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ABSTRACT

The Importance of Luck in Executive Promotion Tournaments: Theory and Evidence*

We empirically test whether executives' increases in base salary when promoted to CEO result from the wage bids of competing firms (i.e., "market-based tournaments") or from the strategic choices of the firm's board of directors to elicit optimal executive incentives (i.e., "classic tournaments"). Our test emphasizes the effect of the "importance of luck" (i.e., the variance of luck) on the pay raises that accompany promotion. Specifically, we focus on how that effect differs between the two types of tournaments. An estimated negative relationship between the importance of luck and the executive salary spread supports market-based tournaments, whereas a positive relationship supports classic tournaments. The results are non-monotonic in firm size. Executive tournaments in both the bottom 13% of firms (i.e., total assets below $376 million) and the top 2.5% of firms (i.e., total assets above $112 billion) are more consistent with classic tournaments, whereas the nearly 85% in the middle of the distribution of firm size are more consistent with market-based tournaments. Also, controlling for firm size, highly concentrated product markets are more consistent with market-based tournaments. Extending market-based tournament theory to allow executives to choose the luck variance reveals that executives infuse their tournaments with a high luck variance, which lowers the expected pay differential and depresses incentives.

JEL Classification: G32, G39, J31, M12

Keywords: executive compensation, promotion tournaments, importance of luck, uncertainty in promotion contests, classic and market-based tournaments, vertical pay disparity, firm size, market structure

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1. Introduction

Even within the elite circle of richly compensated executives in an organization's C-suite, the Chief Executive Officer (CEO) typically stands out as the highest paid executive, often by a considerable margin. This pay disparity is even more striking given that firms generally promote their CEOs from within rather than recruiting them from other firms (Cziraki and Jenter 2022). When the CEO's seat vacates, the firm's other executives in the C-suite compete to fill it. While those competitors may vary in their talents, the fact that they reached the C-suite generally means that they are high performers and tough competitors. Although one executive ultimately prevails and becomes the CEO, the substantial pay premium that the winner typically reaps would seem to reflect more than a pure talent differential.

How, then, should we think about the big pay gap between the CEO and the firm's other executives? What generates it? The accounting and finance literatures on executive compensation have analyzed those questions in the context of "classic" tournament theory (Lazear and Rosen 1981). From that perspective, the firm's board of directors chooses pay spreads strategically to elicit optimal effort from the (non-CEO) executives who compete for the CEO's job. That perspective ignores the role of the competitive labor market in allocating executive talent across organizations. Omitting labor market competition from the debate over the sources of executive wage differentials is puzzling for at least two reasons.

First, in thinking about pay determination in most other (i.e., non-executive) labor markets, it is common and natural to discuss employers' competition for workers' services.

Second, theoretical models of "market-based" tournaments are available. Specifically, a recently growing literature in labor economics concerns "market-based" tournaments, which are based on asymmetric employer learning in the executive labor market, with pay spreads determined by the bids of competing firms in auctions for executive talent. That literature is largely theoretical, and the existing evidence is mainly based on non-executive labor markets outside of the United States. The logic underlying market-based tournaments derives from Waldman (1984). The idea is that executives' current employer has better information about their abilities than do competing employers. When an executive is promoted to CEO, competing employers interpret that promotion as a positive signal of the executive's ability and are, therefore, willing to offer higher pay to that executive than to those who did not get promoted. Consequently, to retain the CEO after a promotion the current employer must increase their compensation enough to prevent the CEO from being poached.

In addition to making a theoretical contribution to be described shortly, this study addresses three empirical questions. First, are the compensation prizes in executive promotion tournaments chosen strategically by the firm's board of directors to create optimal incentives for the firm's (non-CEO) executives, or are they determined by labor market competition? Second, is the evidence of market-based tournaments, should it exist, stronger in large firms? Third, is the evidence of market-based tournaments, should it exist, stronger in firms that operate in a highly concentrated product market (controlling for firm size)?[1]

The rationale for the latter two empirical questions concerns the degree to which a firm is "visible" to competing firms in the executive labor market that could potentially poach the firm's executives. Large firms (and therefore their executives) are more prominent and visible, and get

[1] Several prior studies have explored the connection between product market characteristics and the executive labor market. Jung and Subramanian (2021) provide theory and empirical evidence highlighting the link between firms' product markets and CEO labor markets. They show that search frictions in the CEO labor market, agency conflicts, and product market characteristics interact to affect CEO labor market tightness, firm size, and CEO incentive pay. Jung and Subramanian (2017) provide a structural industry equilibrium model to examine how competitive CEO-firm matching and product markets jointly determine firm value and CEO pay. Their results show that changes in product market characteristics significantly affect firm size and CEO pay. Li, Lu, and Philips (2019) examine the relationship between product market conditions and CEO power, finding that firms are more likely to have powerful CEOs in product markets with more entry threats.

more media attention, than small firms. Similarly, even for firms of identical size, those in highly concentrated product markets are more visible than those in less concentrated markets.

The answer to our first empirical question has important policy implications, discussed in section 8. But answering that question is hard because the empirical implications of classic and market-based tournaments are nearly identical (Waldman 2013). To make headway, we apply an insight from DeVaro and Kauhanen (2016), which shows that the variance of luck[2] in the promotion contest affects promotions in fundamentally different ways between the two tournaments. Specifically, in classic tournaments the luck variance has a positive effect on the executive pay spread, whereas the effect is negative in market-based tournaments.

In the non-executive sample from Finland analyzed in DeVaro and Kauhanen (2016), no empirical measure of the luck variance was available, so a direct test of the preceding prediction was impossible. An advantage of the executive context is that we can construct a natural measure of the within-tournament variance of the luck faced by tournament contestants. Our innovation here is twofold, first in developing an empirical measure of the "importance of luck" in executive promotion tournaments and, second, in using it to conduct the first empirical test in which the sign of its coefficient in a regression of the executive pay spread reveals whether executive promotion tournaments are classic or market-based.[3]

Our results based on the full sample are consistent with market-based tournaments given that increases in the measured importance of luck are associated with smaller executive base salary spreads, with those smaller spreads arising from lower CEO base pay rather than higher

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[2] The variance of luck is the variance of an additive, mean-zero stochastic term that determines the individual performances of each of the tournament's contestants who compete for promotion. In executive tournaments, the contestants themselves might be able to influence this variance through their choices (e.g., choosing corporate strategies). In section 6, we extend market-based tournament theory to capture that idea.

[3] Lord and Saito (2012) show evidence that CEO salaries are positively related to the income risk associated with the equity-based components of the executive compensation package, consistent with the theory of compensating differentials. They do not study the pay gap between the CEOs and firm's other executives. Treating the executive pay gap as the independent variable, Du, Huang, and Jain (2019) find that it relates negatively to a firm's credit risk.

base pay for the non-CEO executives. However, that result exhibiting, on average, evidence of market-based tournaments masks a non-monotonicity in firm size. Specifically, our results support classic tournaments in both the bottom 13% of firms (i.e., less than $376 million in total assets) and the top 2.5% (i.e., above $112 billion in total assets), whereas for the nearly 85% of firms in the middle of the firm size distribution, the results support market-based tournaments.[4]

An interpretation of this non-monotonicity result is as follows. Once a firm reaches a very large size and is therefore already quite visible, further size increases bring little further increase in visibility for its executives. But another effect may operate for those executives. Their opportunities to “upgrade” (i.e., change jobs to become an executive at an even larger firm) are relatively scarce because their current firm is already near the top of the size distribution. The thin job market these very-large-firm executives face reduces the likelihood that they will be poached. This weakening of the competitive pressure from the market-based mechanism makes it easier for boards of directors to commit to wage levels for these executives, as required in classic tournaments. Very large firms can then focus more on using executive pay spreads to create executive incentives. Small firms can do the same because their executives are less visible in the labor market, which lessens competitive pressure.

Our results also support market-based tournaments in settings with high concentration in the product market, controlling for firm size.

The theoretical literature on market-based tournaments assumes that the tournament’s luck variance is a pre-determined parameter that executives treat as exogenous. Our theoretical contribution extends the theory to make this parameter endogenous, i.e., we allow executives’ decisions to affect the luck variance in the tournaments in which they compete. This extension is

[4] Our evidence supporting market-based tournaments in the majority of firms complements work by Cziraki and Jenter (2022), who interpret their results as supporting asymmetric learning in the executive labor market. As we discuss in section 8, their study and ours are mutually reinforcing.

easily motivated, i.e., given that executives exert considerable influence over the firm's operation and strategic direction (e.g., which product lines or geographic markets to enter), often they can influence, at least to some extent, the uncertainty that affects tournament outcomes.[5] We show formally that executives increasingly amplify the luck variance in their own tournaments, which in a market-based setting reduces the expected pay gap between themselves and the CEO, thereby lowering their incentives to exert (costly) effort because the size of the pay increase they can expect to receive upon promotion is smaller. This result is noteworthy because this executive strategy would have exactly the opposite effect in a classic tournament.

Our study contributes by: 1) applying the theory of market-based tournaments to show how a new measure of a tournament's luck variance can be used to empirically distinguish such tournaments from classic tournaments; 2) providing empirical evidence that the relationship between a tournament's luck variance and the executive pay spread is negative, on average, as predicted by market-based tournaments; 3) showing that the second result masks a non-monotonicity in firm size, with small and the very largest firms (based on total assets) appearing more consistent with classic tournaments; 4) showing that evidence of market-based tournaments is stronger in firms in highly concentrated product markets (holding firm size constant); and 5) extending market-based tournament theory to make the luck variance endogenous and showing that executives amplify the luck variance in their tournaments, thereby lowering the expected pay gap between themselves and the CEO and weakening their incentives to exert costly effort.

The study is organized as follows. Section 2 discusses background and related literature. Section 3 covers the theory and hypotheses underlying our empirical results. Sections 4 and 5

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[5] Coles, Li, and Wang (2018) provide empirical evidence concerning the mechanisms by which competing executives increase the luck variance. Specifically, they find that R&D intensity and corporate focus increase in the CEO industry pay gap, whereas capital expenditure decreases in the CEO industry pay gap. The idea of incentives for risk taking also appears in the mutual fund literature (e.g., Brown, Harlow, and Starks 1996).

describe the data and empirical analysis, respectively. Section 6 extends market-based tournament theory to allow executives to endogenously choose the luck variance in their tournaments, which culminates in a new result (Proposition 1). Section 7 reports sensitivity analysis for the main empirical results in section 5, plus some further results. The sensitivity analysis is deferred until after the theory section because the theory helps to motivate some of it. Section 8 presents policy implications and a discussion. Section 9 concludes.

2. Background and Related Literature

The market-based tournament model was introduced by Gibbs (1995) and Zábojník and Bernhardt (2001), building on the insights of Waldman (1984). More recent contributions to this theoretical literature are Zábojník (2012), Waldman (2013), Gürtler and Gürtler (2015), Ekinci, Kauhanen, and Waldman (2019), and DeVaro and Gürtler (2020).[6] This labor economics literature on market-based tournaments is relatively neglected in the accounting and finance literatures, which motivate executive tournaments using the classic approach of Lazear and Rosen (1981). Conceptually, the study by Coles, Li, and Wang (2018) gets closer to the market-based approach than most other studies in the accounting and finance literatures, by introducing the concept of an "industry tournament" among CEOs, with the industry's top CEO getting rewarded with the CEO's job at the industry's best firm (in terms of pay, prestige, perks, etc.).

Coles, Li, and Wang (2018) correctly observe that the high degree of internal promotion observed at the top of a firm's hierarchy should not be interpreted as evidence of a non-existent or minimally active external labor market. Peer benchmarking, as discussed in Bizjak, Lemmon, and Nguyen (2011), offers a mechanism for CEOs to extract market-based compensation prizes even without switching firms. Moreover, counteroffers sufficient for retention can be made both

[6] Contributions to the empirical literature on market-based tournaments include DeVaro and Kauhanen (2016) and Ekinci, Kauhanen, and Waldman (2019).

to CEOs and to other executives to protect a firm from losses due to actual or anticipated raids. In such cases the retained executive's compensation matches what they would earn if they were to switch firms. Thus, an actual separation is not required for a strong market-based tournament mechanism to operate, and indeed most formal market-based tournament models focus on a unique zero-turnover equilibrium (e.g., Zábojník and Bernhardt 2001, Waldman 2013, Gürtler and Gürtler 2015, Ekinci, Kauhanen, and Waldman 2019, DeVaro and Gürtler 2020).

Both our study and Coles, Li, and Wang (2018) analyze the problem of motivating executives in promotion tournaments, and both emphasize the potential importance of the outside labor market in shaping tournament outcomes and the career progression of top executives. They differ in three ways.

First, that study concerns only the incentives of CEOs, whereas ours concerns only the incentives of the firm's non-CEO executives. The theoretical framework of executive promotion tournaments is even better suited for studying the incentives of non-CEO executives than for studying those of CEO. The central idea in tournament theory is that the prospect of an internal promotion creates incentives. That prospect is available to non-CEOs but not to CEOs, and indeed the evidence shows that there is a bias favoring internal promotions to fill CEO vacancies, particularly in the wake of high organizational complexity (see, for example, Cziraki and Jenter 2022, Agrawal, Knoeber, and Tsoulouhas 2006, and Naveen 2006). The *only* way for a successful CEO to advance their career is to switch firms (Fee and Hadlock 2003), whereas non-CEOs enjoy the prospect of significant within-firm career advancement.

Second, Coles, Li, and Wang (2018) focus on an industry-wide tournament in which the contestants are all CEOs in different firms, whereas we focus on the internal incentives of non-CEOs who compete against each other within the same firm. Consequently, in their study pay differentials are measured within-rank and across firms, whereas in ours they are measured within-firm and across ranks.

Third, their study uses as its theoretical foundation the classic, within-firm approach of Lazear and Rosen (1981) and Hvide (2002), despite the inherently market-based nature of an industry-wide tournament. In contrast, ours is agnostic concerning whether the internal incentives faced by a firm's non-CEO executives are more accurately described by classic or market-based tournaments. We develop and implement a new empirical test to determine which approach best describes the data in different types of production environments.

Our interpretation of our results on firm size and market structure concerns the degree to which firms are visible to competing employers. If a firm is more visible and well known, its executives are also likely to have greater visibility. A seminal study of workers' degree of visibility in the labor market is Milgrom and Oster (1987), which applies the idea to study discrimination in promotion decisions. The firm visibility literature has also linked visibility to phenomena other than labor mobility (e.g., attracting institutional investors, as discussed in Bushee and Miller 2012 and the studies referenced therein).

Our study bases its theoretical foundation simultaneously on classic and market-based tournament theory. Although, to our knowledge, that approach is new to the accounting and finance literatures, elements of market-based logic and raiding appear in Agrawal, Knoeber, and Tsoulouhas (2006), Kale, Reis, and Venkateswaran (2009), Kini and Williams (2012), Burns, Minnick and Starks (2017), Coles, Li, and Wang (2018), and Cziraki and Jenter (2022), even though these studies neither examine nor attempt to identify market-based tournaments.

