidence of a significant increase in CEO pay in both absolute and relative terms since 1990, which is consistent with a better alignment of interest between managers and shareholders (Murphy, 1999; Aggarwal and Samwick, 1999; Bertrand and Mullainathan, 2001; Bebchuk and Fried, 2004; and Frydman and Saks, 2009; among others).

Another important strand of literature explains the level and the functional form of pay as "skimming" issues rather than as optimal contracting outcomes. Differences in pay are, partly, attributed to entrenchment, luck, and change in social norms relating to pay (Yermack, 1997; Bertrand and Mullainathan, 2001; Bebchuk and Fried, 2004; Kuhnen and Zwiebel, 2008; Kuhnen and Niessen, 2009, among others). According to this view, top executives have, to some extent, power and lever to set their own pay. In particular, Bebchuk and Fried (2004) point out that the use of options instead of stock, the low sensitivity of pay to performance in large firms (negative scaling), severance pay, and debt compensation (inside debt) can be better explained as governance issues than as optimal contracting outcomes. Their view, however, is challenged both theoretically and empirically (Edmans, Gabaix, and Landier, 2009; and Edmans and Gabaix, 2010).

A third strand of the literature attributes the recent increase in the level of pay to changes in the nature and risk of the CEO's job, rather than to agency problems. Gabaix and Landier (2008) show that, if we attribute the pay rise only to agency problems, an average U.S. CEO might steal 80% of their pay, which is implausible. Among the explanations for the recent pay rise are: increasing competition for scarce managerial talent (Lucas, 1978; Rosen, 1981, 1982; Frydman, 2005; Murphy and Zábojnik, 2007; and Terviö, 2008); significant growth in firm size (Gabaix and Landier, 2008); development of an international market for talent arising from globalization (Marin and Verdier, 2004); increasing firm complexity (Garicano and Rossi-Hansberg, 2006); and the use of peer group in compensation (Bizjak, Lemmon, and Naveen (2008), Hayes and Schaefer (2009), and Bizjak, Lemmon, and Nguyen, 2009). Other papers argue that new technologies change managerial function and pay (Garicano and Rossi-Hansberg, 2006; Giannetti, 2008). Tighter governance regimes are also likely to have contributed to increases in pay in response to the risk resulting from a higher rate of forced CEO turnover (Hermalin, 2005; Peters and Wagner, 2009). Relatedly, Chhaochharia and Grinstein (2009) find that CEO compensation significantly decrease in firms most affected by new board requirements to enhance board oversight following the corporate scandals in 2001 and 2002.

Despite a rich literature on executive compensation, direct empirical evidence on whether and to what extent pay reflects executives' contribution to shareholder value is scant (Frydman and Jenter, 2010). Using the event of CEO turnovers, Chang, Dasgupta, and Hilary (2009) show that the stock market reacts more negatively when highly paid CEOs leave. Taylor (2009) provides a dynamic learning model where shareholders update their beliefs about CEO ability through past stock price performance and adjust pay accordingly.

Our paper draws inspiration from a growing body of literature that uses sudden deaths to overcome the identification issues related to the contribution of top executives to shareholder value. In a seminal paper, Johnson et al. (1985) use sudden deaths of 53 executives to estimate the value of executives' continued employment. They find positive stock price reaction to the death of founder-CEOs and negative reaction to that of professional CEOs. Later papers have applied this approach to examine different roles of CEOs and chairmen (Worrell et al., 1986), the effect of inside block ownership (Slovin and Sushka, 1993), and the impact of managerial entrenchment on firm value (Borokhovich et al., 2006; and Salas, 2010, respectively). Other studies (Roberts, 1990; Fisman, 2001; and Faccio and Parsley, 2009) have used sudden deaths (or rumors of poor health) of politicians to estimate the value of having a politically connected CEO. Bennedsen, Pérez-González, and Wolfenzon (2007) study the event of the deaths of CEOs, and of their relatives, and show that CEOs are instrumental for corporate performance. More recently, Nguyen and Nielsen (2009) use sudden deaths to estimate the value of independent directors.

Our paper is similar in spirit to Hayes and Schaefer (1999). The authors compare the positive reaction to 29 sudden deaths of CEOs to the negative stock reaction when managers are raided. They attribute this difference in stock price reaction to differences in managerial ability, because raided managers are likely to have high ability, whereas suddenly deceased CEOs possess average ability. In addition, their paper discusses how the stock price reaction to the termination of employment would be a function of executives' contribution to firm value net of pay. In contrast to Hayes and Schaefer (1999), this study uses stock price reactions to examine the extent to which executives are paid for their contribution to firm value. To the best of our knowledge, our paper is the first to study the relationship between executive contributions to value and pay level.

## II. What can death tell about executive compensation?

A. Identification of executive contribution

To illustrate the pertinence of stock market reactions to sudden deaths to the question of whether executive compensation is related to executives' contributions to value, we introduce some simple notation inspired by Hayes and Schaefer (1999). Consider a firm that loses a manager as a result of sudden death. Prior to death, the deceased manager's effort influenced the value of the firm. Let $v_d$ denote the expected incremental value of cash flows under his management and $w_d$ denote the present value of expected compensation had the executive not died. After the death, the firm hires a replacement manager. Let $(v_r - w_r)$ denote the expected incremental value of the replacement net of his pay. In addition, the firm may incur replacement and search costs, which we denote $k$. The change in value of firm $i$, $\Delta V_i$, resulting from the sudden death is therefore given by:

$$\Delta V_i = (v_r - w_r) - (v_d - w_d) - k. \quad (1)$$

If search costs are low, the change in firm value provides an estimate of the deceased's net contribution to shareholder value $s_d$ ($s_d = -\Delta V_i$). Since any rent from the firm-manager relationship is divided between shareholders and managers, the total value created by the terminated firm-manager relationship, $\Pi_d$, equals:

$$\Pi_d = s_d + w_d. \tag{2}$$

Relating the estimate of deceased executive's contribution to shareholder value, $\Delta V_i$, to his compensation, $w_d$, allows us to test whether executives are compensated for their contribution to value:

$$\Delta V_i = \beta\, w_d + \varepsilon. \tag{3}$$

If executive pay is efficient, we expect $\beta$ to be negative, because an efficient labor market implies that executives are paid according to their contribution to value. Moreover, from the estimated $\beta$ we can infer how rent from the firm-manager relationship, $\Pi_d$, is shared between managers ($w_d$) and shareholders ($s_d$). From equation (3), we note that $\hat{\beta}$ estimates the average $\Delta V_i/w_d$. Assuming that $s_d = -\Delta V_i$ the fraction of rent to shareholders, $\theta$, equals:

$$\theta = \frac{s_d}{s_d + w_d} = \frac{-\hat{\beta}}{1-\hat{\beta}}. \tag{4}$$

Thus, relating the net contribution to value (the stock price reaction) to the contracting outcome provides insights that are helpful in understanding executive pay.

B. Empirical specification

We measure the change in firm value ($\Delta V_i$) due to the terminated firm-manager relationship by the cumulative abnormal return (CAR) around the sudden death. To avoid deriving spurious correlation from firm-size effects, we relate CAR to the total annual compensation as a percentage of firm value (PAYSCALE) in Equation (5), which is our empirical specification of Equation (3):

$$CAR_i = \alpha + \beta \text{ PAYSCALE} + \gamma X_i + \varepsilon. \qquad (5)$$

Equation (5) effectively relates the perceived contribution of executives to shareholder value to their current pay level. If executives are paid for their contribution to shareholder value, we expect a negative correlation, $\beta$, between CAR (contribution to value net of pay) and PAYSCALE (executive compensation). We refer to this as positive sorting between contribution to value ($s_d$) and compensation ($w_d$), which is a necessary condition for an efficient labor market for executives. Empirically we cannot, however, identify positive sorting if a large fraction of executives have extreme bargaining power. This identification problem occurs only in the special case where executives with large contributions have all the bargaining power and, thus, capture all the rent from the firm-manager relationship. In such cases the stock price reaction to sudden death is close to zero. Given that only 9 (23) out of 149 deceased executives in our sample have stock price reactions in the interval from -0.25% to 0.25% (-0.5% to 0.5%) this identification concern is not supported by our data.

In addition to the sign, the size of the $\beta$-coefficient provides information on how rent from the firm-manager relationship is shared between executives and shareholders. In the empirical specification, $\beta$ is the product of the fraction of rent shared with the shareholders and the executives' expected tenure (because compensation in Equation (5) is measured on an annual basis). Thus, from Equation (4) we note that if executives are expected to stay for $x$ years, then the fraction of rent to shareholders is $\theta = \frac{-\hat{\beta}/x}{1-\hat{\beta}/x}$, whereas managers keep (1-$\theta$).