3. Theory and Hypotheses

To clarify terminology and notation, a distinction between "luck" and "the importance of luck" in the context of executive promotion tournaments is helpful. Let P_{ij} be the performance of (non-CEO) executive j in tournament i. Executive j's performance is the sum of three components (ability, effort, and luck) denoted a_{ij}, e_{ij}, and u_{ij}, respectively. Thus, $P_{ij} = a_{ij} + e_{ij} + u_{ij}$. Luck, u_{ij}, is a random variable with mean 0 and variance θ_i. Tournament i's executives draw their individual luck terms independently from that tournament's luck distribution. Henceforth, we refer to θ_i as the "variance of luck" or the "importance of luck" in determining executives' performances and promotion outcomes.

Intuitively, luck represents random factors beyond executives' control that determine their performances in the tournament. The larger its variance, the more likely it is that luck will drive the tournament's outcome. If θ_i is high, then extreme values of u_{ij} (both positive and negative) are likely. In that case, the executive in tournament *i* who draws the highest luck value, u_{ij}, is likely to end up with the highest performance, P_{ij}, (and therefore win the promotion to CEO), regardless of the efforts and abilities of the tournament contestants. Thus, a high θ_i means that luck is important in determining the tournament's outcome. Given that θ_i has a subscript *i* but no subscript *j*, all executives in a tournament face the same θ_i even though they each draw a different luck term, u_{ij}.

Classic tournament theory assumes that the board of directors can credibly commit to the pay spread between the CEO and other executives, choosing it strategically to elicit the optimal effort level from the non-CEO executives (Lazear and Rosen 1981). In contrast, market-based tournament theory assumes that the board cannot make such commitments.[7] Rather, the pay spread is determined in an auction. Competing firms make compensation offers to each executive after observing their job assignments (i.e., whether the board promoted them). The executive's current board observes the executive's performance, whereas competing employers can only observe the executive's job assignment, interpreting it as a signal of the executive's ability (Waldman 1984). The online appendix formally presents the classic and market-based tournament models in sections A1 and A2, respectively, highlighting the contrasting predictions concerning θ_i that underlie the hypotheses that we test empirically.

[7] Ekinci, Kauhanen, and Waldman (2019) develop a hybrid model that contains elements of both.

The importance of luck is central to our study because the two tournament models differ fundamentally in how the executive pay spread responds to increases in θ_i. In the classic model, the board increases the pay spread to counteract the erosion in executive incentives that occurs when θ_i increases. In the market-based model, an increase in θ_i decreases the pay spread.[8] Intuitively, in a market-based tournament, an increase in θ_i diminishes the importance of effort and ability (relative to luck) in determining non-CEO executives' performances and promotion outcomes. This muddies the information about executive ability that competing employers can infer from executives' job assignments. Thus, those employers are less impressed by promotions and less unimpressed by failures to achieve promotion. The compensation offers that a competing employer makes to a firm's promoted and non-promoted executives then move closer together, because that employer's inferences about the abilities of promoted and non-promoted executives move closer together. These insights underlie our primary research hypotheses:

Hypothesis 1a (*Classic Tournaments*). The pay differential between the CEO and the firm's other executives *increases* in θ_i if promotion tournament *i* is classic.

Hypothesis 1b (*Market-Based Tournaments*). The pay differential between the CEO and the firm's other executives *decreases* in θ_i if promotion tournament *i* is market-based.

Although H1b has not been investigated empirically in prior research, H1a has been tested in Eriksson (1999) using data from Denmark and in Kato and Long (2011) using data from China. In those investigations the anticipated positive relationship was found, consistent with

[8] Whereas the pay spread in the two tournaments responds differently to changes in θ_i, there is no difference between the two tournaments concerning executive incentives, which depend only on the size of the pay spread and not on how it is generated. In both tournaments, higher executive spreads (or anticipated spreads in the case of market-based tournaments) induce greater equilibrium effort choices by non-CEO executives.

classic tournaments. What is new to the literature, as stated in H1b, is that market-based tournament theory predicts a negative sign and, therefore, that the sign of the estimated coefficient allows classic and market-based tournaments to be distinguished empirically when H1a and H1b are considered together.[9]

Market-based pay determination requires that executive talent be visible in the eyes of competing employers (as opposed to investors). Competing employers must be able to observe a given firm's executives, and those executives' job assignments, before attempting to poach those executives. Large firms (and their executives) are more visible than small firms, for multiple reasons. On average, larger firms are better known, get more press, are more established, and their executives have wider social networks of current and former employees and business associates. Thus, empirical evidence favoring H1b should strengthen in large firms, as stated in the following hypothesis.

Hypothesis 2 (*Firm size*). The market-based wage-setting mechanism (H1b) strengthens in large firms because they, and therefore their executives, are more well-known and visible.

The relationship between firm size and visibility may have limits. Increases in firm size may increase visibility up to a point, but once a certain position in the size distribution is reached, the incremental visibility gain to further increases in size may be negligible.

A firm's degree of visibility to competing firms in the market for executive talent may also depend on market structure. For example, consider two firms of the same size, but one is a monopolist in its product market (or a firm in a highly concentrated product market) whereas the

[9] The insight concerning how the two tournament types exhibit differential responses in the pay spread to changes in the importance of luck builds on DeVaro and Kauhanen (2016). But in that empirical context (non-executives in Finland) there was no available measure of θ_i, so the insight could not be directly tested empirically. In the present context (U.S. executives) the idea can be empirically tested using a new measure of θ_i that we develop.

other is one of many firms with similar market shares. The monopolist's prominent position in its product market gives its executives greater visibility than the executives in the other firm. Thus, empirical evidence favoring H1b should strengthen in firms in highly concentrated product markets, as stated in the following hypothesis.

Hypothesis 3 (*Product market structure*). The market-based wage-setting mechanism (H1b) strengthens in firms in highly concentrated product markets (controlling for firm size) because they, and therefore their executives, are more well-known and visible.

The distinction between product and labor markets is important for H3. A firm could be a monopolist in its product market but still face competition from other firms in the labor market for hiring and retaining executive talent. Firm size is held constant in H3 because higher market concentration may proxy for larger firm size. The prediction in H3 is that when two firms of the same size are compared, the one that is in a more concentrated product market is more visible (to competing executive employers) than the other firm. This higher visibility means that their executives in the more concentrated market are also more likely to be noticed by potential other employers in the market who might hire them.

4. Data and Measures

Stage 1 of the two-stage empirical analysis uses quarterly data to construct a novel measure of θ_i that varies across tournaments and that is the independent variable in the stage-2 statistical model (estimated at the tournament level) to test Hypotheses 1 (*a* and *b*), 2, and 3. Throughout this section, i indexes tournaments (and CEO-firm pairs), t indexes quarters, n_i denotes the number of non-CEO executives competing in tournament i, T_i denotes the number of quarters that CEO-firm pair i is observed in the quarterly Compustat data, and N denotes the number of tournaments on which the stage-2 empirical model is estimated.

4.1. Data

The merged CRSP/COMPUSTAT data set, which provides information on firm characteristics and performance, is used to construct the tournament-level measure of θ_i in stage 1, as explained in section 4.4. All other variables used in stage 2 are defined from the ExecuComp database for the period of fiscal years 1992 to 2023. ExecuComp includes compensation data for CEOs and other executives in both current and previous S&P 1500 firms. The ExecuComp data are recorded annually by fiscal year and track individual executives and firms over time.

Table 1's Panel A defines all variables in the analysis, Panel B displays their descriptive statistics, and Panel C displays their correlation matrix. Panel C's negative and statistically significant correlation between θ and *SalarySpread* (i.e., -0.088) is consistent with market-based tournaments (H1b).[10]

4.2. Defining Tournaments

Defining tournaments in the stylized theoretical models described in section 3 is straightforward. Doing so empirically is harder. Different tradeoffs accompany alternative empirical definitions. Our approach first selects CEO-firm pairs that are observed in the ExecuComp data for at least five years and then defines a tournament by aggregating over years within these pairs.[11] The reason for imposing $T_i \geq 20$ (quarters) is to ensure enough data within CEO-firm pairs to estimate the θ_i measure in stage 1 using quarterly Compustat data.[12]

[10] By contrast, θ is positively correlated with other components of executive compensation (i.e., 0.071 for the stock spread, and 0.050 for the total compensation spread), except for bonus, which has no statistically significant correlation with θ. *SalarySpread* and total compensation have a high, positive, and statistically significant correlation (0.344).

[11] For example, Apple had five CEOs from the start of the ExecuComp data (1992) to the present: John Sculley (1983-1993), Michael Spindler (1993-1996), Gilbert Frank Amelio (1996-1997), Steve Jobs (1997-2011), and Tim Cook (2011-present). Apple would contribute two observations (i.e., tournaments) to our stage-2 analysis, namely the "Steve Jobs Apple tournament" and the "Tim Cook Apple tournament". The Apple tournaments associated with the other three CEOs would be dropped due to being observed in the data for fewer than five years.

[12] Section 7 performs sensitivity analysis and, upon the suggestion of an anonymous referee, extends the minimum tournament period to 7 years (i.e., $T_i \geq 28$ quarters).

Our definition of tournaments has several advantages, including that its definition of a CEO separation (and therefore replacement) as the conclusion of a tournament is natural. Other advantages derive from aggregating over time within CEO-firm pairs. Such aggregation recognizes that tournaments are of different durations and avoids overweighting long tournaments in the stage-2 statistical model; the aggregation over time renders more defensible an independence assumption across observations in the stage-2 regression.[13] The approach also hews closely to the theoretical models described in section 3 (and online appendix sections A1 and A2), by producing unique pay spreads, measures of θ_i, and performance levels for each tournament, given that within-tournament temporal variation in these variables is not addressed in the theoretical literature. The approach also allows temporal variation within CEO-firm pairs to be exploited in stage 1, to define a θ_i measure that varies across tournaments but not within them. Finally, the time aggregation induces smoothing of underlying measures that are volatile over time, removes time trends, and reduces the impact of seasonality and cyclicality.

The approach has two disadvantages. One is that it defines tournaments as entirely within-firm events, whereas in practice external candidates can also participate.[14] Two considerations mitigate this limitation. First, defining tournaments as within-firm events corresponds exactly to the theoretical models in section 3 (and online appendix sections A1 and A2). Second, external hiring diminishes at the higher ranks of organizations. This empirical regularity is pronounced even in the non-executive portion of job hierarchies (DeVaro, Kauhanen, and Valmari 2019) but it intensifies at the executive level; CEO vacancies are far more likely to be filled via internal promotion than externally (Cziraki and Jenter 2022). Thus,

[13] Nonetheless, tournaments in the sample will still not be entirely independent in the stage-2 regression because of cases in which they involve different CEOs but the same firm (or, less likely, the same CEO across different firms).
[14] Cziraki and Jenter (2022) find that although internal promotion is the way most CEO vacancies are filled, more than half of the external hires that occur involve external promotions of non-CEO executives from other (typically much larger) firms.

empirically defining tournaments as within-firm events is a lesser concern here than in studies of non-executive tournaments, like DeVaro and Kauhanen (2016).

The second disadvantage is that aggregating over time within CEO-firm pairs masks potential turnover among the non-CEO executives. Such turnover might change the nature of tournaments. We do not see this as a major concern. Even if there is executive turnover, the number of contestants and the positions involved remain stable (i.e., the CFO and COO still compete even if the people who fill those seats change during the tournament). Moreover, ignoring non-CEO executive turnover allows us to avoid ad hoc decision rules about what constitutes a new tournament.[15]

4.3. Executive Pay Spread

The stage-2 dependent variable, the pay spread, is defined as:[16]

$SalarySpread_i = CeoSalary_i - ExecSalary_i$.

In this expression, $CeoSalary_i$ denotes the average CEO base salary in tournament i over the years in which the CEO-firm pair is observed, and $ExecSalary_i$ denotes the average base salary (across all n_i non-CEO executives and across all years in which the CEO-firm pair is observed) for tournament i's non-CEO executives. The variables that we average to construct $CeoSalary_i$ and $ExecSalary_i$ are unwinsorized, as in Chung, DeVaro, and Fung (2024).[17] The mean of $SalarySpread_i$ is \$387,237.

[15] For example, if the only change in executive personnel is that the chief technology officer changes around the midpoint of a 7-year CEO-firm match, we do not believe that event should be considered the start of an entirely new tournament. But that is a judgment call. It is unclear how many non-executive seats would have to experience turnover within a CEO-firm match before it might make sense to define a new tournament.

[16] The literatures outside of economics commonly use the ratio of CEO pay and executive pay, rather than their difference, as the dependent variable. As noted in Connelly et al. (2016), "Pay dispersion has become the cornerstone of tournament theory and is frequently operationalized as a ratio (Gupta et al., 2012)." The pay difference, however, is a truer representation of the theoretical models in the online appendix sections A1 and A2 and is, therefore, the more appropriate measure.

[17] That study demonstrates in the ExecuComp data and in Monte Carlo experiments why winsorizing the pay variables is particularly destructive in analyses of executive pay disparity.

Stock and options comprise the largest share of CEO total compensation, particularly in large firms. Nonetheless, for two reasons, we focus only on the difference (between the CEO and the firm's other executives) in base salaries rather than in bonuses, stock options, or total compensation.

First, our hypotheses are based on the theoretical models in the online appendix, both of which concern fixed rather than variable pay.[18] Focusing on executive differences in base pay produces the most accurate and correct empirical tests of those models.

Second, the independent variable in our empirical tests is an estimate of θ_i, to be defined in section 4.4. Alternative measures of the dependent variable that are based on variable pay are subject to spurious correlations because (unlike difference in base salaries, which are known with certainty and fixed at the point of hiring) they all reflect *ex-post* realizations of uncertainty and should, therefore, relate to θ_i even in the absence of tournament mechanisms. Differences in equity-based compensation, or total compensation, are inappropriate as dependent variables for testing our hypotheses, for the two reasons just given. We report those results in section 7 for completeness, but they are atheoretical and cannot be interpreted as tests of our hypotheses.

4.4. Measuring the Importance of Luck in Executive Promotion Tournaments

A measure of θ_i, is needed that: 1) varies across tournaments, 2) is constant across tournament i's n_i contestants, and 3) is a reasonable proxy for the variance of a common stochastic distribution from which all of tournament i's n_i executives draw to obtain their individual luck terms. For example, consider two independent tournaments (A and B).

[18] There are no tournament models in the literature that incorporate equity-based pay. Ekinci, Kauhanen, and Waldman (2019) develop a hybrid model that integrates elements of classic and market-based tournament theory to study individual bonuses (though not equity-based pay) in addition to wages and promotions. Their empirical work is based not on executives but on a four-level job hierarchy in which even the top level (which the authors drop from the analysis) contains mostly non-executive workers.

Tournament *A* has six competing executives, and Tournament *B* has eight, i.e., $n_A = 6$, $n_B = 8$. Let θ_A and θ_B denote the importance of luck in Tournaments *A* and *B*, respectively.

Suppose that luck is normally distributed in both tournaments. Tournament *A*'s six executives each take an independent luck draw from $N(0,\theta_A)$, i.e., u_{A1}, u_{A2}, u_{A3}, u_{A4}, u_{A5}, and u_{A6}. The executive with the highest luck has a particularly good chance of ending up with the highest performance, thereby winning Tournament *A* and getting promoted to CEO. Similarly, Tournament *B*'s eight executives each take an independent luck draw from $N(0,\theta_B)$. The θ_A measure is the same for Tournament *A*'s six executives, and θ_B is the same for Tournament *B*'s eight executives, but θ_A will in general differ from θ_B.

To construct an empirical measure of θ_i, we use quarterly Compustat data to estimate N = 4752 regressions (one for each tournament). Tournament *i*'s regression uses the T_i quarterly observations on firm performance (measured by the natural logarithm of the firm's total sales) as the dependent variable.[19] The regressors in these stage-1 regressions are key economic indicators representing different aspects of the economy that are relevant for a firm's output (sales). These include industry-level sales (based on 2-digit SIC codes) and macro-level economic indicators of market-level performance that can affect firm performance and that are beyond the n_i executives' control. The macro-level economic indicators are: Brave-Butters-Kelley Real Gross Domestic Product Growth and the natural logarithm of Industrial Production (Total Index).[20]

Each regression decomposes the variation in firm performance into a part (measured by R^2) that can be explained by market-level factors beyond the executives' control and a part

[19] In Danish data, Ericsson (1999) also uses total sales as the measure of firm output.
[20] The macro-level economic indicators are monthly and matched with the corresponding month of the firm's total sales in the quarterly Compustat data. The Brave-Butters-Kelley (BBK) Real Gross Domestic Product Growth is obtained from: Indiana University. Indiana Business Research Center, Brave-Butters-Kelley Real Gross Domestic Product [BBKMGDP], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/BBKMGDP, November 6, 2023. The Industrial Production (Total Index) is obtained from: Board of Governors of the Federal Reserve System (US), Industrial Production: Total Index [INDPRO], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/INDPRO, November 6, 2023.

(measured by $1 - R^2$) that is explained by factors that are at least partially within the executives' control. Focusing on the latter, the residual variance measures the importance of luck, i.e., $\theta_i \equiv \frac{\sum_{t=1}^{4T_i} e_{it}^2}{4T_i - K_i}$, where e_{it} is the t^{th} residual from tournament i's regression, and K_i is the number of parameters estimated. Figure 1 shows the histogram for the estimated θ_i, revealing variation in θ_i across different CEO-firm pairs (tournaments). The empirical distribution is right-skewed and resembles a power law.

Related, yet distinct, concepts are measured and used in Daniel, Li, and Naveen (2020), DeVaro, Kim, and Vikander (2017), and Bertrand and Mullainathan (2001). However, neither study addresses tournaments, and their measures do not correspond to the concept of the importance of luck in promotion tournaments. Therefore, their measures are inappropriate here. The measure in Ericsson (1999), reprised in Kato and Long (2011), is conceptually closer to ours given that both studies address tournaments. However, their θ_i measures differ from ours, as do their data structures, given that tournaments defined as CEO-firm pairs are the unit of observation in our analysis but not in theirs. Ericsson (1999) constructs two measures of θ_i. The first is the coefficient of variation of (deflated) sales for each firm. The second is similar but uses industry information.

In our main specification, K_i is the same for all tournaments i, but in some specifications, K_i differs across tournaments. The relevant constraint is that significant variation in T_i across tournaments implies significant variation in the degrees of freedom in the stage-1 regressions. Richer stage-1 specifications can be estimated for tournaments with large T_i, if more parsimonious specifications are adopted for tournaments with small T_i. Section 7 reports sensitivity analyses that vary the specification of the stage-1 regressions that measure θ_i.

Our θ_i measure captures unexplained variation in firm performance after netting out the contribution of market-level factors, as opposed to tournament-level factors. The idea is to remove uncertainties that are common to all tournaments in the market, focusing only on those that vary across tournaments. An example of a tournament-level factor is a publicity shock that positively or negatively affects one of the firm's products or services. When such a shock hits, some segments of the firm's consumer base might suddenly become more (or less) interested in purchasing that product or service.

The different responsibilities, assignments, and functional areas of tournament *i*'s n_i executives imply that, for a given tournament-level θ_i, the executives' individual luck draws may vary. Whereas a technology shock may be expected to disproportionately affect the chief technology officer (or chief information officer) versus the chief financial officer (or chief operating officer), a publicity shock may be expected to disproportionately affect the chief marketing officer. If the shock disproportionately affects one of the firm's products or services, then it should disproportionately affect the executive(s) who oversee that product or service. In fact, when the same firm offers competing products or services, a negative shock could harm the executives who oversee the impacted products while helping the executives who oversee competing products. Similar arguments apply if the same product is targeted to different consumer groups (one of which may be the source of the publicity shock), with the firm's executives specializing in which consumer groups they target.

A diversity of firms from different industries can be found in the top decile of the tournament-level empirical measure, θ_i. Some examples are displayed in Table A.8's Panel A. Luck can be expected to be an important determinant of executive promotion outcomes in these firms. Some of these firms (such as Broadcom, eBay, Electronic Art, iRobot, Sandisk, and Salesforce) are highly visible companies, well-known for their products/services or innovations. The bottom decile of the estimated θ_i also exhibits a diversity of firms from various industries, with some examples displayed in Table A.8's Panel B. Luck can be expected to be of lesser importance in determining executive promotion outcomes in these firms. Some of these firms (such as 3M, Caterpillar, IBM, Johnson & Johnson, and Walgreens Boots Alliance) have multiple tournaments appearing in the bottom decile of θ_i.

4.5. Firm Size and Control Variables

To test H2, we rely on firm size (measured by the natural logarithm of the firm's total assets). To test H3, we use the Herfindahl-Hirschman Index (HHI) as a measure of product-market concentration.

The stage-2 empirical model's controls include the following firm and industry characteristics drawn from the merged CRSP/COMPUSTAT database: leverage, firm age, capital expenditure, research and development expenditure, and industry concentration. While the two salary variables underlying $SalarySpread_i$ are unwinsorized,[21] both the measure of θ_i and the control variables are winsorized at 1% on both ends to mitigate outlier effects.

5. Empirical Analysis

The stage-1 empirical analysis requires estimation of 4752 regressions for every specification of the stage1-regression model that we consider. Table 2 summarizes the results from the particular stage-1 specification that underlies our main results. Table 2 reports descriptive statistics for the stage-1 regression coefficients across the 4752 regressions estimated. The mean of the *t*-statistic for ln(for industry sales) across the 4752 regressions is 3.620, which attains statistical significance at conventional levels.

5.1. Main Result: Executive Pay Spread and the Importance of Luck

The stage-2 empirical model to be estimated for testing H1a and H1b is:

[21] See Chung, DeVaro, and Fung (2024) for a discussion of why winsorizing executive compensation data is destructive. Executives are, by their very nature, in the extremes of the pay distribution, and winsorizing discards some of the most relevant and interesting variation in pay to be explained.

$$SalarySpread_i = \gamma + \beta \ln(\theta_i) + \boldsymbol{X}_i \boldsymbol{\delta} + \varepsilon_i \quad (1)$$

where ε_i is a stochastic disturbance satisfying the usual properties. In model (1), H1a predicts $\beta > 0$, and H1b predicts $\beta < 0$.

Table 3 displays estimation results for model (1) using the full sample of tournaments. Standard errors are bootstrapped (with 10,000 replications) to correct for bias given that θ_i is a generated regressor derived from N stage-1 regressions (Chen, Hribar, and Melessa 2023). Clustered standard errors are not recommended in our case and are not computed (Abadie et a. 2017). Table 3's results reveal a negative estimate of β, i.e., -5.592, which is statistically significant at the five percent level.

The result supports H1b. Specifically, a ten percent increase in the measured θ_i is associated with a decrease of \$55,920 in $SalarySpread_i$.[22] Relative to a mean salary spread of \$387,237 (see Table 1's Panel B) this represents a decrease in the base salary spread of about 14.4 percent, which is a substantial magnitude.

Are larger values of θ_i associated with smaller salary spreads because of lower salaries for CEOs or higher salaries for other executives? To answer that question, we estimate model (1) using these two compensation variables as dependent variables in two separate regressions. Table 4 displays the results.

Panel A's column 1 is the same as our main stage-2 regression reported in Table 3, except that it includes an additional control variable, namely $FinalYear_i$ which is the last year which tournament i operated.[23] The purpose of this extra control is to capture any time trend in *SalarySpread*, within the context of the (cross-sectional) stage-2 regression. The estimated β is negative, statistically significant at the five percent level, and of comparable magnitude to its

[22] This is -5.592 × \$1000 × 10(%) because the salary spread is measured in thousands of U.S. dollars.
[23] A "Steve Jobs Apple" tournament would have *FinalYear* = 2011, given that Steve Jobs was CEO of Apple from 1997 to 2011.

value in Table 3. The coefficient of *FinalYear* is positive but statistically insignificant, though if $\ln(\theta_i)$ is dropped from the regression (Panel A's column 2) it becomes much larger in magnitude and attains statistical significance at the one percent level.

Table 4's Panel B reports results using the CEO's salary and the non-CEOs' salary as the dependent variables, in both cases controlling for *FinalYear*. The estimated β is negative and statistically significant at the ten percent level for CEOs, whereas for non-CEOs it is positive but statistically insignificant. In both models, the coefficient of *FinalYear* is positive, statistically significant at the one percent level, and of similar magnitude. Thus, increases in θ_i are associated with decreases in the salary spread because the CEO's base salary decreases, and these effects operate in an environment in which both salary variables are trending up over time even though their difference (see Panel A's column 1) is not. The high R^2 values are striking in these regressions (0.6 for non-CEOs, 0.55 for CEOs, and 0.35 for the salary spread).

5.2. Firm Size Results

We test H2 by estimating model (1) separately within the terciles of firm size. Table 5 reports the results. The estimated β is negative and statistically significant only for large firms, which supports market-based tournaments, i.e., H1b. For medium-sized firms the estimated β is negative but half the magnitude of its counterpart for large firms and falling just short of statistical significance at the ten percent level. For small firms, the estimated β remains negative but is substantially smaller in magnitude and estimated with low precision.

These results are consistent with H2 and suggest that the evidence of market-based tournaments that is reported for the full sample of tournaments in Table 3 is driven by large firms. Due to these large firms' greater visibility and name recognition, their executives should also have greater visibility and be more likely to be noticed (and remembered) by potential alternative employers of executives.

The magnitudes of the estimated effect can be interpreted as follows. In large firms, a ten percent increase in the measured θ_i is associated with an average annual decrease in the executive salary spread of $109,110. Given that the mean salary spread for large firms is $508,796, this represents a decrease of about 21.4 percent. This effect for large firms is a substantial magnitude and larger than the corresponding magnitude for the full sample (i.e., about 14.4 percent), based on Table 3. The corresponding effects for small and medium-sized firms are interpreted similarly, though these effects are considerably smaller, and neither is statistically significant.

Cziraki and Jenter (2022) find that when CEO positions are filled via poaching another firm's executives, more than half the cases involve (non-CEO) executives (from typically much larger firms) being externally promoted to CEO. This is consistent with our theoretical argument underlying H2, i.e., the greater visibility of large firms extends to the executives they employ, which makes those executives more likely to be the targets of poaching.

As an alternative estimation approach to Table 5, we use the full sample to estimate a nonlinear specification that interacts *FirmSize* with $\ln(\theta_i)$.[24] Results are displayed in Table 6's column 1, which reveals a positive and statistically insignificant main effect of θ_i. The parameter of primary interest for H2 is the interaction, which is negative, though narrowly missing the threshold for statistical significance at the ten percent level.

Table 6's column 2 reports results from a richer specification that allows for more nonlinearity in the estimated relationship of interest. Specifically, we add to the model the square of *FirmSize* and the interaction of this quadratic term with $\ln(\theta_i)$. Results reveal a non-monotonicity that is obscured in the column-1 specification that omits the quadratic terms in *FirmSize*. Whereas the main effect of $\ln(\theta_i)$ is positive but statistically insignificant in column 1,

[24] To mitigate the influence of outliers in the interaction terms involving $\ln(\theta_i)$ and firm size, these interaction terms are winsorized at the top and bottom 1%.

it is considerably larger (and statistically significant at the one percent level) in column 2. Similarly, whereas the linear interaction is negative but statistically insignificant in column 1, it is an order of magnitude larger (and statistically significant at the one percent level) in column 2.

A non-monotonicity is revealed in column 2 by a positive (and statistically significant at the five percent level) coefficient of the interaction of $\ln(\theta_i)$ with the square of *FirmSize*. In short, although the estimated relationship between the importance of luck and the salary spread is negative (consistent with the market-based tournament model) throughout most of the range of values of *FirmSize*, the relationship is positive (consistent with the classic tournament model) for both the small and very large firms.

Figure 2 plots the estimated $\partial SalarySpread_i/\partial \ln(\theta_i)$ as a function of $FirmSize_i$, with the following 7 percentiles of $FirmSize_i$ labeled with tick marks on the horizontal axis: (1, 5, 25, 50, 75, 95, 99). For example, the 75th percentile of $FirmsSize_i$ is 8.9. Figure 2 reveals that classic tournaments have *FirmSize* (measured as the log of total assets in US dollars) either below 5.93 or above 11.63. Thus, firms with total assets below $376 million or above $112 billion run classic tournaments, and those with total assets between these values run market-based tournaments. This evidence consistent with classic tournaments occurs only in the bottom 13% and top 2.5% of the *FirmSize* distribution, so the point estimates are consistent with market-based tournaments for nearly 85% of the range of values for *FirmSize*.

An interpretation of these results is that small firms, and therefore their executives, are less visible to the market, so the market-based mechanism is weak, and the classic model applies. Tournaments become more market-based as firm size (and therefore visibility) increases, but only up to a point. Eventually visibility becomes so high that further increases in firm size do not bring much additional visibility.

A different mechanism may then explain the weakening of the market-based mechanisms for very large firms. For very large firms, the executive labor market becomes thinner because there are fewer firms in the market for an executive to move to as an "upgrade" (i.e., an even larger firm than their current firm). In such very large firms, the reduced pressure from an external executive labor market makes it easier for boards of directors to commit to executive pay levels (as required in classic tournaments) and to focus on setting the pay spread to create optimal executive incentives. Thus, boards of directors can commit to wages and run classic tournaments either when firms are small (so visibility is low) or when they are extremely large (so that their executives face thinner labor markets with few opportunities for job "upgrades").

5.3. Market Structure Results

We test H3 by partitioning the sample into three subsamples defined by low, medium, and high values of the Herfindahl-Hirschman Index (HHI) and estimating model (1) separately within each subsample, controlling for firm size. The subsamples are labeled "highly concentrated market" (for high values of HHI), "moderately concentrated market" (for intermediate values of HHI), and "competitive market" (for low values of HHI).

The HHI cutoffs for defining these subsamples are defined following the merger guidelines of the U.S. Department of Justice and the Federal Trade Commission. Specifically, the competitive subsample has HHI below 0.15. The other two subsamples cover the intermediate range for HHI, including markets that are considered as "moderately concentrated" (i.e., HHI between 0.15 and 0.25, per the guidelines) as well as the high range for HHI, including markets that are considered "highly concentrated" (HHI above 0.25 per the guidelines).

Table 7 reports the results. The "highly concentrated market" subsample reveals a negative and statistically significant estimate of θ_i, supportive of market-based tournaments. Recall that this result controls for firm size. The estimated β is -5.619, which is statistically significant at the five percent level. In the "highly concentrated market" subsample, a ten percent increase in the measured θ_i is associated with a decrease of $56,190 in $SalarySpread_i$. Relative to a mean salary spread of $361,985 in the "highly concentrated market" subsample (unreported in Table 1), this represents a decrease in the base salary spread of about 15.5 percent. This effect for the "highly concentrated market" subsample is a considerable magnitude and is of comparable magnitude to the corresponding effect (about 14.4% percent) for the full sample.