Finally, it is worth noting that our results can be generalized because sudden deaths are randomly drawn from the population of executives. Thus, the sudden death approach is not only helpful in identifying the contribution of executives, but also in providing a random sample of executives for which we obtain new information about the workings of executive pay.

## III. Sample and data

A. Sample selection and definition of sudden deaths

The sample consists of 149 sudden deaths of executives between January 1, 1991 and December 31, 2008. A gross sample of 520 deceased executives of firms listed on AMEX, NASDAQ, and NYSE was identified by searching Factiva, Lexis-Nexis, and Edgar Online, using keyword search terms for executives (CEO, president, chairman, executive, etc.) and for death (passed away, died, deceased, etc.). The search terms do not include keywords designed to capture sudden deaths (e.g., "sudden" or "unexpected"), because of a large variation in the cited cause of death across media outlets. Rather, we perform a general search designed to identify all deceased executives; among these, we then identify sudden deaths by classifying the causes of death. Our sample of 149 executive deaths was identified from more than 10,000 newspaper articles and more than 2,000 corporate filings to the SEC related to executive changes.

Identifying the value of the services provided by executives requires that the deaths be sudden and unanticipated by the stock market. Given that we identify a gross sample of deceased executives, we attempt to apply a medical definition of sudden deaths whenever possible. Among natural deaths (deaths caused by diseases), we include heart attack and stroke, as well as cases in which the cause is unknown but the death is described as sudden and unexpected, with an absence of news about declining health prior to the death. Among unnatural deaths, we include accidents and traumatic deaths but exclude suicides, because such cases might relate to the current situation surrounding the firm.[1]

Our ability to follow such a stringent medical definition is obviously limited by our use of newspaper articles to classify causes of death. We have therefore tried to be careful to ascertain that the deaths in our sample were indeed sudden and unexpected. We verify causation by conducting additional searches for news containing the name of the executive in a one-year period surrounding his/her death. In cases of inconsistency in the reported cause of death across various sources, we include, conservatively, only events for which we find no conflicting evidence to indicate that the death is sudden and unexpected. As a result, death caused by heart attack, for example, will only be classified as sudden if we cannot find any evidence of a prior history of heart problems or declining health prior to the death. Similarly, deaths described as "sudden" or "unexpected" without a specific cause are only included if we did not find any news suggesting that the executive had health-related problems.

From the gross sample of 520 deceased executives, we identify 149 individual executives who died suddenly according to our definition. We include heart attacks, stroke, and accidents, as well as deaths for which the cause is unreported but described as unanticipated. Panel A of Table 1 reports the causes of death for all deceased executives, while Panel B shows the causes for deaths classified as sudden.

Panel A shows that, out of the 520 deceased executives in our gross sample, 149 (28.7 percent) of the deaths were, according to our definition, sudden. Of the remaining decedents, 143 executives died of cancer; 55 died from complications related to various specified diseases; 13 died from complications related to surgery; 6 committed suicide; and 78 were reported to have died from unspecified illnesses, while the cause of death is unknown for the remaining 76 cases.

[1] Our definition of sudden deaths is similar to those in Johnson et al. (1985), Faccio and Parsley (2009), and Nguyen and Nielsen (2009).

Panel B of Table 1 shows that the most common cause of sudden death is heart attack (72 cases), followed by accidents (25 cases) and strokes (10 cases). Finally, a total of 42 deaths (28.2 percent) are described in the news as sudden and unexpected without specific details about the medical cause of death.

Panel C of Table 1 reports the position of the suddenly deceased executives. Out of the total sample of 149 executives, 81 are CEOs; 28, executive presidents or chairmen; and 40, CFOs, COOs, or vice presidents.

For the sample of sudden deaths, the death date and news date were verified by an additional search of news containing the name of the executive. In cases in which the death is reported by multiple news agencies, the earliest date is assigned as the news date. Executive deaths are, on average, reported in the news with a time lag of 1.3 days, with a median of 1 day. Our sample includes one extreme case in which a firm held back the announcement for 12 days. Otherwise, the delay is mainly caused by intervening weekends. The mean-time lag between death and news dates is 0.76 trading days. Almost half of the deaths (46.3%) are reported on the day of death, and 86.6% of all firms reported within one trading day. For the remaining 20 cases, 16 reported on trading day +2, one on +3, two on +4, and one on +10.

We also check the possibility of confounding news surrounding the event. Whenever there is important corporate news from day -1 to day +1 around the news date, the events are eliminated from the sample. Examples of confounding news include announcement of quarterly earnings, important contract announcements, merger and acquisition or asset sales decisions, major strike, drug development or patent grant, and stock repurchases. A special case is the cancellation of the pending merger between Danielson Holding Corp. and Midland Financial Group, because presidents of both companies died in the same plane crash. In two cases, multiple executives from the same company were involved in the same fatal accident (Bruno Inc. suffered a devastating loss of five executives when its corporate jet crashed on December 11, 1991. Agco Corp. lost their president and vice president in a fatal private jet crash on January 4, 2002.) Executives from these special cases are excluded from the final sample because we cannot identify the value of each individual. Finally, six cases of deaths related to firms with market capitalizations of less than $10 million where stock market reactions and control variables take extreme values. To alleviate potential bias from these extreme cases, we excluded them from the analysis. Our final sample, therefore, includes 149 executives.

### B. Executive compensation

Existing studies of executive compensation rely mainly on S&P 1500 firms that are covered by the ExecuComp database. Because our sample is randomly drawn from listed firms in the United States, we cannot rely exclusively on compensation data from ExecuComp. In keeping with existing literature, we follow ExecuComp's data procedures and hand collect compensation variables from SEC Def14a filings to calculate total annual compensation. Our measure of total annual compensation is identical to the *tdc1* variable in Execucomp.

For most compensation items, we can directly observe the dollar value from the SEC filings. For options, we follow ExecuComp's valuation procedures by calculating the Black-Scholes (BS) value, using dividend yield and volatility data from Compustat. To assess the accuracy of our ability to follow this procedure, we check the consistency of the calculated BS-value with the information provided by ExecuComp for S&P 1500 firms in our sample. Generally, our estimate exactly matches the value reported in ExecuComp. For the few cases showing a discrepancy, our estimate provides option values close to ExecuComp values. Thus, our measures of executive compensation match the data used by prior literature. In addition, it is worth noticing that option values in ExecuComp after 2006 change from BS-value to fair value. To avoid inconsistencies, we use our hand-collected data and estimate BS-values for the entire sample period.

### C. Descriptive statistics

Table 2 provides descriptive statistics for our sample of deceased executives. Panel A reports individual characteristics. The average (median) CEO age is 59.4 years (60 years), which is slightly higher than the sample average (median) of 59.0 (58.0) years. A substantial variation exists in executive age, with a range at the time of death from 38 to 91 years, and 98.7 percent of our executives are male.

Panel B of Table 2 reports firm characteristics. The average firm in our sample has $1.5 billion in market capitalization, a market-to-book ratio of assets of 2.4, and an average age of 36.6 years.

Panel C shows statistics on executive compensation. Total compensation averages $1,102,200 ($273,700 in salary; $162,800 in bonus; $352,000 in option and restricted stock; and $313,700 in other forms) with a median of $456,700. The average CEO was compensated with $1,424,400, whereas other executives received, on average, $718,500. The difference in compensation is mainly driven by higher option and restricted stock grants and access to other forms of compensation. The average (median) executive in the ExecuComp universe, for instance, receives $2,128,200 ($940,300) in total compensation ($374,200 in salary, $314,900 in bonus, $962,600 in option and restricted stocks, and $476,500 in other forms). At the same time, the average (median) S&P 1500 firm has market capitalization of $7.2 billion ($1.5 billion)—larger than our event firms. Not surprisingly, therefore, executives in S&P 1500 firms receive larger compensation than do a random sample of listed firms in the United States.

## IV. Are executives paid for their contribution to value?

In this section, we first relate the stock return in the period coincident with the sudden death of executives to their total annual compensation. Second, we decompose total compensation into market pay and abnormal pay using an out-of-sample approach based on firm and industry characteristics.

## A. Stock price reactions to sudden deaths

To examine the stock price reaction to sudden deaths, we access daily returns from the Center for Research in Security Prices (CRSP) for each of our 149 events for an eleven-day period around the death (from day -5 to day +5). The event day is defined as the trading day of the executive's death or the first trading day following the death, if it occurred on a non-trading day. To calculate the abnormal return, we follow the standard event study approach and assume a single-factor model, where beta is estimated using the data from the pre-event window. We obtain almost identical results using market-adjusted returns and, therefore, only present results from the market model.

Panel A in Table 3 presents the time series of abnormal returns for the eleven trading days around the death date. We report the mean abnormal return and the number of positive and negative abnormal returns for each of the trading days. Panel A indicates that, on average, a small and negative share price adjustment is associated with the unexpected loss of executives. In particular, the stock price reaction on the days surrounding the death is negative for three straight days, from day -1 to +1. This pattern suggests that deaths are incorporated into market prices in the period from the death until the event becomes publicly known to all market participants. We also observe that stock reactions on average become positive from day +2 to +3, which tend to be the days during which the firms nominate the interim executive or replacement.

In Panel B we report event study results for valuation effects of sudden deaths of executives. Cumulated average abnormal returns are calculated for the two-, three-, and four-day event windows from day -1 to 0, -1 to +1, and -1 to +2, respectively (day 0 is the death date). We note that the CARs are negative, but insignificant.

In general, our analysis will use the event window from -1 to +1 around the death date.[2] This approach is motivated by two observations. First, our definition of sudden death allows for a 24-hour time interval from the change in the prior clinical state until sudden death. Our sample includes cases in which the media reports that an executive has been hospitalized because of a heart attack, stroke, or accident that occurs on day -1, and that result in death the following day. Second, it takes, on average, 0.76 trading day before the death is reported and covered in the news.

When compared with findings in prior literature on the value of CEOs, our findings of average stock price reactions of -1.22% differ. Johnson et al. (1985) find that the sudden death of founder CEOs increases the stock price by 3.5%, while the death of non-founding CEOs causes the stock price to drop by 1.16%. Hayes and Schaefer (1999) find positive and larger effects, as sudden CEO death increases the stock price by 2.84%. Salas (2010) finds that, on average, stock prices increase by 0.9% following the sudden death of top executives. Our sample covers a more recent time period, whereas prior papers include deaths as far back as 1971. As a result we have fewer founders in our sample (21.4% in our sample versus 31.9% in Johnson *et al.* (1985) and 27.7% in Salas (2010)) In addition, our study includes other top executives, rather than focusing exclusively on CEOs.

The cumulative abnormal return of -1.22%, equivalent to $18.8 million, is our estimate of the executive's contribution to firm value net of pay. If executives are expected, for example, to stay in their positions for 10 years, total contribution to value equals $29.8 million ($18.8 million + 10 years * $1.1 million of annual compensation). Thus, the univariate results indicate that an average executive retains approximately 37% (11/29.8) of the value he/she creates. In the following subsection, we explore the relationship between pay and the stock price reaction in the cross-section.

[2] In a robustness check in Section VI, we propose alternative event windows, including one anchored around the news date. Our results are not affected in any meaningful way by the definition of the event date.

B. Executives' contributions to value and their pay

In Table 4 we relate the value of executives' continued service to their pay. Panel A provides descriptive statistics on the size of the stock market reaction for all executives, CEOs and other executives, respectively. For each type, we report the average CAR, total annual compensation, and PAYSCALE (total compensation divided by market capitalization) for firms with positive and negative CARs, respectively. Average (median) PAYSCALE in our sample equals 0.61% (0.22%) of firm value. PAYSCALE varies substantially, from a minimum of 0% to a maximum of 9.36%. Part of this variation reflects our use of total annual compensation in the year before death. In Section VI.D we show that results from the main analysis are not affected by outliers in PAYSCALE. Results are consistent when we use the two- or three-year average compensation before death to compute PAYSCALE, or when we estimate the relationship using a median regression.

Panel A shows large variations in the stock price reaction to sudden deaths. Although the average CAR is negative, 67 out of 149 events are associated with positive CARs, with an average (median) market reaction of 4.99% (2.35%). For firms with negative stock price reactions, the average (median) CAR equals -5.77% (-3.33%). Perhaps more interestingly, the level of pay is larger in firms with positive CARs. On average these executives are paid $1,221,000, as compared to $1,015,000 for executives with negative CARs. However, this picture is reversed when we scale pay by market capitalization. Executives with positive CARs are paid 0.5% of firm value on an annual basis, as compared to 0.69% for executives with negative CARs. Thus, there appears to be a negative correlation between PAYSCALE and the value of continued employment.

When the sample is divided into CEOs and other executives, an identical picture emerges. CEOs with positive CARs get higher compensation in dollar terms but a lower share of firm value than do CEOs with negative CARs. Interestingly, these differences appear larger for CEOs than for other executives.

In Panel B we take the first step toward estimating the relationship between the value of continued employment and PAYSCALE as described in Equation (5) in Section II. In Column 1 we find a negative and significant relationship between PAYSCALE and the executives' net contributions to value. The estimated beta coefficient equals -2.39, and is significant at the one-percent level. This finding is consistent with positive sorting between executives' contributions to value and their pay, which is a necessary condition for an efficient managerial labor market.

In our framework managers with positive (negative) stock price reactions are paid more (less) than the total rent from the firm-manager relationship. If managers are overpaid we expect a positive correlation between the stock price reaction and compensation. To bolster our interpretation of the empirical test we therefore split the sample according to the sign of the cumulative abnormal return. In Column 2 we find a positive correlation between PAYSCALE and contribution to value for executive with positive CARs. In Column 3 we find a negative and significant correlation between CARs and PAYSCALE for executives with negative stock price reactions. While we cannot infer how rent is shared, these results confirm our conjecture that stock price reactions to sudden deaths are informative about the level of pay.

Our baseline estimate of beta equals -2.39 for all executives. This number reflects the product of the expected years of continued service and the fraction of the executives' contribution to firm value accruing to shareholders. If executives, on average, are expected to hold their positions for ten years, the beta estimate implies that for 123.9 cents of value created by the executive, shareholders will get 23.9 cents (2.39/10), while the executive keeps 100 cents. The executive's share of rent ($1/(1-\beta/x)$) increases with the number of expected years of service, $x$. Thus, if executives are expected to hold their positions for ten years, our estimate implies that out of one dollar of value created, 19.3 percent will go to shareholders, while 80.7 percent will go to the top executive. Section V provides a detailed discussion and analysis of the expected tenure to provide a more precise interpretation of this important result.

C. Controlling for other determinants of executives' contribution to value

Our analysis, so far, does not take other determinants of executives' contributions to value into account. In particular, Johnson et al. (1985) show that founder CEOs differ from professional CEOs. Worrell et al. (1986) focus on differences between CEOs and other executives, and Salas (2010), on the effect of executive tenure. Moreover, executives' financial interest in their firms might come primarily from ownership, rather than from compensation. In this section we incorporate these potential determinants as well as general firm characteristics in our regressions. Table 5 reports the results.

Column 1 of Table 5 introduces the control variables subject to most scrutiny in prior studies. We find a negative but insignificant effect of founders, and a positive and significant effect of executive ownership. The result on founder CEOs contrasts with Johnson et al. (1985), but is consistent with Salas (2010), who finds that the founder effect is reversed when controlling for managerial ownership. Thus, presence of founders is valuable to shareholders, while high executive ownership is not. Stock market reactions to CEOs appear more positive, although the effect is insignificant. Executive age has a positive and significant correlation with contribution to value, while tenure is negative and insignificant. These results are consistent with Salas (2010), who examines CEO death over a longer time period. More importantly, the coefficient of PAYSCALE remains negative and significant when founder, CEO, ownership, age, and tenure effects are taken into account.

In Column 2, we introduce standard firm characteristics as controls: market capitalization, market-to-book ratio of assets, return on assets, and volatility. Again, there is little impact on our variable of interest. PAYSCALE remains negative and significant at the five-percent level. The estimated beta coefficient equals -1.70, which is slightly smaller than the results reported in Table

4. We further note that determinants of pay such as firm size and volatility can only influence our results if these also affect the stock price reaction. In the following section we further partition pay into market and abnormal pay, and show that our results in Table 5 are not affect by omitted determinants of compensation.

In Column 3, we include governance characteristics (board size, outsider ratio, and staggered board) that might impact both the contribution to value and executive compensation. In general we find no significant effects of governance characteristics on the cumulative abnormal return. Our variable of interest, PAYSCALE, is not affected by the inclusion of governance variables in the empirical specification.

In Columns 4 and 5 we split the sample based on the sign of the stock market reaction. Consistent with the findings in Table 4, we find a positive and significant correlation between value and PAYSCALE for firms with positive CARs, and the opposite for firms with negative CARs. Finally, Column 6 shows results for the subsample of CEOs which are strikingly similar to the those reported for the full sample in Column 3.