The estimated β is negative in the competitive and moderately concentrated subsamples. Compared to the magnitude of the estimated β in the highly concentrated market, the one in the moderately concentrated market is higher and the one in the competitive market is lower, but both results are statistically insignificant at conventional levels. Table 7's results support H3 in that the firms in highly concentrated markets (controlling for firm size) appear to run market-based executive promotion tournaments. The greater visibility that their high market concentration provides extends to the executives these firms employ, which bestows those executives with a greater likelihood of attention from alternative employers.

Table 8 further investigates H3 with two interactive specifications analogous to those in Table 6 but using industry concentration (HHI) instead of *FirmSize*. We report Table 8 to maintain a parallel structure to our presentation of results for *FirmSize*, though we view the results in Table 7 as preferable. The reason is that Table 7 partitions the data using cutoffs that were identified as being of particular interest by the U.S. Department of Justice and the Federal Trade Commission. We believe this creates a clearer picture than ignoring those cutoffs and treating HHI as continuous as in Table 8.

Column 1 reveals negative values for both the main effect of $\ln(\theta_i)$ and its interaction with industry concentration (HHI), though neither estimated coefficient attains statistical significance at conventional levels. The richer specification in column 2 reveals a negative main effect of $\ln(\theta_i)$ that attains statistical significance at the ten percent level. Neither of the interaction terms in column 2 are statistically significant at conventional levels. The point estimates in column 2 are consistent with H3, i.e., the interaction coefficient for the quadratic in HHI is negative (-71.3) and larger in magnitude than the positive interaction coefficient (40.2). Even though neither interaction is statistically significant, the point estimates imply that for sufficiently concentrated markets (i.e., high values of HHI) the negative relationship between $\ln(\theta_i)$ and HHI strengthens.

5.4. Summary of Main Results

To summarize, the empirical results are consistent with market-based executive tournaments in our overall sample, except for tournaments in small and very large firms, which are consistent with classic tournaments. This non-monotonicity implies an important caveat to the empirical support for H2. That is, for most of the distribution of firm size, executive tournaments appear more market-based, and increasing firm size (and therefore visibility) strengthens the evidence favoring market-based tournaments. But only up to a point. For extremely large firms, the classic model appears more applicable, perhaps because thinner executive markets lessen the competition that firms face in the executive labor market.

This is an important caveat to the empirical support for H2, but it only applies to firms in about the top 2.5 percent of the *FirmSize* distribution. The set of tournaments exhibiting classic wage setting is larger at the bottom end of the *FirmSize* distribution, covering about the bottom 13 percent of tournaments. Finally, the market-based mechanism that applies to the majority of tournaments strengthens when industry concentration increases (holding firm size fixed).

6. Executives' Influence Over the Importance of Luck in Their Promotion Contests

The canonical classic and market-based tournament models on which H1a and H1b are based assume that θ_i is exogenous, i.e., tournament *i*'s contestants treat θ_i as parametric when making their effort choices. That assumption is questionable in executive tournaments, given that executives' considerable authority and influence within the organization may allow them to alter the luck distribution via their strategic decisions (e.g., which product lines to enter or which geographic markets to penetrate). For example, section 4.4 describes a publicity shock as a tournament-level factor that may affect some of a firm's executives more than others, depending on their functional areas. The probability of such a shock occurring, and its magnitude and duration conditional on occurrence, might depend on a host of prior executive decisions.[25]

Classic tournament theory has been extended in previous research (Hvide 2002, Gilpatric 2009) to treat θ_i as an endogenous executive choice. For example, Hvide (2002) extends the classic tournament model of Lazear and Rosen (1981) by allowing executives to choose θ_i at tournament *i*'s outset. The board then chooses the pay spread, and then the executives choose effort levels. In the unique equilibrium, tournament *i*'s executives choose infinite θ_i and invest zero effort. Intuitively, the more uncertainty that executives can inject into their tournament, the more its outcome is determined by luck rather than (costly) effort. If the executives can render the outcome of their own tournament sufficiently uncertain, they should invest no effort at all, and since that strategy is assumed to be costless, the executives pursue it as far as they can. If a finite upper bound on θ_i is assumed, executives set θ_i equal to that.

Unlike classic tournament theory, market-based tournament theory has not been extended to treat θ_i as an endogenous executive choice. We do so in section 6.1, presenting this study's theoretical contribution in Proposition 1. In section 6.2 we highlight some implications of the new theoretical result.

6.1. Extending Market-Based Tournament Theory to Render θ_i Endogenous

In this section, we extend the market-based tournament model (described in online appendix section A2) to allow executives to influence the θ_i that they face in their promotion contest. Proposition 1 summarizes the new result. To repeat some of the notation introduced in

[25] Such decisions include which product or service lines to introduce or discontinue, which segments of the consumer population to target and with what intensity, what marketing methods and forums to use, how heavily to invest in securing the services of public relations experts before and during the occurrence of shocks, etc.

the online appendix's section A2, let p denote an executive's probability of getting promoted to CEO, and let W_{ceo} and W_{exec} denote the equilibrium wages paid to the CEO and to non-promoted executives, respectively. Let C denote the executive's strictly convex effort cost function, with the standard properties defined in online appendix section A1. Let the non-negative parameter α be the coefficient of the executive's cost of effort, C, in the expected utility function, E(U). Let c_{ceo} and c_{exec} denote positive production function parameters. Specifically, they are the job-specific slopes of job-specific production functions that are linear in ability.

Following Waldman (2013), assume $c_{ceo} > c_{exec}$, so that executive performance is more sensitive to ability in the CEO job than in the non-CEO executive job. As in Hvide (2002), assume that non-CEO executives choose θ_i at tournament i's outset. Thereafter, events proceed as in Waldman (2013). The online appendix provides a proof of the following new result.

Proposition 1. If the non-CEO executives in market-based tournament i have sufficient distaste for effort (i.e., if α is sufficiently high) then in equilibrium they choose infinite θ_i and zero effort.

First, consider the case of $\alpha = 0$, so that effort vanishes from the model. Executives' expected utility, E(U), then reduces from $pW_{ceo} + (1\text{-}p)W_{exec} - \alpha C(e_{i1})$ to $pW_{ceo} + (1\text{-}p)W_{exec}$. Symmetric equilibrium implies $p = 0.5$, so E(U) = $0.5(W_{ceo} + W_{exec})$. In this case, $\partial \mathrm{E}(U)/\partial\theta_i$ is negative and diminishing in magnitude in θ_i, so executives choose a θ_i that is as small as possible. The reason for this result is that when θ_i increases, W_{ceo} and W_{exec} move closer together, but (given that $c_{ceo} > c_{exec}$) W_{ceo} decreases by more than W_{exec} increases,[26] implying that expected executive compensation drops. In the other direction, by reducing the amount of uncertainty in their tournament's outcome, i.e., θ_i, and thereby improving the information available to

[26] See the proof in the online appendix's section A3 for a formal argument with exact expressions.

competing employers in the labor market, executives can increase both the size of the expected prize (i.e., the distance between W_{ceo} and W_{exec}) and their expected compensation.

When $\alpha > 0$, a second (competing) effect emerges, which dominates the first effect just described when α is sufficiently large. The larger is α, the greater executives' distaste for effort. Recall that $E(U) = pW_{ceo} + (1-p)W_{exec} - \alpha C(e_{i1})$. Intuitively, when θ_i increases, tournament outcomes are driven increasingly by luck and less by effort and ability. From the executives' perspectives, the value of exerting effort as a means of increasing the promotion probability then diminishes. The greater the increase in θ_i the more intense this effect. When α is large enough to outweigh the first effect described in the preceding paragraph, executives choose infinite θ_i and invest zero effort, as in the classic tournament of Hvide (2002).[27]

In the market-based model, however, there is an additional consideration that exacerbates, rather than mitigates, the diminished effort that occurs when θ_i increases, and this is a crucial difference between Hvide (2002) and our analysis. Recall that the pay spreads in the two tournament models exhibit opposite responses when θ_i increases. When θ_i increases, the pay spread increases in classic tournaments and decreases in market-based tournaments. Thus, in market-based tournaments, when executives choose higher values of θ_i, equilibrium effort drops even if the pay spread is fixed, and it drops by even more given that the pay spread shrinks.

6.2. Implications of the New Theoretical Result

Proposition 1 has implications for executive effort allocation, vertical pay disparity, and delegation of decision-making authority within the organization's executive suite. CEOs must decide how much authority to grant their executives concerning major strategic decisions like what product lines or geographic markets to enter or exit. Regardless of tournament type, if

[27] Higher values of α reduce the sensitivity of effort choices to incentives and frequently imply reduced effort. A high α means that the reductions in effort that are induced by an increase in θ_i increase expected utility substantially.

executives are delegated the authority to choose θ_i, they will choose risky strategies and will invest little effort. In the case of market-based tournaments, that situation will result in a more compressed executive pay structure, whereas under classic tournaments it will result in a more dispersed pay structure. Moreover, widening or shrinking of the pay gap has implications not just for executive effort investments but also for executives' risk-taking behavior.[28]

Infinite θ_i and zero effort, both in Hvide (2002) and in Proposition 1, may appear extreme. Two points should be noted, however. First, these extreme results arise because of the assumption that executives can costlessly increase θ_i. Thus, if θ_i is not bounded from above, the executive chooses infinite θ_i, and if θ_i is bounded from above, the executive chooses its upper bound. In practice, however, there may be various costs to increasing θ_i. Those would mute executives' tendencies (in either tournament type) to drive up θ_i, which in turn would dampen the tendency for effort to be driven to zero. Second, "zero effort" should not be interpreted literally to mean no effort exertion by executives. Zero is a standard normalization, to be interpreted as the executive's "regular" effort level that would be exerted in the absence of any incentives.[29]

7. Sensitivity Analysis and Further Results

We conduct a series of variations (e.g., using different measurements of θ_i) on the main empirical analysis to assess the sensitivity of our main results, finding that our main results are quite robust to these variations. We summarize a selection of eleven of these variations here (Table 9), with the empirical results presented in the online appendix's Table A.1. After summarizing these, we conclude this section with some further results that define the stage-2 dependent variable using compensation components other than base salary.

[28] Prior empirical work has found that increasing the size of the tournament prize increases both executive (and firm) performance and executives' risk-taking behavior, given that the option-like nature of tournaments means that a greater risk level increases an executive's chances of winning. See, for example, Brown, Harlow, and Starks (1996), Kale, Reis, and Venkateswaran (2009), Kini and Williams (2012), and Burns, Minnick, and Starks (2017).
[29] See Holmström and Milgrom (1991), Lazear (2000), and an extended discussion in DeVaro and Gürtler (2020).

Table 9's first row shows Variation 0, which is the baseline case that describes the main results of section 5.1. The six variations in the bottom half of Table 9 (i.e., those ending in "w") repeat the corresponding variation in the top half but winsorizing *SalarySpread* at 1% on both ends.[30] Even in the unwinsorized variations, the lower extreme of *SalarySpread* is already truncated by our sample selection rules, given that we require *SalarySpread* > 0 to ensure that the sample comports with a key assumption of tournament theory.

The baseline model restricts the stage-1 estimation samples to tournaments lasting at least five years (i.e., 20 quarters). Some of Table 9's variations tighten this restriction to tournaments lasting at least seven years (i.e., 28 quarters). A tighter restriction increases the degrees of freedom in the stage-1 regression, which improves precision of the stage-1 parameter estimates. But this comes at the expense of a substantially reduced sample size in the stage-2 analysis (from 4752 to 3176), plus amplification of whatever survivorship bias might afflict our main analysis from restricting attention to tournaments lasting at least five years.

Other variations in Table 9 expand the set of regressors in the stage-1 models. These variations are motivated in part by the theoretical analysis in section 6, for the following reasons. Most of the theoretical tournament literature treats θ_i as pre-determined and, therefore, exogenous. The few studies in the theoretical tournament literature that treat θ_i as endogenous allow the n_i executives to choose its value before the tournament starts; that is the approach in Hvide (2002) and Gilpatric (2009) for the classic model and in our Proposition 1 for the market-based model. Both theoretical assumptions are extreme, i.e., exogenous θ_i assumes that executives cannot influence θ_i, whereas endogenous θ_i assumes that executives fully determine

[30] As argued in Chung et al. (2024), measures of vertical executive pay dispersion should not be winsorized because the extremes of the pay distributions (particularly the upper extreme) are interesting and worthy of study. Winsorizing destroys some of the most relevant and interesting variation in salary spreads to be explained. But 1% winsorization on both ends is customary in the accounting and finance literatures, so for completeness we report these results as robustness checks.

θ_i. Empirically, we expect that reality lies between these extremes. Particularly in executive tournaments, managers can likely affect θ_i through their decisions. But even in executive settings the importance of luck is unlikely to be entirely chosen.

Our residual-based θ_i measure reflects a blend of factors that are controllable and uncontrollable by executives. Augmenting the stage-1 regression to include more market-level controls (all of which net out uncontrollable market-level factors) yields a θ_i measure that is relatively more controllable by executives, whereas including fewer market-based controls (with those omitted controls absorbed in the residual) yields a measure that is relatively less controllable. Our approach, therefore, allows us to vary the extent to which the θ_i measure is controllable by the executives.

Several variations in Table 9 include year dummies in the stage-1 regression. In addition to capturing additional macro-level factors, these should capture the time-varying skill of an executive, i.e., learning over time. This helps to mitigate the empirical challenge of distinguishing executive luck from executive skill. The intercept in each tournament's stage-1 regression captures time-invariant executive skill; it is effectively an executive fixed effect.

A downside to including year dummies is that they may also capture factors that would preferably be embedded within θ_i, which is designed to capture "unexplained variation in firm performance after netting out the contribution of market-level factors, as opposed to tournament-level factors." Our θ_i measure aims to remove uncertainties that are common to all tournaments in the market, focusing only on uncertainties that vary across tournaments. Some effects captured by year dummies are tournament-specific rather than market-level.[31] We therefore view

[31] For example, suppose Firm A introduces a new product in year t that turns out to be very popular, causing a spike in total sales. In that same year, Firm B "upgrades" one of its services in a way that turns out to be very unpopular, causing total sales to plummet. The year-t dummy variable would have a large positive coefficient in Firm A's stage-1 regression and a large (in magnitude) negative coefficient in Firm B's stage-1 regression. Such effects should not be netted out in the stage-1 regressions; they should be part of the residual variation that measures θ_i.

variations that include year dummies as complementary to, rather than superior to, our main stage-1 specification. The variations in Table 9 yield different measures of θ_i. In unreported results, we find that the correlation between the measures of θ_i resulting from Variations 0 and 5 is 0.662, and the correlations between the θ_i measures arising from other pairs of variations are all higher.