Results from Table 5 confirm the findings from the parsimonious model in Table 4. We obtain broadly consistent results on the relationship between executives' compensation and their contributions to firm value when including the control variables from prior studies.[3]

D. Market versus abnormal pay

Stock price reactions might include an assessment of the replacement cost of the deceased executive and the market pay for the replacement. In our prior tests, we cannot exclude the possibility that the correlation between pay and contribution to value is driven by high replacement costs or by the deceased's compensation relative to the expected replacement. The prospect of high search costs might induce higher current executive pay or higher compensation

[3] For the sake of presentation and exposition of our main results, Tables 6, 7, 8, and 9 include the same control variables, but do not report the estimated coefficients.

for the replacement. Similarly, Cremers and Grinstein (2009) argue that hiring costs depend on the industry talent pool. When firms hire outside managers, they tend to benchmark pay to the industry level and to rely more on equity-based compensation. In such cases, our results might be due to search costs and industry effects, rather than to compensation for contribution to value.

To address this issue we follow prior literature and decompose pay into two components: market pay and abnormal pay (Core, Holthausen, and Larcker, 1999; Murphy, 1999; Bebchuk and Fried, 2003, 2004). Market pay is the fraction of pay that can be explained by firm size, industry, and operating performance, while abnormal pay measures the residual. In this model, search costs are anticipated by the market and included in the measure of market pay. Abnormal pay, on the other hand, measures whether the executive is paid more or less in comparison to the benchmark. Thus, relating abnormal pay to the contribution to value overcomes the concern related to search costs and the compensation level of the replacement.

Prior literature provides helpful insights into the interpretation of market and abnormal pay for our settings. Gabaix and Landier (2008) argue that more talented executives are allocated to large firms, leading to increases in compensation as a function of firm size. If this assumption is correct, market pay should correlate negatively with the stock price reaction to sudden death.

Existing literature on the link between abnormal pay and shareholder value provides mixed results. Using the event of CEO turnovers, Chang, Dasgupta, and Hilary (2009) provide evidence that high relative CEO pay is positively related to the market's perception of CEO ability. By contrast it is often argued that abnormal pay is a good measure of whether the executive is paid more than her contribution to firm value. In particular, a large body of literature interprets positive values of abnormal pay as evidence of entrenchment and rent extraction (Core, Holthausen, and Larcker, 1999; Murphy, 1999; Bebchuk and Fried, 2003, 2004). Inherently, these arguments suffer from the same identification problem we previously mentioned: ability and contribution to value are unobserved. Thus, abnormal pay could, in principle, capture both high ability and entrenchment.

Results from Table 6 shed light on this debate. In Columns 1 to 3, we use different compensation models to decompose executive compensation into market and abnormal pay using data from the ExecuComp universe. Following the approach of Core, Holthausen, and Larcker (1999); Murphy (1999); and Gao, Harford, and Li (2009) we calculate abnormal pay as the difference between the actual and predicted total annual compensation from our benchmark model:

$$Pay_{it} = a_0 + a_1 X_{i,t} + \varepsilon_{i,t} \tag{6}$$

where $X$ includes firm size (market capitalization), stock return over the last 12 months, return on assets, market-to-book, volatility, and industry and time effects. The estimated residual—actual pay minus predicted pay—measures abnormal pay. The predicted pay from our benchmark model measures market pay resulting from firm and executive characteristics.

In Column 1, the compensation model only includes industry and year effects. We find surprisingly similar results for both components of pay. The beta for market pay equals -2.03, as compared to -1.79 for abnormal pay. Thus, both components of pay have a negative and significant correlation with net contribution to value. In Column 2, we include market capitalization in the compensation model, and find betas of -2.42 and -2.58, respectively.

In Column 3, we regress total pay on market capitalization, stock return, return on asset, market-to-book ratio of assets, volatility and industry and year effects. In Column 4 we add control variables to our regression of interest. Column 4 provides betas of -1.66 and -1.75 for market and abnormal pay, respectively. We obtain the same results for the subsample of CEOs as reported in Column 7.

In summary, we find little difference between market and abnormal pay. Understanding the potential explanation for this lack of difference proves interesting. Results in Columns 5 and 6 are helpful in sorting out why there are no differences between market and abnormal pay. We show results for executives with positive and negative stock market reactions, respectively. For executives with positive CARs, both market and abnormal pay are positively and significantly related to the net contribution to value. Apparently, some low-ability executives get assigned to larger firms with higher pay. This allocation suggests that inefficiencies in CEO assignment exist, as found in Edmans and Gabaix (2010). However, Column 6 provides evidence of positive sorting between talent and firm size. Talented executives get assigned to larger firms and correspondingly enjoy higher compensation. Our results suggest that the mismatch is dominated by the sorting between talent and firm size as suggested by Gabaix and Landier (2008). Abnormal pay identifies entrenched executives only when the stock market reaction is positive. For executives with negative CARs, abnormal pay is negatively and significantly related to the net contribution to value. Collectively, although abnormal pay might capture both entrenchment and ability, the negative and significant correlation between CAR and PAYSCALE in the full sample suggests that the ability effect dominates.

### E. Managerial ownership and founding families

Another source of compensation for executives is from share ownership rather than direct compensation. For executives with large ownership, most of their financial interest in the firm comes from ownership, not compensation. In this case, executives pay a fraction of their own compensation. Thus, our result on rent sharing might be biased. While we so far include the level of managerial ownership in our regressions, the fraction of rents shared with shareholders might depend on whether the executive is a professional (with little direct ownership) or a member of the founding family. In this section, we explore the impact of managerial ownership and founding families on our results.

Managerial ownership varies from 0% to 89.7%, with an average (median) of 9.1% (1.6%), in our sample. Of the 149 deceased executives, 97 have less than 5% ownership. In Table 7, we focus on professional executives with small ownership stakes. Column 1 restricts the sample to executives holding less than 5% of outstanding shares. We obtain a beta coefficient of -3.21, which means that, with an average tenure of 10 years, 75.8 percent of the rent from the firm-manager relationship is being paid out as compensation. In contrast, we obtain a beta of 5.77 when the deceased's ownership is above 5%, in Column 2.

In total, 32 out of our 149 deceased executives are founders or co-founders of the firm. In Column 3, we restrict the sample to non-founder executives. For this subsample we find a beta of -2.58. Again, this contrasts with the evidence in Column 4, in which we estimate beta on the subsample of founders. For founders, beta equals 9.24. Thus, as hypothesized by Johnson et al. (1985), founders have greater power to set their own pay, and end up extracting more rents than they contribute. In Column 5, we confirm these insights by restricting the sample to professional executives who are non-founders and hold less than 5% of equity. For this subsample we still find a negative and significant beta.

Columns 1 to 5 demonstrate that our results on rent sharing are not significantly affected by issues related to managerial ownership or founding families. In contrast, our results suggest that powerful insiders extract more rent than they contribute, whereas professional executives, on average, do not.

## V. Interpretation

An important component in the interpretation of our results is the deceased executive's expected tenure. In an interesting interpretation of our results, the expected tenure could be estimated to infer more precisely how value is split between executives and shareholders. We rely on evidence from existing studies as well as on an empirical model of expected tenure, using data from ExecuComp.

### A. Prior literature on executive tenure

Using a long time series of executive employment, Huson, Parrino, and Starks (2001) provide estimates of expected tenure. Over the sub-period from 1989 to 1994, they estimate a one-year turnover frequency of 11.2 percent, implying that the average CEO serves for 8.9 years. However, their sample is dominated by large firms in which turnover is likely to occur more frequently. In comparison, Denis and Denis (1995) estimate a 9.3 percent turnover frequency for a more representative sample, implying an average tenure of 10.8 years. Kaplan and Minton (2008), on the other hand, argue that actual CEO turnover is higher because prior studies focus only on turnover in ongoing companies. When turnover caused by bankruptcy and takeovers is taken into account, annual CEO turnover in the period from 1992 to 2005 increases to 15.6%—equivalent to an average tenure of 6.4 years.

Our estimate of how rent from the firm-manager relationship is shared between executives and shareholders depends on expected tenure. If the expected tenure is 10.8 years, as in Denis and Denis (1995), then, according to Model 1 in Table 5, the executives and shareholders split the value created from the firm-manager relationship in the proportion of 83 against 17 in favor of the executive. However, if the expected tenure is 6.4 years, as in Kaplan and Minton (2008), then, the value split is 75 versus 25. One immediate concern with this simple approach is the need to condition on age to obtain a more precise estimate of expected tenure.

### B. A model of expected tenure

To evaluate our results, we estimate the expected tenure of deceased executives based on turnover frequencies in the ExecuComp database. We first estimate a probit model of the one-year turnover probability controlling for total annual compensation, executive age, return on assets, and industry and year effects. Expected tenure is calculated as the inverse of the predicted turnover probability from this model. On average, 16.3% of the executives in our sample are expected to leave the firm within the following year, implying an average expected tenure of 6.1 years and an average retirement age of 65 years. Thus, our conditional estimate of expected tenure is slightly lower than the unconditional estimate for the average CEO in Denis and Denis (1995), and Huson, Parrino, and Starks (2001). We attribute part of this difference to the fact that executive turnover has recently increased (Peters and Wagner, 2009).

In Table 8 we refine our model of the relationship between executive contribution to value and the present value of executive pay by interacting PAYSCALE with expected tenure. The interacted term essentially captures the present value of total pay during the expected tenure of the executive. More importantly, the estimated coefficient will reveal the expected fraction of value created by the executive that is paid out in compensation. Column 1 presents the baseline result for all executives. In correspondence with prior results, we find a negative and significant relationship between executives' contribution to value and the present value of pay. The estimated coefficient of -0.236 implies that for 1.236 dollar of wealth created, the executive keeps 100 cents (80.8% of total wealth created), while shareholders obtain 23.6 cents (19.2% of total wealth created).

Recognizably, our model cannot factor in all the characteristics that affect expected tenure. In Columns 2 and 3, we restrict the sample to executives for which the estimated retirement age takes reasonable values. Column 2 restricts the sample to executives who are expected to retire before the age of 75 (i.e., the sum of current age and expected tenure is lower than 75). Column 3 caps the expected retirement age at 70 years. In Column 4, we restrict the sample to CEOs. Our results are remarkably similar across these subsamples.

One potential problem with our estimation of expected tenure is that the turnover probability is likely to increase in age and spike around retirement ages (e.g., 65, 70, and 75), before returning to lower levels. To address this issue we construct a half-life estimate of expected tenure from our probit model. For each executive, we estimate the number of years it takes for the predicted cumulative turnover probability to reach 0.5. This half-life estimate is then doubled to obtain an estimate of expected tenure. The half-life estimation yields an average expected tenure of 9.6 years for our sample. We then interact the half-life estimate of expected tenure with PAYSCALE and re-run the regression. Results are reported in Columns 5 and 6 of Table 8. We obtain coefficients of -0.18 for all executives and -0.177 for CEOs. The half-life model, thus, estimates that rent from the firm-manager relationship is shared in the proportion of 84.7 versus 15.6 percent in favor of the executive.

In summary, our results suggest that the value created by the firm-manager relationship is split 80/20 in favor of the executive. One caveat related to the interpretation is that our model specifications assume that we are counting all of the compensation that executives earn. Our pay measures are based on SEC disclosure rules. Before 2006, there were incomplete disclosures about perks and no disclosure about deferred compensation and pensions. To the extent that SEC disclosures under-count executive compensation, managers might capture more than 80% of the rents from the firm-manager relationship. However, for a sample of S&P 1500 firms, Grinstein, Weinbaum, and Yehuda (2009) show an average value of perks of $127,200, which represents 6% of an average executive's total compensation in ExecuComp.[4] Thus, unreported perks are unlikely to change our main results. We reach similar a conclusion in Section V.C, below, in which we investigate the impact of contingent pay, i.e., deferred compensation and pension.

## C. Contingent payment upon death

Another potential caveat to our analysis is that the stock price reaction might reflect contingent payments upon executive deaths. For example, if the employment contract implies that firms have to pay significant incremental compensation to the deceased's estate, the stock reaction might reflect this payment rather than the executive's contribution. Furthermore, our

[4] Our average firm is smaller than the average S&P 1500. A more appropriate benchmark for the level of perks is S&P Midcap 400 or SmallCap 600 indices, with total perks equal to $102,900 and $44,900, respectively.

cross-sectional results on the relationship between compensation and contribution to value might be spurious if such contingent payments are a function of annual compensation. In this case, the estimated beta coefficient will reflect the relationship between contingent payment and annual compensation, rather the relationship of interest.

Unfortunately, before 2007, firms were not obliged to disclose information on contingent payments to executives in cases of retirement, resignation, or death. To alleviate the concern that our results are driven by undisclosed contingent payments, we examine executive deaths occurring after the spring of 2007, when SEC regulation required firms to report previously unseen information about aspects of executive compensation, including severance pay.

In total, we have 8 events occurring after the new SEC-imposed disclosure requirements. In general, we find that contingent payments include deferred cash compensation (pension benefits); base-salary balance payments; and options and restricted stocks with immediate vesting and shortened exercise. Because deferred benefits would have to be paid out irrespective of the death, these benefits have no impact on the stock price reaction. Base-salary balance payments refer to a firm's practice of paying the base salary for the full calendar year— continuing after the death. Thus, for the average firm in our sample, this incremental contingent payment would amount to six months of base salary, equivalent to $136,900, which is a tiny fraction of the average loss of $18.8 million in market capitalization. For options, it appears to be standard that firms allow immediate vesting, but shorten the exercise period to a maximum of one year after death.[5] This practice will change the value of granted options and restricted stocks. Dahiya and Yermack (2008) analyze this effect for a sample of S&P 500 firms, and find that "sunset" provisions reduce the value of equity compensation when managers retire, resign, or die. If this effect holds for the average firm, contingent payments related to sunset provisions are negative.

[5] Seven out of eight firms have a policy of immediate vesting and a one-year exercise period. One firm uses immediate vesting and an up-to-three-year exercise period. In comparison, Dahiya and Yermack (2008) find an average exercise period of 3.15 years after deaths in a sample of S&P 500 firms.

In summary, no mechanical or significant relationship appears to exist between contingent payments and total annual compensation. Thus, the uncovered relationship between executive pay and contribution to value is unlikely to result from contingent payments upon death.

## VI. Alternative specifications and robustness checks

In this section we provide additional evidence, using alternative specifications of our event study. Our robustness analysis focuses on three important issues: a) confounding news, b) the event dates, c) our sample of sudden deaths, and d) the potential impact of outliers in PAYSCALE. Table 9 summarizes this exercise.

### A. Confounding news

Our sample-selection procedure pays particular attention to confounding news by excluding firms with important corporate events surrounding the sudden deaths. Examples of confounding news include announcements of earnings, merger and acquisition decisions, and news on a major strike, etc. The results we report in the above sections derive from the final sample that already excludes events with confounding news.

### B. Alternative specifications of the event study

The focus of our analysis on the three-day event window, from -1 to +1, is motivated by three observations: first, although we use a strict definition of sudden death, news about heart attacks, strokes, and accidents can occur on day -1. Second, the announcements of deaths in local and regional newspapers are, as noted by Johnson et al. (1985), likely to precede announcements in national newspapers, such as the *New York Times* and *Wall Street Journal*. Thus, the share price reaction might occur before the news date obtained from search engines, such as Factiva and LexisNexis. Our third observation is that the average death is reported with a time lag of less than one trading day (reduced to 0.7 day if we exclude a single outlier), which means that the stock price reaction on average occurs fairly close to the actual date of death. As the chosen event date specification is simply one among several possibilities, Table 9 reproduces our main result, using two alternative approaches. Column 1 shows the results when we use the two-day event window surrounding the news announcement date. In Column 2, we follow the approach suggested by Johnson et al. (1985) and focus the empirical tests on a firm-specific announcement period, defined as the trading period from the event date to the news date. As roughly 75% of our events have an announcement period of one trading day or less, and more than 94% of the deaths are reported within two trading days, the announcement period is quite short for the majority of the sample.

Collectively, we find a negative and statistically significant correlation between stock market reaction and PAYSCALE of similar magnitude to the estimated effect using windows around the date of deaths (Column 3 of Table 5). Thus, our results appear to be consistent and robust to alternative specifications of the event window.

C. Age of executives and known cause of death

Another valid concern with the sudden death literature relates to the sample selection. To be able to measure empirically the stock price reactions, deaths are required to be both sudden and unexpected by the stock market. Although our definition of sudden deaths attempts to ensure that these two conditions are satisfied, executive age implies an increased probability of mortality and discontinuation of service. Simply put, a sudden death of an eighty-year-old executive might not be as surprising as the sudden death of a fifty-year old. Similarly, the probability of retirement will also bias the stock market reaction.

We address this concern by conducting complementary tests that take age into consideration. We first restrict the sample to executives who are aged 65 or under at the time of death. Column 3 of Table 9 shows a beta coefficient of -1.84. We take the robustness exercise one step further by requiring that we know the causes of death. In this subsample, we find a beta coefficient of -1.25, as is reported in Column 4.

In summary, Table 9 provides evidence that our results are robust to alternative specifications of the event study and to our sample selection of sudden and unexpected deaths.

D. Alternative measures of compensation

We have used the compensation of the year before the death as our main measure of executive pay. The possibility remains that this one-year benchmark does not, somehow, represent the average pay level. Although our sudden death approach provides us with a random sample of executives, we provide further evidence that our results are robust to this specification.