Variations 2, 2w, 5, and 5w add three additional macro-level variables to the original three regressors in the baseline stage-1 models. The original three regressors are ln(Industry-level Sales), Real Gross Domestic Product Growth, and ln(Industrial Production). The three additional regressors, which represent different aspects of the economy and are relevant for a firm's output (sales), are ln(Producer Price Index), the Federal Funds Effective Rate, and the Unemployment Rate.[32]

Estimation results for Table 9's variations are in Table A.1 and reveal that the main results are largely insensitive to these alternatives. In the unwinsorized variations, all estimates of β from model (1) are negative, as in Table 3, and all are statistically significant at conventional levels except that of for Variation 5, which has a *t*-statistic of 1.5. Winsorizing *SalarySpread* yields even stronger evidence of market-based tournaments than our main (unwinsorized) results, with all estimates of β negative and statistically significant at the five percent level.

As further analyses, we re-estimate the models in Tables 4 to 8 using all eleven variations with different θ_i and winsorization of *SalarySpread* mentioned above (see Tables A.2 to A.5 in

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[32] ln(producer price index) is the natural logarithm of Producer Price Index by Commodity (All Commodities). It is obtained from: U.S. Bureau of Labor Statistics, Producer Price Index by Commodity: All Commodities [PPIACO], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/PPIACO, November 6, 2023. The Federal Funds Effective Rate is obtained from: Board of Governors of the Federal Reserve System (US), Federal Funds Effective Rate [FEDFUNDS], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/FEDFUNDS, November 6, 2023. The Unemployment Rate is obtained from: U.S. Bureau of Labor Statistics, Unemployment Rate [UNRATE], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/UNRATE, November 6, 2023.

the online appendix). Nine out of eleven panels in Table A.2 show that ln(θ_i) is negative and significant for the sub-samples of top and/or middle terciles. Consistent with Table 6, all panels (i.e., all eleven variations) in Table A.3 reveal a negative and significant interaction between *FirmSize* and ln(θ_i) that supports H2. Similarly, all panels in Table A.4 are consistent with Table 7, revealing support for H3 via an estimated coefficient of ln(θ_i) that is negative and significant for the subsamples of highly concentrated markets. Table A.5's results are similar to Table 8's, with an insignificant interaction between ln(θ_i) and HHI.

We close this section with some further results that use alternative measures of the dependent variable, i.e., spreads in components of executive compensation other than base salary (i.e., bonus spread, stock spread, total compensation spread). Section 4.3 explains why such models should not be interpreted as appropriate tests of our hypotheses. Nonetheless, for reference, we report results that use such pay spreads as dependent variables. These results appear in the online appendix's Table A.6 and, unsurprisingly, differ substantially from our results on base salary in Table 3.

The estimated β is positive for all three variables, though the estimate is statistically insignificant in the case of the bonus spread. The regression's explanatory power deteriorates considerably for these three alternative dependent variables. Whereas more than a third of the variation in the base salary spread is explained by the regression, the R^2 drops to 0.06 for the bonus spread, 0.07 for the stock spread, and 0.17 for the total compensation spread (which incorporates the base salary spread as a component).

8. Discussion

Why should accounting and finance scholars, or policymakers, care whether executive promotion tournaments are classic or market-based? One reason is that the effect of policy interventions to regulate pay can differ substantially according to whether pay differentials are generated by classic or market-based tournaments. The following discussion elaborates. We then discuss how our results relate to complementary empirical findings in Cziraki and Jenter (2022) and how both studies point to the relevance of asymmetric learning in executive labor markets.

8.1. Policy Implications

The executive pay differential has grown substantially over time, particularly recently.[33] The increasing pay gap is apparent both in Figure 3, which plots the difference between the CEO's total pay and that of the firm's other executives, and in Figure 4, which plots the corresponding difference between base salaries. The online appendix's Table A.7 displays the data underlying Figures 3 and 4. Is Figure 4's upward trend in the gap in executive base salaries a problem that policymakers should try to curb via regulation? Answering that question requires knowing what type of tournament generates these pay gaps in the first place.

A key issue here is that the two types of tournaments differ in their welfare properties. Assuming that all economic agents are risk neutral, classic tournaments yield first-best optimal effort provision by executives (Lazear and Rosen 1981), whereas that need not be so in market-based tournaments, where in general the equilibrium pay spread (and therefore executive effort levels) may be smaller or larger than under classic tournaments. That difference between the two tournament models has a host of policy implications, of which the following is but one example.

Due to their power and influence within the organization, CEOs may in some firms be able to inflate their own pay to exorbitant levels (Bebchuk and Fried 2006). If CEOs exercise such control over their pay under classic tournaments, this automatically implies inefficient effort allocation (i.e., the firm's executives invest too much effort, which is unprofitable for the

[33] Moreover, it is positively correlated with the pay differential between the CEO and the average pay of the firm's other employees. The latter differential has ignited a public debate over "exorbitant" CEO pay and within-firm vertical pay disparity.

firm due to excessive compensation costs). In that setting, policy interventions to curb CEOs' ability to inflate their pay would be welfare enhancing.

In contrast, under market-based tournaments, CEO inflation of their own pay could *enhance* the efficiency of effort allocation if the market-based equilibrium effort level lies below the first-best effort level. Thus, the possibility of CEOs taking actions to inflate their own pay, which is generally maligned as harmful, can imply more efficient incentives for non-CEO executives in a market-based setting. For that reason, policy interventions (such as pay caps, to be discussed shortly) that seek to limit CEOs' ability to inflate their own pay could be harmful in a market-based setting by worsening executives' provision of effort. This point is noteworthy given that our empirical results support market-based tournaments in many settings.

One regulatory restriction to reduce CEO pay and, therefore, the executive pay gap is a cap on CEO pay, as imposed by the American Recovery and Reinvestment Act of 2008 on failing firms in receipt of public bailout assistance (DeVaro and Fung 2014).[34] Under market-based tournaments, a cap can be harmful by worsening executive effort allocation and by inducing turnover of talented CEOs. Such caps should predict CEO departures under market-based tournaments but not necessarily under classic tournaments.

Other examples of regulatory policies with predicted effects that differ between the two tournaments concern enforceability of restrictive covenants in executive employment contracts (such as non-compete and non-solicitation agreements). These contracts limit executives' mobility across firms, which should depress executive compensation in market-based tournaments but not in classic ones. The preceding two regulatory examples (i.e., pay caps and restrictive covenants) are opposite sides of the same coin: restrictions on pay induce mobility

[34] The issues associated with regulatory restrictions on CEO or executive pay are also relevant in other countries, such as pay restriction imposed on CEOs of centrally administered state-owned enterprises (CSOEs) in China in 2009 (Bae, Gong, and Tong 2024), the 2013 executive pay initiative in Switzerland, and ongoing executive remuneration reforms or regulations in other countries.

changes, and restrictions on mobility induce pay changes. Both predictions derive from a relationship between mobility and pay that is key to market-based but not classic tournaments.

This point about mobility has managerial implications that extend beyond government regulation. For example, negative shocks to a particular CEO's compensation are more likely to trigger the CEO's departure in a market-based than in a classic tournament. The argument is clearest when compensation is construed broadly to include all monetary and non-monetary components of pay. In a market-based setting, but not in a classic one, the CEO is compensated just enough to match what a competing firm would pay them. Thus, any event specific to the CEO's current job that reduces the CEO's satisfaction should induce the CEO to switch firms. This argument echoes the preceding one concerning pay caps, only there the negative pay shock was regulatory in nature, whereas here it is more general and may be non-monetary. This means, importantly, that executive retention and talent management strategies hinge on whether executive promotion tournaments are classic or market-based.

The effects of policy interventions designed to influence the importance of luck in executive tournaments depend crucially on the type of tournament. An example comes from the empirical literature in accounting and finance that links within-firm vertical pay disparity to firm performance (e.g., Mueller, Ouimet, and Simintzi 2017; Rouen 2020; Chung, DeVaro, and Fung 2024). Although that evidence is somewhat mixed and based on different aspects of vertical pay disparity, there is some evidence of an inverted-*U*-shaped relationship between firm performance and the executive pay differential. An implication is that excessively high pay spreads can harm firm performance, which is of potential concern given the trends in Figures 3 and 4.

Suppose that some firms are operating on the downward-sloping segment of the inverted-*U*, meaning the executive pay spread is too high (perhaps because CEOs are inflating their own pay beyond what is optimal, as in Bebchuk and Fried 2006). A regulator might consider policy interventions targeted at reducing θ_i. If tournaments are classic, this policy would have the desired effect of reducing the executive pay gap, thereby increasing profit and making executive effort allocation more efficient. But if tournaments are market-based, the policy would worsen the situation by widening the pay gap even more, thereby further reducing profit and exacerbating the inefficiency in executive effort allocation.

8.2. Asymmetric Learning in the Executive Labor Market

Market-based tournament theory is built on an assumption of asymmetric learning in the labor market, where competing firms know less about an executive's ability than does their current employer. Our empirical results supporting the market-based model throughout most of the firm-size distribution point to the relevance of asymmetric learning in the executive labor market. Complementary empirical work by Cziraki and Jenter (2022) further supports the role of asymmetric learning.

Those authors note that their results can be explained by asymmetric learning (and firm-specific human capital) and not by models of perfectly competitive and frictionless labor assignment in which CEO skills are perfectly observable by all employers in the market and are fully portable across firms. Such assumptions are key to some influential models of executive labor allocation (e.g., Gabaix and Landier 2008, Tervio 2008). Together, our results and those of Cziraki and Jenter (2002) offer evidence that such assumptions appear questionable in the executive labor market, i.e., the role of asymmetric learning should not be ignored.

Cziraki and Jenter (2022) study only S&P 500 firms, whereas our study based on ExecuComp data includes both current and previous S&P 1500 firms. Although both studies report results that draw contrasts between firms of different sizes, there is less variation in such comparisons in Cziraki and Jenter (2022) because they consider only large cap firms whereas we also consider mid and small-cap firms. The size-based contrasts that Cziraki and Jenter (2022) uncover might be even more pronounced if their analysis sample extended beyond large firms.

The results of both studies point to the importance of asymmetric learning in large-cap firms (with the caveat that in our study those in the far-right tail of the firm size distribution appear to be classic tournaments). Those are the only firms studied in Cziraki and Jenter (2022) and the only ones in which we find support for market-based tournaments.

9. Conclusion

The classic tournament model of Lazear and Rosen (1981) continues to be the dominant paradigm in research on executive pay spreads in the accounting and finance literatures. An alternative perspective in which those spreads are the outcomes of the compensation bids of competing employers (rather than the strategic choices of boards of directors) deserves more attention than it has received. This is especially so in the age of social media, with volumes of information about executive talent regularly broadcast faster and to wider audiences. Such information dissemination is key to the market-based perspective.

The preceding policy discussion explains why identifying which theoretical model is relevant to executive tournaments is important. This study is the first to pose and answer that question. The analysis reveals the crucial role of θ_i for empirically distinguishing between the two tournaments. The key insight is that executive pay spreads are increasing in θ_i in classic tournaments and decreasing in θ_i under market-based tournaments.

The empirical evidence supports classic tournaments in the lower and extreme upper parts of the firm-size distribution (i.e., below the bottom 13% and above the top 2.5% of the distribution of total assets), with market-based tournaments in between. As discussed in section 8.1, the two different tournament models have different policy implications. Our results suggest that the optimal policy design is conditional on firm size (i.e., total assets); policies targeting small and very large firms should differ from those targeting medium-sized and large firms.

Our evidence also supports market-based tournaments in highly concentrated product markets, controlling for firm size. Our estimated effects of θ_i on the executive salary spread are large in magnitude. Our theoretical contribution extends the market-based tournament model to treat θ_i not as an exogenous parameter but as an endogenous choice of the competing executives. The new theoretical result is that executives inject their own tournaments with large amounts of uncertainty, resulting in smaller executive pay gaps that dampen their incentives to invest effort.

In closing, we note that our evidence of market-based tournaments throughout most of the distribution of firm size helps to explain the prevalence of formal mechanisms – like the formation of peer groups for benchmarking executive compensation – that are regularly used to determine CEO pay, particularly in large firms.[35] In classic tournaments, the board sets the pay spread solely to create optimal incentives for the firm's non-CEO executives. If that is how the board sets the spread, then it is unclear how benchmarking against what other firms pay their CEOs is relevant to that calculation. In contrast, the benchmarking practice is easily understood in a market-based context, as a means of retaining the firm's CEO (particularly given the absence of internal promotion incentives for the CEO) rather than as a means of purposefully incentivizing the firm's non-CEO executives.

[35] There is even evidence that these peer groups for benchmarking are sometimes purposely chosen in a manner that justifies the board overpaying the CEO. For example, the peer groups might be particularly large for high-paying firms, which make the CEO look underpaid by comparison (Bizjak, Lemmon, and Nguyen 2011).

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Figure 1. Distribution of Estimated θ (Importance of Luck)

Histogram for the estimated θ, i.e., the estimated importance of luck.

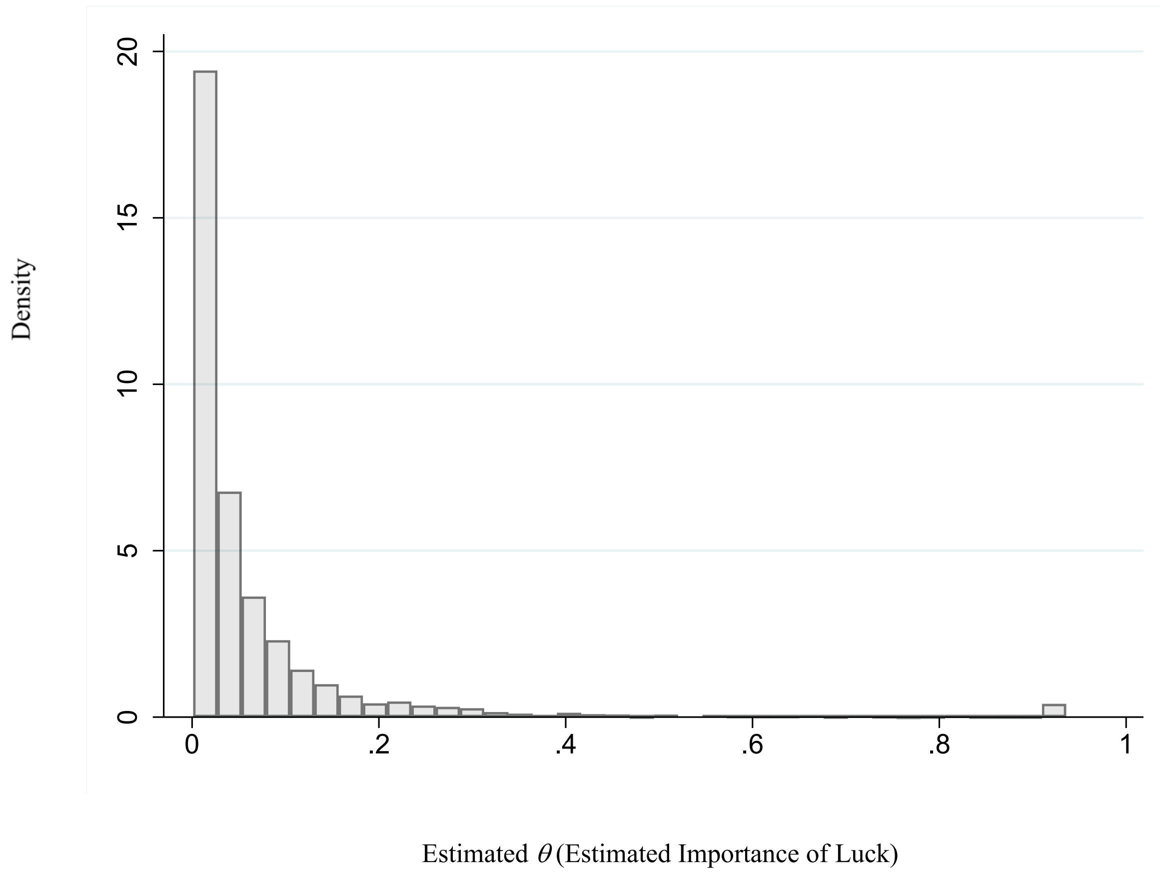

Figure 2: Marginal Effect of ln(θ) on *SalarySpread* plotted as a function of *FirmSize*

This graph, which uses the estimated coefficients in the first 3 row of Model 2 of Table 6, plots ∂*SalarySpread*/∂ln(θ) as a function of *FirmSize*. The vertical axis, *SalarySpread*, is measured in thousands of US $. The horizontal axis is *FirmSize*, with tick marks to label the following 7 percentiles (1, 5, 25, 50, 75, 95, 99). For example, the 25th and 75th percentiles of *FirmSize* are 6.6 and 8.9. *SalarySpread* = 0 where *FirmSize* = 5.93 (i.e., the 13th percentile) and *FirmSize* = 11.63 (i.e., the 97.5 percentile). Thus, the tournaments in the bottom 13% (i.e., total assets below $376 million) and top 2.5% (i.e., total assets above $112 billion) of the *FirmSize* distribution appear classic, and the nearly 85% in between appear market-based.

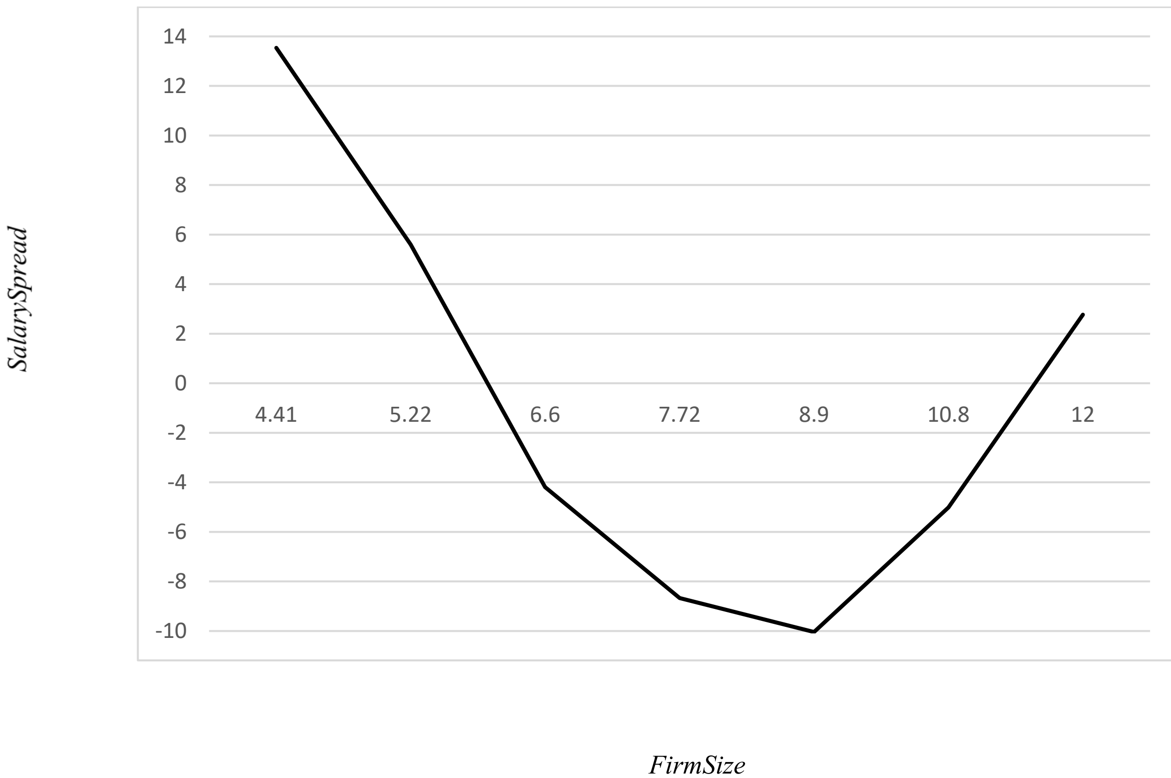

Figure 3. Difference (in thousands of US $) between CEO's total compensation and that of firm's other executives

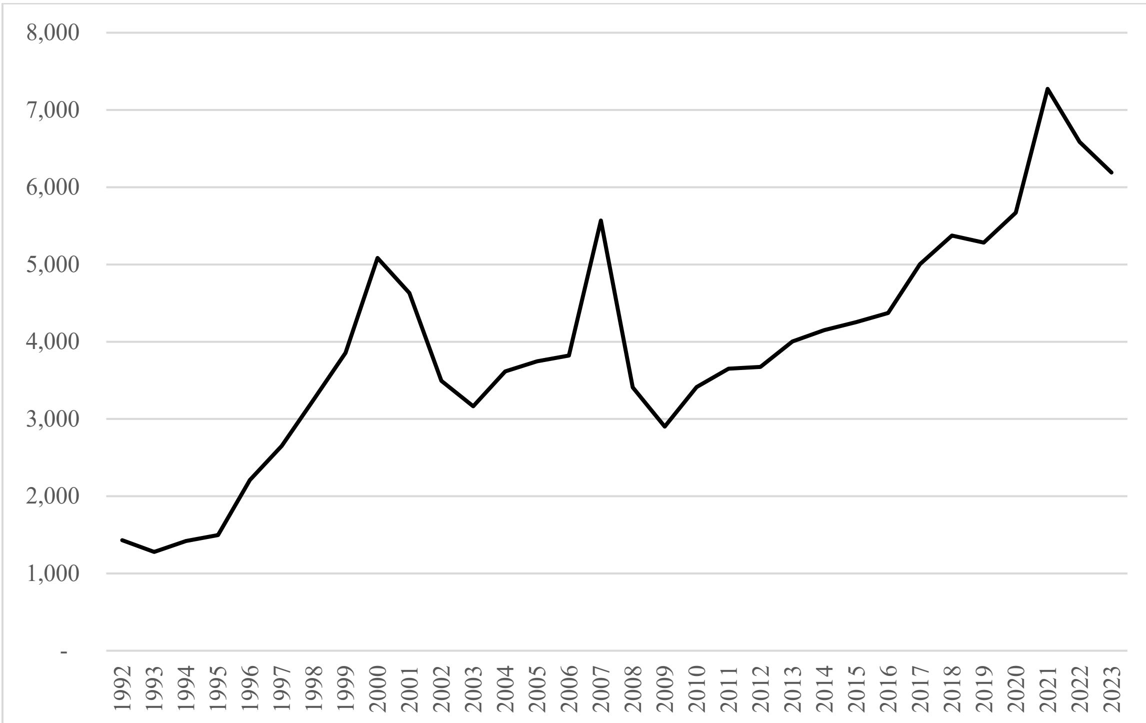

Figure 4. Difference (in thousands of US $) between CEO's salary and that of firm's other executives

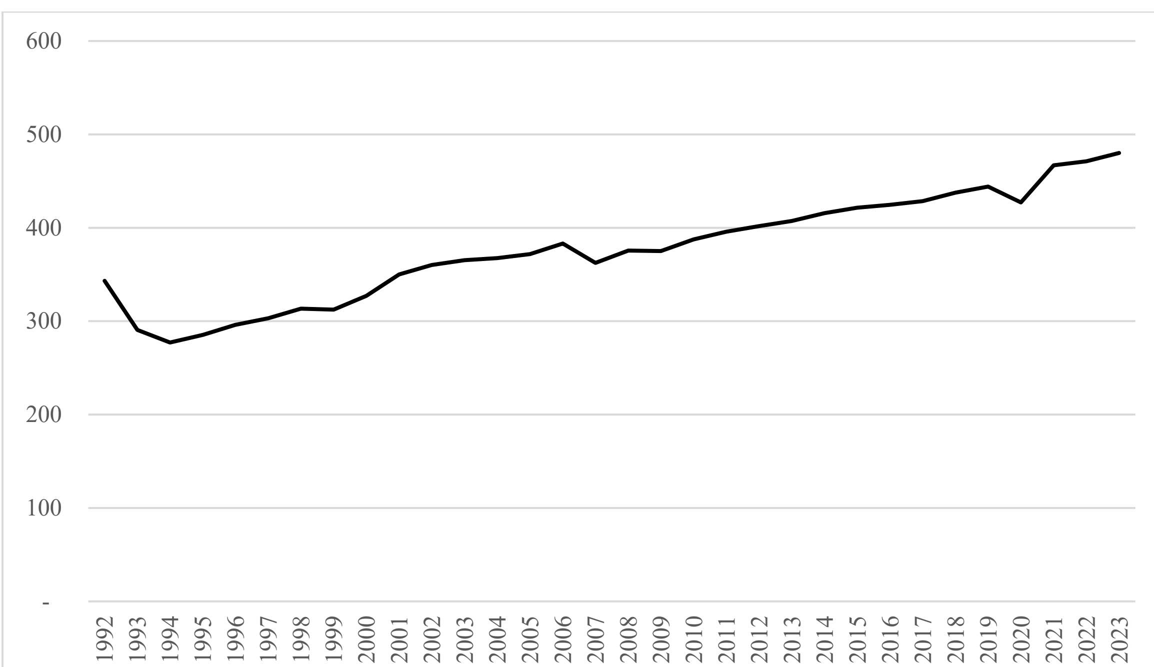

Table 1. Variables and Descriptive Statistics

Panel A gives the definitions of each variable used in the analysis. Panel B displays descriptive statistics of the variables based on the full sample used in the regression analysis (Table 2). Panel C displays a correlation table. All variables, except for those describing the executive pay spread, are winsorized at the top and bottom 1%.

Panel A. Variable Definitions

Variables	**Definitions**
SalarySpread	Difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $)
θ	Measured "importance of luck" in the promotion tournament captures unexplained variation in firm performance after netting out the contribution of market-level factors that are beyond the executives' control. See section 4.4.
T	The number of quarters in the CEO-firm pair (tournament)
FirmSize	Firm size measured by the natural logarithm of total assets (in millions of US $)
ROA	Return on Assets, computed as the ratio of income before extraordinary items to total assets
Executive Directors	Number of executive(s) served as a director during the fiscal year
Leverage	Ratio of long-term debt to total assets
CapExp-to-Assets	Capital expenditure to total assets
Industry concentration (HHI)	Herfindahl-Hirschman index is computed using total sales of firms in the same industry that is based on the Standard Industrial Classification (SIC) 2-digit code
Bonus Spread	Difference between CEO pay (in bonus) and the average pay (in bonus) of the firm's non-CEO executives (in thousands of US $)
Stock Spread	Difference between CEO pay (in stock and options) and the average pay (in stock options) of the firm's non-CEO executives (in thousands of US $)
Total Compensation Spread	Difference between CEO pay and the average pay of the firm's non-CEO executives (in thousands of US $)

Panel B. Descriptive Statistics of Key Variables – Full Sample

Statistics	N	Mean	Std. Dev	Min	p10	p25	Median	p75	p90	Max
SalarySpread	4752	387.237	222.221	0.134	158.472	244.898	362.309	489.984	616.994	3674.824
θ	4752	0.071	0.133	0.001	0.005	0.011	0.027	0.070	0.159	0.936
T	4752	36.710	16.913	20.000	20.000	24.000	32.000	44.000	60.000	100.000
FirmSize	4752	7.829	1.689	2.753	5.725	6.606	7.726	8.978	10.095	12.019
ROA	4752	0.035	0.078	-0.756	-0.020	0.011	0.037	0.070	0.107	0.280
Executive Directors	4752	1.676	0.698	0.545	1.000	1.125	1.500	2.000	2.667	4.143
Leverage	4752	0.217	0.167	0.000	0.016	0.079	0.196	0.319	0.438	0.894
CapExp-to-Assets	4752	0.046	0.045	0.000	0.002	0.016	0.036	0.063	0.097	0.350
Industry concentration (HHI)	4752	0.180	0.162	0.012	0.041	0.066	0.129	0.240	0.383	0.864
Bonus Spread	4752	242.273	663.366	-9495.903	-23.812	0.000	70.389	277.941	617.318	16002.820
Stock Spread	4752	2677.894	7550.254	-10404.350	133.833	532.403	1578.143	3506.579	6141.240	455621.400
Total Compensation Spread	4752	3847.407	6363.699	-12951.940	516.895	1161.356	2549.355	4974.127	8383.500	314842.000

Panel C. Correlation Table of Key Variables

	SalarySpread	θ	*T*	*FirmSize*	ROA	Executive Directors	Leverage	CapExp-to-Assets	HHI	Bonus Spread	Stock Spread
θ	-0.088***	1									
T	0.058***	0.157***	1								
FirmSize	0.505***	-0.128***	0.007	1							
ROA	0.110***	-0.336***	0.062***	0.124***	1						
Executive Directors	-0.045***	-0.036**	0.039***	0.050***	0.100***	1					
Leverage	0.186***	0.022	-0.053***	0.201***	-0.081***	-0.047***	1				
CapExp-to-Assets	-0.052***	-0.021	-0.063***	-0.149***	0.045***	0.098***	0.081***	1			
HHI	0.127***	-0.082***	0.000	-0.026*	0.136***	0.022	0.038***	0.012	1		
Bonus Spread	0.278***	-0.021	0.039***	0.177***	0.027*	0.098***	0.008	0.034**	0.015	1	
Stock Spread	0.168***	0.071***	0.022	0.228***	0.030**	-0.039***	0.060***	-0.049***	-0.001	-0.060***	1
Total Compensation Spread	0.344***	0.050***	0.041***	0.365***	0.061***	-0.045***	0.100***	-0.066***	0.021	0.121***	0.943***

***, **, * indicate statistical significance of pairwise correlation at the 1%, 5%, and 10% levels, respectively.

Table 2. Summary of Stage-1 Regression Results

Stage 1 of the empirical analysis requires estimation of $N = 4752$ regressions for every specification of the stage1-regression model that we consider. The table below reports descriptive statistics for the stage-1 regression coefficients across the 4752 regressions estimated. The three variables included on the right-hand side of the stage-1 model are ln(Industry-level Sales), Real GDP Growth, and ln(Industrial Production). For example, the average *t*-statistic (across the 4752 regressions) of the estimated coefficient of ln(industry sales) is 3.620, a value which meets the threshold for statistical significance at conventional levels. Later we assess the sensitivity of our results to changes in the stage-1 specification.