In Column 5 of Table 9, we compute an average PAYSCALE by scaling the two-year average compensation by market capitalization. We obtain a beta of -2.304, which is slightly lower that the estimates in Table V. In an unreported regression we obtain a beta of -3.32 if we average over three years. The sample size, however, decreases to 76, as a result of the lack of data. To overcome this issue we have calculated average PAYSCALE based on data availability. Thus, for executives with three years of data, we take an average over three years, and for executives with two years of data, we take an average over two years, whereas we use the annual compensation, if compensation data are only available for that year. We obtain a beta of -2.18, which is similar to prior results.

Outliers in PAYSCALE might also affect our estimate of beta. In particular, we note large variation in PAYSCALE—even when we average over several years of compensation data. To evaluate the effect of outliers on our results, we run a median regression of Equation (5). A median regression minimizes the sum of the absolute residuals rather than the sum of the squared residuals, thereby reducing the bias caused by potential outliers in the data. Column 6 of Table 9 reports the estimated beta coefficient from the median regression. When we reduce the weight placed on outliers in the data, we obtain a slightly larger and more significant beta coefficient of -2.087. It follows that outliers do not drive our main finding of positive sorting between executive contribution to value and pay.

In summary, Table 9 provides evidence that our results are robust to alternative specifications of the event study and to our sample selection of sudden and unexpected deaths.

## VII. Conclusions

This paper attempts to investigate whether executive compensation is related to executive contributions to firm value. Our underlying idea is that if the managerial labor market is efficient, managers should be compensated according to their contribution to value. While constituting tragic events, sudden deaths offer exogenous identification of the value of executives' continued service. Indeed, because executive compensation is the outcome of a bargaining process through which any rent from the firm-manager relationship is shared with shareholders, we can identify whether and how this occurs.

Compiling a sample of 149 executives who suddenly died in the United States from 1991 to 2008, we find that, following death, stock prices drop by 1.22% on average. Since the average capitalization of firms in our sample is $1.5 billion, average firm value decreases by almost $18.8 million. We also find large variation in stock reactions: the stock price declines (increases) for around 60% (40%) of the executives.

More importantly, we find positive sorting between managerial ability and compensation. That is, managers with higher contribution to shareholder value receive higher compensation. Our approach also allows us to estimate how value created by managers is shared between executives and shareholders. Results indicate that executives appear, on average, to retain approximately 80% of the value they create. This fraction appears large, and is subject to debate and discussion. On the one hand, the sizeable fraction (80%) might reflect the prospect of the scarcity of managerial talent. On the other hand, our results also show that some executives profit from entrenchment. Overall, the results are informative about the workings of the managerial labor market.

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## Table 1.
## Cause of Executive Deaths

This table reports the composition of our sample of executives of AMEX-, NASDAQ-, and NYSE-listed firms who suddenly died between the dates of January 1, 1991 and December 31, 2008. Based on the cause of death cited in newspaper reports of the deaths, Panel A classifies the causes into: *cancer*; *complications from specified diseases* (other than cancer); *complications from surgery*; *sudden death* (accidents, heart attack, strokes, and deaths described as sudden and unexpected with no other cause cited); *suicide* (self-inflicted gunshots; death from carbon-monoxide poisoning); *unspecified illness* (cause of death described as brief or long illness); and *undisclosed* (in cases where no cause is reported but the death is not described as sudden or unexpected). Panel B shows the reported cause of death for the subsample of sudden deaths from Panel A. Panel C shows the positions held by the suddenly deceased executives.

| | **N** | **Share of total** |
|---|---|---|
| *A. Cause of death* | | |
| Cancer | 143 | 0.275 |
| Complications from specified diseases | 55 | 0.106 |
| Complications from surgery | 13 | 0.025 |
| Sudden death | 149 | 0.287 |
| Suicide | 6 | 0.012 |
| Unspecified illness | 78 | 0.150 |
| Undisclosed | 76 | 0.146 |
| All | 520 | 1.000 |
| *B. Cause of sudden death* | | |
| Heart attack | 72 | 0.483 |
| Stroke | 10 | 0.067 |
| Accident or murder | 25 | 0.168 |
| Sudden and unexpected death, but unspecified cause | 42 | 0.282 |
| All | 149 | 1.000 |
| *C. Position held by suddenly deceased executive* | | |
| CEO | 81 | 0.544 |
| President and Chairmen | 28 | 0.188 |
| Other executives: CFO, COO, and Vice Presidents | 40 | 0.269 |
| All | 149 | 1.000 |

**Table 2.**
**Descriptive Characteristics of Executives Who Suddenly Died**

This table reports descriptive statistics for our sample of executives of AMEX-, NASDAQ-, and NYSE-listed firms who suddenly died between January 1, 1991 and December 31, 2008. We follow a strict definition of sudden death from medical literature, which defines sudden death as an unexpected death that occurs instantaneously or within a few hours of an abrupt change in the person's previous clinical state. We also include accidental and traumatic deaths that are unanticipated by the stock market and unrelated to current firm conditions. Panel A reports the following executive characteristics: *age* (measured in years); *gender* (indicator taking the value one if the executive is male); and *tenure* (measured in years). Panel B shows the following firm characteristics: *market capitalization* (in millions of $); *market-to-book ratio* of assets; and *firm age* (measured in years). Panel C reports executive compensation in $1,000s: *salary*; *bonus*; *options and restricted stocks*; *other compensation*; and *total compensation*. Option grants are valued using the Black-Scholes formula, following documentation from ExecuComp. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

| | **All** | **Type of Executive** | | | |
|---|---|---|---|---|---|
| | | **CEO** (1) | **Other** (2) | **Difference** (1)-(2) | **t-stat** |
| *A. Executive characteristics* | | | | | |
| Age (years) | 59.00 | 59.44 | 58.47 | 0.97 | 0.553 |
| Gender (male=1) | 0.987 | 0.988 | 0.985 | 0.002 | 0.124 |
| Tenure (years) | 9.426 | 9.469 | 9.375 | 0.094 | 0.061 |
| *B. Firm characteristics* | | | | | |
| Market capitalization (mill. $) | 1541.7 | 1259.6 | 1877.8 | -618.2 | -0.822 |
| Market-to-book ratio | 2.364 | 2.683 | 1.948 | 0.698 | 1.209 |
| Firm age (years) | 36.58 | 34.42 | 39.14 | -4.73 | -0.829 |
| *C. Executive compensation (in thousand $)* | | | | | |
| Salary | 273.7 | 302.9 | 239.0 | 64.0 | 1.736* |
| Bonus | 162.8 | 129.1 | 203.0 | -73.9 | -1.232 |
| Option and restricted stocks | 352.0 | 532.3 | 137.1 | 395.2 | 1.647 |
| Other compensation | 313.7 | 460.1 | 139.4 | 320.7 | 1.065 |
| Total compensation | 1102.2 | 1424.4 | 718.5 | 705.9 | 1.544 |
| N | 149 | 81 | 68 | | |

## Table 3.
## The Stock Price Reaction to Sudden Death of Executives

This table shows the stock price reaction to the sudden death of executives. Panel A shows the mean abnormal return for each trading day from five days before the death to five days after. Panel B shows the cumulative abnormal return for various event windows surrounding the death date. In addition to the mean abnormal return, we report the corresponding Patell Z-score and the number of positive and negative stock price reactions. Our sample includes executives of AMEX-, NASDAQ-, and NYSE-listed firms who died suddenly between the dates of January 1, 1991 and December 31, 2008. We follow a strict definition of sudden death from medical literature, which defines sudden death as an unexpected death that occurs instantaneously or within a few hours of an abrupt change in the person's previous clinical state. We also include accidental and traumatic deaths that are unanticipated by the stock market and unrelated to current firm conditions. $^{***}$, $^{**}$, and $^{*}$ denote significance at the 1, 5, and 10 percent levels, respectively.