Statistics	N	Mean	Std. Dev	Min	p10	p25	Median	p75	p90	Max
Coefficient of ln(Industry-level Sales)	4752	0.772	1.364	-12.350	-0.358	0.058	0.564	1.268	2.246	17.509
Std error of ln(Industry-level Sales)	4752	0.328	0.350	0.011	0.087	0.136	0.225	0.392	0.649	5.555
t-statistic of ln(Industry-level Sales)	4752	3.620	5.497	-19.866	-1.383	0.299	2.286	5.664	10.526	52.556
Coefficient of Real GDP Growth	4752	-0.001	0.020	-0.167	-0.020	-0.007	-0.001	0.005	0.015	0.326
Std error of Real GDP Growth	4752	0.011	0.013	0.000	0.001	0.004	0.008	0.014	0.023	0.258
t-statistic of Real GDP Growth	4752	-0.239	1.661	-15.738	-2.211	-1.101	-0.159	0.648	1.541	9.192
Coefficient of ln(Industrial Production)	4752	1.254	4.087	-30.535	-2.512	-0.619	0.941	2.817	5.356	55.378
Std error of ln(Industrial Production)	4752	1.175	1.310	0.052	0.311	0.479	0.795	1.377	2.334	22.702
t-statistic of ln(Industrial Production)	4752	1.681	4.009	-17.549	-2.634	-0.770	1.200	3.674	6.481	34.377
Coefficient of constant	4752	-9.651	19.583	-180.756	-30.793	-17.100	-6.531	1.050	7.769	124.238
Std error of constant	4752	4.552	5.156	0.168	1.102	1.812	3.136	5.352	9.006	98.482
t-statistic of constant	4752	-2.750	5.487	-42.171	-9.109	-5.229	-2.081	0.358	2.847	30.237
Adjusted R-squared	4752	0.508	0.298	-0.173	0.074	0.267	0.541	0.767	0.886	0.986

Table 3. Relationship Between Pay Spread and the Importance of Luck

Regression results when *SalarySpread* is the dependent variable. *SalarySpread* is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). The sample is the full sample of tournaments defined in section 4.2. Variables are defined in Table 1's Panel A. The importance of luck (θ) is estimated using the stage-1 specification summarized in Table 2; the natural logarithm of θ is used as the explanatory variable. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: *SalarySpread*	Model (1) Full sample
ln(θ)	-5.592**
	(2.345)
T	1.029***
	(0.207)
Firm Size	72.120***
	(2.143)
ROA	49.052
	(30.555)
Executive Directors	-25.704***
	(5.231)
Leverage	68.128***
	(20.224)
CapExp-to-Assets	-380.745***
	(84.759)
Constant	-53.590
	(49.843)
Industry dummies	Yes
R-squared	0.35
Number of observations	4752

Table 4. Mechanism and Components of Pay Spread

This table provides results on the mechanism and components of pay spread. Panel A reports regression results when *SalarySpread* is the dependent variable. Panel B reports regression results when *CEO salary* and non-CEO executive salary is the dependent variable respectively. *SalarySpread* is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). The sample is the full sample of tournaments defined in section 4.2. Variables are defined in Table 1's Panel A. The additional control variable, *FinalYear*, is the last year which tournament *i* operated. The importance of luck (θ) is estimated using the stage-1 specification summarized in Table 2; the natural logarithm of θ is used as the explanatory variable. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Pay Spread and the Importance of Luck with *FinalYear*

Dependent variable: *SalarySpread*	Model (1) Full sample	Model (2) Full sample
ln(θ)	-5.747**	
	(2.352)	
T	1.084***	1.082***
	(0.216)	(0.238)
FinalYear	0.613	3.993***
	(0.383)	(0.404)
Firm Size	71.620***	
	(2.200)	
ROA	47.442	
	(30.510)	
Executive Directors	-24.070***	
	(5.453)	
Leverage	63.675***	
	(20.281)	
CapExp-to-Assets	-356.268***	
	(82.641)	
Constant	-1283.307*	-7656.052***
	(773.541)	(812.444)
Industry dummies	Yes	Yes
R-squared	0.35	0.02
Number of observations	4752	4752

Panel B. Components of Pay Spread

	Model (1) Dependent variable: CEO salary	Model (2) Dependent variable: Non-CEO executives salary
ln(θ)	-5.656*	0.119
	(3.047)	(1.341)
T	2.457***	1.372***
	(0.320)	(0.148)
FinalYear	7.263***	6.652***
	(0.505)	(0.240)
Firm Size	144.840***	73.225***
	(2.925)	(1.395)
ROA	32.753	-14.512
	(43.766)	(20.975)
Executive Directors	3.137	27.206***
	(8.421)	(4.043)
Leverage	49.577*	-13.696
	(26.494)	(11.593)
CapExp-to-Assets	-586.307***	-230.078***
	(107.886)	(45.828)
Constant	-14800***	-13500***
	(1025.602)	(488.975)
Industry dummies	Yes	Yes
R-squared	0.55	0.60
Number of observations	4752	4752

Table 5. Relationship Between Pay Spread and the Importance of Luck (by Terciles of Firm Size)

Regression results when *SalarySpread* is the dependent variable. *SalarySpread* is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). Samples are partitioned by terciles of firm size (total assets). Variables are defined in Table 1's Panel A. The importance of luck (θ) is estimated using the stage-1 specification summarized in Table 2; the natural logarithm of θ is used as the explanatory variable. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Model (1)	Model (2)	Model (3)
Dependent variable: *SalarySpread*	Top *FirmSize* tercile	Middle *FirmSize* tercile	Bottom *FirmSize* tercile
ln(θ)	-10.911**	-5.566	-2.29
	(5.354)	(3.412)	(3.052)
T	1.857***	0.830***	0.664***
	(0.533)	(0.270)	(0.217)
Firm Size	70.685***	69.578***	61.360***
	(6.429)	(11.623)	(4.598)
ROA	293.471*	43.778	18.385
	(155.583)	(88.168)	(26.634)
Executive Directors	-28.378**	-25.934***	-22.416***
	(11.497)	(8.869)	(5.060)
Leverage	24.071	111.610***	53.993*
	(40.009)	(35.987)	(31.670)
CapExp-to-Assets	-546.219**	-347.614**	-270.736***
	(212.424)	(164.579)	(78.324)
Constant	97.823	-212.765*	-86.031**
	(125.817)	(109.116)	(38.922)
Industry dummies	Yes	Yes	Yes
R-squared	0.22	0.15	0.19
Number of observations	1615	1568	1569

Table 6. Relationship Between Pay Spread and the Importance of Luck (Interactive Specification with Firm Size)

Regression results when *SalarySpread* is the dependent variable. *SalarySpread* is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). These nonlinear specifications include the interaction between ln(θ) and the relevant independent variable (i.e., firm size). Variables are defined in Table 1's Panel A. The importance of luck (θ) is estimated using the stage-1 specification summarized in Table 2; the natural logarithm of θ is used as the explanatory variable. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	11.361	85.205***
	(10.018)	(28.778)
ln(θ) × Firm Size	-2.154	-21.702***
	(1.348)	(7.784)
ln(θ) × Firm Size × Firm Size		1.236**
		(0.518)
Firm Size	63.958***	-13.878
	(5.619)	(31.123)
Firm Size × Firm Size		4.967**
		(2.109)
T	1.034***	1.046***
	(0.207)	(0.207)
ROA	66.276**	93.599***
	(31.935)	(33.518)
Executive Directors	-25.396***	-25.427***
	(5.276)	(5.293)
Leverage	70.599***	75.200***
	(20.136)	(20.623)
CapExp-to-Assets	-380.602***	-376.048***
	-85.277	-85.794
Constant	4.844	292.380**
	(59.489)	(119.346)
Industry dummies	Yes	Yes
R-squared	0.35	0.35
N	4752	4752

Table 7. Relationship Between Pay Spread and the Importance of Luck (by Market Structure)

Regression results when *SalarySpread* is the dependent variable. *SalarySpread* is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). Samples are partitioned by market structure. Competitive industries (column 1) correspond to a Herfindahl-Hirschman Index (HHI) less than 0.15. Moderately concentrated markets (column 2) correspond to a HHI between 0.15 and 0.25. Highly concentrated markets (column 3) correspond to an HHI greater than 0.25. Variables are defined in Table 1's Panel A. The importance of luck (θ) is estimated using the stage-1 specification summarized in Table 2; the natural logarithm of θ is used as the explanatory variable. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Model (1)	Model (2)	Model (3)
Dependent variable: *SalarySpread*	Competitive market	Moderately concentrated market	Highly concentrated market
ln(θ)	-2.633	-8.531	-5.619**
	(6.315)	(5.921)	(2.519)
T	1.547***	1.357***	0.621***
	(0.529)	(0.521)	(0.195)
Firm Size	79.732***	68.557***	70.551***
	(5.591)	(5.463)	(2.488)
ROA	22.144	108.262	41.737
	-112.346	-109.266	-31.017
Executive Directors	-0.628	-43.375***	-29.759***
	(15.613)	(8.963)	(5.323)
Leverage	57.645	127.045**	46.289**
	(54.326)	(51.756)	(23.075)
CapExp-to-Assets	-428.363**	-210.071	-296.094***
	(192.179)	(233.415)	(104.672)
Constant	-187.121**	39.903	-115.285***
	(91.704)	(94.936)	(35.256)
Industry dummies	Yes	Yes	Yes
R-squared	0.28	0.32	0.39
Number of observations	1106	944	2702

Table 8. Relationship Between Pay Spread and the Importance of Luck (Interactive Specification with Industry Concentration)

Regression results when *SalarySpread* is the dependent variable. *SalarySpread* is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). The nonlinear specifications include the interaction between ln(θ) and the relevant independent variable (i.e., market structure proxied by Herfindahl-Hirschman index (HHI)). Variables are defined in Table 1's Panel A. The importance of luck (θ) is estimated using the stage-1 specification summarized in Table 2; the natural logarithm of θ is used as the explanatory variable. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-4.654	-8.392*
	(3.464)	(4.651)
ln(θ) × HHI	-4.232	40.206
	(18.279)	(51.922)
ln(θ) × HHI × HHI		-71.288
		(91.867)
HHI	59.937	350.178*
	(64.454)	(183.932)
HHI × HHI		-440.726
		(314.424)
T	1.020***	1.024***
	(0.206)	(0.206)
Firm Size	71.944***	71.832***
	(2.131)	(2.130)
ROA	43.488	37.415
	(30.618)	(30.597)
Executive Directors	-25.431***	-25.951***
	(5.264)	(5.200)
Leverage	68.401***	69.602***
	(20.327)	(20.360)
CapExp-to-Assets	-356.078***	-348.723***
	-85.013	-85.215
Constant	-64.217	-92.946*
	(49.733)	(52.239)
Industry dummies	Yes	Yes
R-squared	0.35	0.35
N	4752	4752

Table 9. Summary of Sensitivity Analysis

This table summarizes the variations of the main analysis that are discussed in section 7. See Tables 3 and A.1 of the online appendix for the empirical results. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Variation number	Macro-level regressors in stage 1	Year dummies in stage 1?	# quarters in stage-1, i.e., T_i	*SalarySpread* winsorized?	Main Results: coefficient of $\ln(\theta)$	Corresponding tables
0 (baseline)	ln(Industry-level Sales), Real Gross Domestic Product Growth, ln(Industrial Production)	No	20	No	-5.592**	Table 3
1	ln(Industry-level Sales), Real Gross Domestic Product Growth, ln(Industrial Production)	Yes	20	No	-3.997**	Table A.1, Panel A
2	ln(Industry-level Sales), Real Gross Domestic Product Growth, ln(Industrial Production), ln(Producer Price Index), Federal Funds Effective Rate, Unemployment Rate	Yes	20	No	-3.590*	Table A.1, Panel A
3	ln(Industry-level Sales), Real Gross Domestic Product Growth, ln(Industrial Production)	No	28	No	-6.811**	Table A.1, Panel A
4	ln(Industry-level Sales), Real Gross Domestic Product Growth, ln(Industrial Production)	Yes	28	No	-4.533*	Table A.1, Panel A
5	ln(Industry-level Sales), Real Gross Domestic Product Growth, ln(Industrial Production), ln(Producer Price Index), Federal Funds Effective Rate, Unemployment Rate	Yes	28	No	-3.713	Table A.1, Panel A
0w (baseline)	Same as Variation 0 (baseline)			Yes	-4.900**	Table A.1, Panel B
1w	Same as Variation 1			Yes	-4.476**	Table A.1, Panel B
2w	Same as Variation 2			Yes	-4.142**	Table A.1, Panel B
3w	Same as Variation 3			Yes	-6.185**	Table A.1, Panel B
4w	Same as Variation 4			Yes	-5.260**	Table A.1, Panel B
5w	Same as Variation 5			Yes	-4.583**	Table A.1, Panel B

Online Appendix

Section A1 presents the classic tournament model of Lazear and Rosen (1981). Section A2 presents the market-based tournament model of Waldman (2013), building on Ghosh and Waldman (2010).[36] Section A3 presents the proof of Proposition 1. Throughout this online appendix, the subscript i (indexing tournaments) that is appended to θ_i in the main text is suppressed given that the online appendix discussions pertain only to a single tournament.

A1. Classic Tournament Model

Consider two identical, risk-neutral executives, indexed by subscripts j and k, who compete in the same firm for promotion to the rank of CEO. Their job performances, P, are the sum of their efforts, e, and their luck, u, so $P_j = e_j + u_j$ and $P_k = e_k + u_k$, where u_j and u_k are distributed independently, symmetrically, and identically, with mean zero and variance θ. The parameter θ captures the importance of luck in the tournament.

The firm's board observes which executive has the higher performance and promotes that individual to CEO (awarding compensation contract W_{ceo}), retaining the other as a subordinate (with compensation W_{exec}), where $W_{ceo} > W_{exec}$. Let $C(e)$ denote the executive's cost of exerting effort, where $C(0) = 0$, $C'(0) = 0$, $C'(e) > 0$ for $e > 0$, and $C''(e) > 0$ for $e > 0$. After observing W_{ceo} and W_{exec}, which are chosen by the board *ex ante* to elicit the optimal executive effort choices, executive j chooses e_j to maximize expected utility, i.e., $pW_{ceo} + (1 - p)W_{exec} - C(e_j)$, where p is the probability that executive j wins (i.e., that $P_j > P_k$) which can be expressed as $p = G(e_j - e_k)$, where G is the cumulative distribution function for $u_k - u_j$, and $\partial p/\partial e_j = g(e_j - e_k)$. Executive k's problem is symmetric. The first-order condition

[36] Other market-based tournament models include Gibbs (1995), Zábojník and Bernhardt (2001), Zábojník (2012), Gürtler and Gürtler (2015), and DeVaro and Gürtler (2020).

defining e_j^* is: $(W_{ceo} - W_{exec})\partial p/\partial e_j^* - C'(e_j^*) = 0$. Symmetric equilibrium implies $e_j^* = e_k^*$, so the first-order condition can be rewritten as: $(W_{ceo} - W_{exec})g(0) = C'(e^*)$. Two conditions follow:

$\partial e^*/\partial(W_{ceo} - W_{exec}) > 0$ (A1)

$\partial e^*/\partial g(0) > 0$ (A2)

When u_j and u_k are normally distributed, $g(0) = 0.5(\theta\pi)^{-0.5}$. Thus, (A2) implies

$\partial e^*/\partial\theta < 0.$ (A3)

Intuitively, if the pay spread is held constant, as luck becomes more important (relative to effort) in determining performance and promotion outcomes, executives exert less effort.[37]

The board chooses W_{ceo} and W_{exec} to maximize expected profit, E(Π), subject to incentive compatibility and participation constraints, yielding the following first-order conditions in which the output price is normalized to 1:

$\partial E(\Pi)/\partial W_{ceo} = (1 - C'(e))\partial e/\partial W_{ceo} = 0$ and $\partial E(\Pi)/\partial W_{exec} = (1 - C'(e))\partial e/\partial W_{exec} = 0$.