| Trading day / Event window | N | Mean abnormal return | Patell Z | Number of Positive: Negative | Median return | Sign rank test |
|---|---|---|---|---|---|---|
| *A. Daily abnormal returns* | | | | | | |
| -5 | 149 | 0.15 | 0.505 | 78:71 | 0.02 | 1.288 |
| -4 | 149 | -0.47 | -0.343 | 69:80 | -0.10 | -0.190 |
| -3 | 149 | 0.09 | -0.768 | 65:84 | -0.21 | -0.846 |
| -2 | 149 | 0.23 | 0.744 | 71:78 | 0.06 | 0.139 |
| -1 | 149 | -0.17 | -0.380 | 76:73 | 0.01 | 0.959 |
| 0 | 149 | -0.74 | -0.381 | 66:83 | -0.43 | -0.982 |
| +1 | 149 | -0.32 | -0.732 | 72:77 | -0.09 | 0.303 |
| +2 | 149 | 0.42 | 1.692** | 79:70 | 0.13 | 1.452* |
| +3 | 149 | 0.35 | 0.122 | 74:75 | -0.07 | 0.631 |
| +4 | 149 | 0.05 | -0.276 | 69:80 | -0.08 | -0.190 |
| +5 | 149 | -0.15 | -1.579* | 70:79 | -0.22 | -0.025 |
| *B. Cumulative abnormal returns* | | | | | | |
| (-1,+0) | 149 | -0.90 | -0.538 | 74:75 | -0.04 | -0.631 |
| (-1,+1) | 149 | -1.22 | -0.861 | 63:86 | -0.59 | -1.174 |
| (-1,+2) | 149 | -0.80 | -0.100 | 67:82 | -0.48 | -0.518 |

## Table 4.
## Executives' Contributions to Firm Value and Their Pay

This table shows the relationship between the value of executives' contribution and their annual pay. Panel A reports descriptive statistics on the value of continued service and total compensation. The value of continued service is estimated by the stock price reaction in the event window from (-1,+1) around the death date. Total compensation is the sum of salary, bonus, option and stock grants, and other compensation that the executive received in the year prior to his death. PAYSCALE is total compensation scaled by market capitalization. Panel B shows OLS regressions of the value of continued service on PAYSCALE. t-stats are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

***A. Descriptive Statistics***

| | | | **Executive type** | | | |
|---|---|---|---|---|---|---|
| | **All** | | **CEOs** | | **Others** | |
| **Stock market reaction** | **Positive** | **Negative** | **Positive** | **Negative** | **Positive** | **Negative** |
| CAR (-1,+1) | | | | | | |
| Mean | 4.99 | -5.77 | 6.50 | -6.84 | 3.21 | -4.48 |
| Median | 2.35 | -3.33 | 3.98 | -4.07 | 2.34 | -2.42 |
| Total compensation (mill. $) | | | | | | |
| Mean | 1.221 | 1.015 | 1.492 | 1.375 | 0.902 | 0.582 |
| Median | 0.391 | 0.462 | 0.496 | 0.482 | 0.371 | 0.357 |
| PAYSCALE (total comp./market cap.) | | | | | | |
| Mean | 0.50 | 0.69 | 0.53 | 0.95 | 0.45 | 0.39 |
| Median | 0.22 | 0.20 | 0.24 | 0.29 | 0.22 | 0.10 |
| N | 63 | 86 | 34 | 47 | 29 | 39 |

**B. OLS Regressions**

| | **All executives** | | | **CEOs** | | |
|---|---|---|---|---|---|---|
| **Stock market reaction** | **All** | **Positive** | **Negative** | **All** | **Positive** | **Negative** |
| | **1** | **2** | **3** | **4** | **5** | **6** |
| PAYSCALE | -2.385*** | 4.772*** | -3.389*** | -2.762*** | 5.867*** | -3.403*** |
| | (-3.98) | (4.87) | (-7.67) | (-3.63) | (4.21) | (-7.16) |
| R-squared | 0.097 | 0.280 | 0.412 | 0.132 | 0.357 | 0.533 |
| N | 149 | 63 | 86 | 81 | 34 | 47 |

**Table 5.**
**Executives' Contribution to Firm Value and Their Pay**

This table shows the relationship between the value of executives' contribution and their annual pay. The dependent variable is the stock price reaction in the event window from (-1,+1) around the death date. *PAYSCALE* is total compensation (sum of salary, bonus, options and stock grants, and other compensation) scaled by market capitalization. *Founder* equals one if the executive founded the firm. *CEO* is an indicator for chief executive officers. *Ownership* is the percentage ownership held by the deceased executive. *Age* and *tenure* are measured in years. *Market capitalization* is log. of firm market capitalization. *Market-to-book* is the market to book ratio of assets. *Return on assets* is operating profits over book value of assets. *Board size* is the number of directors on the board. *Volatility* is the 60-month standard deviation of the monthly stock return. *Outsider ratio* is the fraction of outside directors on the board. *Staggered board* is an indicator if election to the board is staggered. t-stats are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

| **Stock market reaction** | **All**<br>**1** | **All**<br>**2** | **All**<br>**3** | **Positive**<br>**4** | **Negative**<br>**5** | **CEOs**<br>**6** |
|---|---|---|---|---|---|---|
| PAYSCALE | -2.179*** | -1.704** | -1.689** | 4.708*** | -2.619*** | -1.594** |
| | (-3.65) | (-2.59) | (-2.55) | (3.65) | (-5.44) | (-2.03) |
| Founder | -0.026 | -0.025 | -0.021 | -0.017 | -0.021 | 0.025 |
| | (-1.41) | (-1.37) | (-1.16) | (-0.77) | (-1.13) | (0.92) |
| CEO | 0.012 | 0.008 | 0.008 | 0.019 | 0.010 | |
| | (0.09) | (0.57) | (0.59) | (1.25) | (0.83) | |
| Ownership | 0.001* | 0.001** | 0.001** | 0.001* | -0.001 | 0.001 |
| | (1.96) | (1.99) | (2.01) | (1.74) | (-1.35) | (1.62) |
| Age | 0.002*** | 0.002*** | 0.002*** | -0.001 | 0.001** | 0.003*** |
| | (3.08) | (3.15) | (2.88) | (-0.39) | (2.09) | (2.77) |
| Tenure | -0.001 | -0.001 | -0.001 | 0.001 | -0.001 | -0.001 |
| | (-0.70) | (-0.83) | (-0.68) | (0.85) | (-0.03) | (-0.33) |
| Market capitalization | | 0.004 | 0.002 | 0.005 | 0.005 | -0.003 |
| | | (0.98) | (0.38) | (0.98) | (1.04) | (-0.45) |
| Market-to-book ratio | | -0.005** | -0.005* | 0.002 | -0.001 | -0.005 |
| | | (-2.11) | (-1.97) | (0.32) | (-0.63) | (-1.54) |
| Return on assets | | 0.014 | 0.011 | -0.108** | 0.027* | -0.002 |
| | | (0.71) | (0.57) | (-2.16) | (1.91) | (-0.07) |
| Volatility | | -0.009 | -0.008 | -0.07 | 0.001 | 0.016 |
| | | (-0.89) | (-0.75) | (-0.50) | (0.07) | (0.77) |
| Board size | | | 0.001 | 0.004 | 0.001 | 0.004 |
| | | | (0.20) | (0.85) | (0.26) | (0.96) |
| Outsider ratio | | | 0.044 | 0.041 | 0.009 | 0.112* |
| | | | (1.19) | (0.91) | (0.28) | (1.85) |
| Staggered board | | | 0.008 | 0.001 | -0.003 | 0.033 |
| | | | (0.51) | (0.08) | (-0.28) | (1.56) |
| R-squared | 0.194 | 0.264 | 0.273 | 0.480 | 0.582 | 0.421 |
| N | 149 | 149 | 149 | 63 | 86 | 81 |

## Table 6.
## Market Level versus Abnormal Pay

This table shows the relationship between the value of executives' contribution and a decomposition of compensation into market level and abnormal pay. In our compensation model, we run a regression of total compensation on market capitalization, stock return (12-month), return on assets, market-to-book, volatility (60-month), industry, and year effects. Market-level compensation is the predicted component of pay from the compensation model, whereas abnormal pay is the residual. Both components are then scaled by market capitalization. The dependent variable in our main regression is the cumulative abnormal return from the event window from (-1,+1) around the death date. Control variables include: founder; CEO; age; tenure; ownership; log of market capitalization; market-to-book ratio of assets; return on assets; volatility, board size; outsider ratio; and staggered board. t-stats are in parentheses. $^{***}$, $^{**}$, and $^{*}$ denote significance at the 1, 5, and 10 percent levels, respectively.

| **Stock market reaction** | **All**<br>**1** | **All**<br>**2** | **All**<br>**3** | **All**<br>**4** | **Positive**<br>**5** | **Negative**<br>**6** | **CEOs**<br>**7** |
|---|---|---|---|---|---|---|---|
| Market level PAYSCALE | -2.027$^{***}$ | -2.417$^{***}$ | -2.406$^{***}$ | -1.663$^{**}$ | 5.302$^{***}$ | -2.566$^{***}$ | -1.628$^{**}$ |
| | (-3.15) | (-4.02) | (-3.95) | (-2.46) | (4.21) | (-5.26) | (-2.06) |
| Abnormal PAYSCALE | -1.789$^{**}$ | -2.581$^{***}$ | -2.565$^{***}$ | -1.754$^{**}$ | 4.490$^{***}$ | -2.629$^{***}$ | -2.061$^{***}$ |
| | (-2.50) | (-3.94) | (-3.86) | (-2.43) | (3.63) | (-4.99) | (-2.34) |
| Control variables | No | No | No | Yes | Yes | Yes | Yes |
| R-squared | 0.111 | 0.112 | 0.100 | 0.274 | 0.572 | 0.590 | 0.433 |
| N | 149 | 149 | 145 | 145 | 61 | 84 | 80 |
| **Compensation model** | | | | | | | |
| Market cap | | Yes | Yes | Yes | Yes | Yes | Yes |
| Stock return | | | Yes | Yes | Yes | Yes | Yes |
| Return on Assets | | | Yes | Yes | Yes | Yes | Yes |
| Market-to-book | | | Yes | Yes | Yes | Yes | Yes |
| Volatility | | | Yes | Yes | Yes | Yes | Yes |
| Industry effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

## Table 7.
## Managerial Ownership and Founding Families

This table shows the relationship between the value of executives' contribution and their annual pay. The dependent variable is the stock price reaction in the event window from (-1,+1) around the death date. *PAYSCALE* is total compensation (sum of salary, bonus, options and stock grants, and other compensation) scaled by market capitalization. *Founder* equals one if the executive founded the firm. *CEO* is an indicator for chief executive officers. *Ownership* is the percentage ownership held by the deceased executive. *Age* and *tenure* are measured in years. *Market capitalization* is log. of firm market capitalization. *Market-to-book* is the market to book ratio of assets. *Return on assets* is operating profits over book value of assets. *Volatility* is the 60-month standard deviation of the monthly stock return. *Outsider ratio* is the fraction of outside directors on the board. *Board size* is the number of directors on the board. *Outsider ratio* is the fraction of outside directors on the board. *Staggered board* is an indicator if election to the board is staggered. t-stats are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

| **Sample** | **Ownership stake < 5%** | **Ownership stake ≥ 5%** | **Non-Founder** | **Founders** | **Non-founders with ownership stake < 5%** |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| PAYSCALE | -3.206*** | 5.773*** | -2.579** | 9.236*** | -2.950*** |
| | (-5.51) | (3.22) | (-4.94) | (2.73) | (-5.10) |
| Founder | 0.053* | -0.063** | | | |
| | (1.94) | (-2.36) | | | |
| CEO | 0.005 | 0.037 | -0.007 | 0.053 | -0.010 |
| | (0.03) | (1.40) | (-0.60) | (1.25) | (-0.65) |
| Ownership | 0.005 | 0.001 | 0.001* | -0.001 | 0.006 |
| | (0.95) | (0.88) | (1.83) | (-0.68) | (0.97) |
| Age | 0.001 | 0.003** | 0.002*** | 0.003 | 0.002** |
| | (1.35) | (2.50) | (2.86) | (1.40) | (2.14) |
| Tenure | -0.001 | -0.001 | 0.001 | -0.001 | -0.001 |
| | (-0.75) | (-0.50) | (0.14) | (-0.47) | (-0.75) |
| Market capitalization | -0.002 | 0.022** | -0.001 | 0.025 | -0.001 |
| | (-0.41) | (2.05) | (0.18) | (1.29) | (-0.03) |
| Market-to-book ratio | -0.002 | -0.010** | -0.003 | -0.020 | -0.002 |
| | (-0.79) | (-2.32) | (-1.66) | (-0.54) | (-0.82) |
| Return on assets | 0.029 | -0.005 | 0.029* | -0.120 | 0.027 |
| | (1.63) | (-0.11) | (1.81) | (-1.54) | (1.51) |
| Volatility | 0.012 | -0.008 | 0.013 | -0.012 | 0.020 |
| | (0.70) | (-0.59) | (0.90) | (-0.63) | (1.16) |
| Board size | 0.001 | 0.009 | -0.002 | 0.020 | -0.001 |
| | (0.19) | (1.19) | (-0.08) | (1.49) | (-0.04) |
| Outsider ratio | 0.001 | 0.098 | 0.043 | 0.127 | 0.051 |
| | (1.66) | (1.11) | (1.43) | (0.76) | (1.53) |
| Staggered board | -0.003 | 0.043 | 0.003 | 0.031 | -0.005 |
| | (-0.20) | (1.53) | (0.30) | (0.62) | (-0.37) |
| R-squared | 0.450 | 0.547 | 0.505 | 0.543 | 0.469 |
| N | 97 | 52 | 117 | 32 | 91 |

## Table 8.
## Expected Tenure and Pay for Contributions

This table shows the relationship between the value of executives' continued service and their pay during their expected tenure. Expected tenure is estimated from a model of turnover probability using data from the ExecuComp universe. The expected turnover is the predicted turnover from a probit regression. In Columns 1 to 4, the expected tenure estimate equals one divided by the one-year predicted turnover probability. In Columns 5 and 6, expected tenure is estimated by a half-life turnover probability model. The half-life model estimates the number of years it takes for the cumulative turnover probability to reach 0.5. This half-life estimate is then doubled to obtain an estimate of expected tenure. We interact the predicted expected tenure with *PAYSCALE*, which equals total annual compensation scaled by market capitalization. The dependent variable in our main regression is our cumulative abnormal return from the event window from (-1,+1) around the death date. Control variables include: founder, CEO, age, tenure, ownership, log. of market capitalization, market-to-book ratio of assets, return on assets, volatility, board size, outsider ratio, and staggered board. t-stats are in parentheses. $^{***}$, $^{**}$, and $^{*}$ denote significance at the 1, 5, and 10 percent levels, respectively.

| **Sample** | **All** | **Age + exp. tenure < 75 years** | **Age + exp. tenure < 70 years** | **CEOs** | **All** | **CEOs** |
|---|---|---|---|---|---|---|
| **Exp. tenure model** | **1-year probability** | **1-year probability** | **1-year probability** | **1-year probability** | **Half-life** | **Half-life** |
| | **1** | **2** | **3** | **4** | **5** | **6** |
| PAYSCALE * Expected tenure | -0.236$^{**}$ (-2.20) | -0.232$^{**}$ (-2.06) | -0.244$^{**}$ (-2.04) | -0.285$^{***}$ (-2.15) | -0.180$^{**}$ (-2.54) | -0.177$^{**}$ (-2.09) |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.269 | 0.288 | 0.268 | 0.423 | 0.277 | 0.420 |
| N | 141 | 119 | 106 | 76 | 141 | 76 |
| **Turnover probability model** | | | | | | |
| Total compensation | Yes | Yes | Yes | Yes | Yes | Yes |
| Age | Yes | Yes | Yes | Yes | Yes | Yes |
| Return on assets | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry effects | Yes | Yes | Yes | Yes | Yes | Yes |

**Table 9.**
**Alternative Specifications of Event Study, Compensation, and Estimation Method**

This table shows the relationship between the cumulative abnormal returns to the sudden death of executives and their *PAYSCALE* for alternative specifications of the event samples and event windows. *PAYSCALE* is the total annual compensation scaled by market capitalization. *Average PAYSCALE* is the average total compensation in the last two years scaled by market capitalization. Column 1 shows the CARs around the news date. Column 2 reports CARs for the period from death date (day -1) to the news date. Columns 3 to 6 report CARs from (-1,+1) around the death date. Column 3 includes only executives aged 65 or under. Column 4 includes only executives with a known cause of sudden death. Column 5 includes executives with two years of compensation data. Column 6 is a median regression on the full sample. t-stats are in parentheses. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

| **Event sample** | **All** | **All** | **Age ≤65** | **Known cause** | **All** | **All** |
|---|---|---|---|---|---|---|
| **Event date** | **News** | **Death** | **Death** | **Death** | **Death** | **Death** |
| **Event window** | **(-1,0)** | **(-1, news date)** | **(-1,+1)** | **(-1,+1)** | **(-1,+1)** | **(-1,+1)** |
| **Estimation method** | **OLS** | **OLS** | **OLS** | **OLS** | **OLS** | **Median regression** |
| | **1** | **2** | **3** | **4** | **5** | **6** |
| PAYSCALE | -1.328*** | -1.517*** | -1.836** | -1.249* | | -2.087*** |
| | (-2.82) | (-2.74) | (-2.51 ) | (-1.68) | | (-7.64) |
| Average PAYSCALE | | | | | -2.304*** | |
| | | | | | (-3.34) | |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| R-squared | 0.299 | 0.334 | 0.299 | 0.305 | 0.285 | |
| N | 149 | 149 | 119 | 107 | 137 | 149 |