These and the executive's first-order condition together imply $W_{ceo} - W_{exec} = 1/g(0)$. Note that $\partial(W_{ceo} - W_{exec})/\partial g(0) < 0$. Letting S^* denote the equilibrium compensation spread and recalling that $u_k - u_j$ is normally distributed, the preceding expression implies:

$\partial S^*/\partial\theta > 0.$ (A4)

Given that $(W_{ceo} - W_{exec})g(0) = 1$, any change in $g(0)$ induced by a change in θ is offset by a change in the spread. Intuitively, the board increases the generosity of the prize (which in turn increases effort) to offset the depressed incentives created by an increase in the importance of

[37] The result, which appears on page 847 of Lazear and Rosen (1981), holds for the normal distribution but not for every continuous, symmetric distribution. The reason is that since $g(0)$ is the value of the density function at a particular point, whereas θ is a characteristic of the entire distribution, two distributions might have similar values of their density functions at 0, yet an arbitrary order of variances. The result holds under fairly general conditions, however, for any scale transformation of the error term.

luck in determining performance.[38] Given that the effects of changes in θ on both $g(0)$ and the spread are exactly offsetting, e^* is invariant to changes in θ when the spread can change.

A2. Market-Based Tournament Model

Assume a two-period model in which two executives (indexed by j and k) are hired into a firm in period 1, with that hiring decision observed by competing employers. Once hired, both executives compete for promotion to the rank of CEO. Suppose that the CEO's position can either be staffed or remain vacant. At the start of period 1 it is common knowledge that executive j has innate ability, A_j, which is a_H with probability ρ and a_L with probability 1-ρ, where $0 < a_L < a_H$. Executive j's period-t effective ability, η_{jt}, is $\eta_{j1} = A_j$ and $\eta_{j2} = \delta A_j$, where $\delta > 1$ represents general human capital. Executive j has period-1 performance of $P_{jexec1} = d_{exec}+c_{exec}(\eta_{j1}+e_{j1}+u_{j1})$, where the subscript 1 denotes the time period, e is the effort choice, and u is a mean-zero, normally distributed stochastic term with variance θ. As in the classic model, the parameter θ captures the importance of luck in the tournament. The parameters d_{exec} and c_{exec} are constants known to all. Executive j's period-2 performance if promoted is $P_{jceo2} = (1+f)[d_{ceo}+c_{ceo}(\eta_{j2}+e_{j2}+u_{j2})]$ whereas the same individual's performance as an executive is $P_{jexec2} = (1+f)[d_{exec}+c_{exec}(\eta_{j2}+e_{j2}+u_{j2})]$, where $f = F \geq 0$ if the executive remains with the original employer in period 2 and $f = 0$ if the executive switches employers, so that f captures firm-specific human capital.

Let $0 < c_{exec} < c_{ceo}$, and $d_{ceo} < d_{exec}$, so that performance increases faster with ability in the CEO job than in the executive job. In both periods, executives can choose any effort level in $[e_L,e_H]$, where $e_L = 0$ is sometimes assumed. Executive j's period-t effort cost is $\alpha C(e_{jt})$, where

[38] The result that the board chooses the pay spread that yields the first-best level of effort assumes that executives are risk neutral. If they are risk averse then the board would find it optimal to partially insure them against income risk by choosing a smaller spread, resulting in an equilibrium effort level below the first best. However, even then the qualitative result of interest would continue to hold, i.e., increases in θ would induce the board to increase the spread, as long as risk aversion is not too extreme and the effort cost function is sufficiently convex.

$\alpha > 0$ and $C(e)$ is as defined in section A1 of this online appendix. Higher values of α lower the sensitivity of effort choices to incentives and frequently imply reduced effort.

The board privately observes its executives' performances each period, whereas period-2 job assignments are publicly observed. After observing executive *j*'s period-1 performance, P_{j1}, the executive's board forms an updated belief, $\eta^e(P_{j1})$ at the start of period 2 concerning the executive's effective ability. The timing is as follows. At the start of period 1, all firms make wage offers to each executive, and each executive chooses an employer. Then executives choose period-1 effort, the value of u is realized, and the executive's performance is observed by their board. At the start of period 2, the board assigns the executive to a job that is publicly observed. Each firm then makes the executive a wage offer, and the executive's original employer then makes a counteroffer. Each executive then chooses an employer, switching firms only if offered a strictly higher wage. Then the executive chooses an effort level, a new value of u is realized, and the executive's employer privately observes the executive's performance.

With a small probability the executive is assumed to separate in period 2 for exogenous reasons unrelated to the executive's ability. Whether the separation occurs is publicly observed in period 2 after the executive's board makes a counteroffer. This assumption eliminates or mitigates the winner's curse property. Now, competing firms offer wages equal to the *expected* productivity of an executive in a given job assignment at a competing firm.

Since the model has only two periods, the executive's period-2 effort choice is zero because of the last-period problem. But in period 1, it may be in the interests of executives to exert effort levels beyond this minimum for the same reason as in a classic tournament. That is, higher period-1 effort levels increase the executive's period-1 performance, which the board privately observes and uses to make a promotion decision. Thus, higher period-1 effort levels imply higher promotion probabilities – and the accompanying wage increases – in period 2.

Consider the case $\alpha < \infty$ so that period-1 effort choices are potentially greater than the minimum. Assume that there is enough firm-specific human capital to ensure that there is no executive turnover other than for exogenous reasons and that the production function is such that the board always wants to promote an executive in period 2 rather than leaving the CEO's seat vacant. The highest-performing executive in period 1 is then promoted. Ties happen with probability zero and are resolved by the board randomly selecting which executive to promote.

Competing firms offer a promoted executive a wage equal to the expected productivity of that executive in the CEO's role at a competing firm, i.e., $W_{ceo} = d_{ceo} + c_{ceo}\text{E}[\eta_{j2} \mid P_{jexec1}>P_{kexec1}]$, assuming without loss of generality that executive j is promoted. For the executive who is not promoted, competing firms offer a wage equal to the expected productivity of that executive in the same job at a competing firm, i.e., $W_{exec} = d_{exec} + c_{exec}\text{E}[\eta_{k2} \mid P_{jexec1}>P_{kexec1}]$, assuming without loss of generality that executive k is not promoted. The fact that executives cannot observe innate abilities (their own or their competitor's) implies a symmetric equilibrium in which the executives make identical period-1 effort choices.

The most important result of the market-based model for the present study is:

$\partial S^{*}/\partial\theta < 0$ (A5)

To understand the intuition for this result, first note that if θ approaches 0, then u_{j1} and u_{k1} disappear from the model, and $P_{jexec1} - P_{kexec1} = c_{exec}(\eta_{j1} - \eta_{k1})$, so that the board observes the executive's ability and never makes mistakes in promotions decisions, i.e., the higher-ability executive is promoted to CEO. Thus, as shown earlier, the expected effective ability of promoted executives in the eyes of competing employers is

$\text{E}(\eta_{j2} \mid j \text{ is promoted}, \theta \to 0) = \delta[(2\rho - \rho^2)a_H + (1 - \rho)^2 a_L]$. In contrast, when $\theta \to \infty$ so that the board's information about executive ability disappears, the board often makes mistaken promotion decisions, and each executive's promotion probability approaches 0.5. The expected effective ability of promoted executives in the eyes of competing employers is then

$E(\eta_{j2} \mid j$ is promoted, $\theta \to \infty) = \delta[\rho a_H + (1-\rho)a_L] < E(\eta_{j2} \mid j$ is promoted, $\theta \to 0)$. Analogous expressions could be given for non-promoted executives, such that in the eyes of competing employers $E(\eta_{j2} \mid j$ is not promoted, $\theta \to 0) < E(\eta_{j2} \mid j$ is not promoted, $\theta \to \infty)$. Thus, when θ increases, employers' expectations (conditional on job assignment) about executive ability converge, implying convergence in equilibrium wages.

A3. Proof of Proposition 1

Proposition 1. If the non-CEO executives in market-based tournament *i* have sufficient distaste for effort (i.e., if α is sufficiently high) then in equilibrium they choose infinite θ_i and zero effort.

Proof: Each executive's expected utility is $E(U) = pW_{ceo} + (1\text{-}p)W_{exec} - \alpha C(e_{j1})$. Note that $p = 0.5$ in the symmetric equilibrium, so $\partial p/\partial\theta = 0$. Recall that $\delta > 0$ represents general human capital. Note that W_{ceo} and W_{exec} can be expressed as:

$W_{ceo} = d_{ceo} + c_{ceo}\delta a_L + c_{ceo}\delta(a_H - a_L)\mu_{ceo}$

$W_{exec} = d_{exec} + c_{exec}\delta a_L + c_{exec}\delta(a_H - a_L)\mu_{exec}$, where

$\mu_{ceo} \equiv 2\rho(1\text{-}\rho)\Phi[(a_H - a_L)/(2\theta)^{0.5}] + \rho^2$ and

$\mu_{exec} \equiv 2\rho(1\text{-}\rho)\Phi[(a_L - a_H)/(2\theta)^{0.5}] + \rho^2$. Next, observe that

$\partial\mu_{ceo}/\partial\theta = \text{-}2\rho(1\text{-}\rho)[(a_H - a_L)/(2\theta)^{1.5}]\phi[(a_H - a_L)/(2\theta)^{0.5}] < 0$

$\partial\mu_{exec}/\partial\theta = \text{-}2\rho(1\text{-}\rho)[(a_L - a_H)/(2\theta)^{1.5}]\phi[(a_L - a_H)/(2\theta)^{0.5}] > 0$

The preceding expressions imply:

$\partial W_{ceo}/\partial\theta = c_{ceo}\delta(a_H - a_L)\partial\mu_{ceo}/\partial\theta < 0$

$\partial W_{exec}/\partial\theta = c_{exec}\delta(a_H - a_L)\partial\mu_{exec}/\partial\theta > 0$

Rewriting the preceding two partial derivatives as follows makes clear that the magnitude of $\partial W_{ceo}/\partial\theta$ exceeds that of $\partial W_{exec}/\partial\theta$, because $c_{ceo} > c_{exec}$:

$\partial W_{ceo}/\partial\theta = \text{-}c_{ceo}\delta(a_H - a_L)2\rho(1\text{-}\rho)[(a_H - a_L)/(2\theta)^{1.5}]\phi[(a_H - a_L)/(2\theta)^{0.5}] < 0$

$\partial W_{exec}/\partial\theta = \text{-}c_{exec}\delta(a_H - a_L)2\rho(1\text{-}\rho)[(a_L - a_H)/(2\theta)^{1.5}]\phi[(a_L - a_H)/(2\theta)^{0.5}] > 0$

Next, compute $\partial E(U)/\partial\theta$:

$\partial E(U)/\partial\theta = p\partial W_{ceo}/\partial\theta + (1\text{-}p)\partial W_{exec}/\partial\theta - \alpha\partial C(e_{j1})/\partial\theta =$

$-c_m p(a_H - a_L)2\rho(1\text{-}\rho)\delta[(a_H - a_L)/(2\theta)^{1.5}]\phi[(a_H - a_L)/(2\theta)^{0.5}] +$

$c_s(1\text{-}p)(a_H - a_L)2\rho(1\text{-}\rho)\delta[(a_H - a_L)/(2\theta)^{1.5}]\phi[(a_L - a_H)/(2\theta)^{0.5}] - \alpha\partial C(e_{j1})/\partial\theta =$

$[c_s - p(c_m + c_s)]d - \alpha\partial C(e_{j1})/\partial\theta,$

where $d \equiv (a_H - a_L)2\rho(1\text{-}\rho)\delta[(a_H - a_L)/(2\theta)^{1.5}]\phi[(a_H - a_L)/(2\theta)^{0.5}] > 0$.

The last line of $\partial E(U)/\partial\theta$ is the sum of two terms. The first term, which is negative, includes d and its coefficient. The second term, which is positive, is $-\alpha\partial C(e_{j1})/\partial\theta$. Sufficiently high α ensures $\partial E(U)/\partial\theta > 0$, so that executives choose infinite θ. Note also that the first term approaches zero as $\theta \longrightarrow \infty$, because the denominator of d is $(2\theta)^{1.5}$.

It remains to show that when $\theta \longrightarrow \infty$, the executives exert zero effort. Executive j chooses period-1 effort, e_{j1}, to maximize expected utility of $E(U) = pW_{ceo} + (1\text{-}p)W_{exec} - \alpha C(e_{j1})$, where p is executive j's promotion probability. Executive j's optimal effort, e_{j1}^*, is defined by the following first-order condition:

$(W_{ceo} - W_{exec})\partial p/\partial e_{j1}^* - \alpha C'(e_{j1}^*) = 0$. Expressions for p and $\partial p/\partial e_{j1}$ are as follows:

$p = \Phi[(a_H - a_L + e_{j1} - e_{k1})/(2\theta)^{0.5}]\rho(1\text{-}\rho) + \Phi[(a_L - a_H + e_{j1} - e_{k1})/(2\theta)^{0.5}]\rho(1\text{-}\rho) +$

$\Phi[(e_{j1} - e_{k1})/(2\theta)^{0.5}](1 + 2\rho^2 - 2\rho)$

$\partial p/\partial e_{j1} = \rho(1\text{-}\rho)\phi[(a_H - a_L + e_{j1} - e_{k1})(2\theta)^{-0.5}]/(2\theta)^{0.5} + \rho(1\text{-}\rho)\phi[(a_L - a_H + e_{j1} - e_{k1})(2\theta)^{-0.5}]/(2\theta)^{0.5}$

$+ (1 + 2\rho^2 - 2\rho)\phi[(e_{j1} - e_{k1})(2\theta)^{-0.5}]/(2\theta)^{0.5} > 0$

Note that $\partial p/\partial e_{j1} \longrightarrow 0$ as $\theta \longrightarrow \infty$. Satisfying the preceding first-order condition then requires that $\alpha C'(e_{j1}^*) \longrightarrow 0$ as $\theta \longrightarrow \infty$. Given that $\alpha > 0$ and (from the definition of C in section A1 of this online appendix) $C'(0) = 0$, it must be that $e_{j1}^* \longrightarrow 0$ as $\theta \longrightarrow \infty$. Q.E.D.

A4. Additional Tables of Results

Table A.1. Relationship Between Pay Spread and the Importance of Luck

This table is analogous to Table 3 but uses different measures of θ from the extended stage-1 specification summarized in Tables 9. The dependent variable, *SalarySpread*, is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). Panel A reports the results based the original, unwinsorized *SalarySpread*. Panel B reports the results based on winsorized *SalarySpread*. The sample is the full sample of tournaments defined in section 4.2. Variables are defined in Table 1's Panel A. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Unwinsorized Pay Spread as Dependent Variable

Dependent variable: *SalarySpread*	Model (1) Theta - Variation 0	Model (2) Theta - Variation 1	Model (3) Theta - Variation 2	Model (4) Theta - Variation 3	Model (5) Theta - Variation 4	Model (6) Theta – Variation 5
ln(θ)	-5.592**	-3.997**	-3.590*	-6.811	-4.533*	-2.19
	(2.335)	(1.956)	(1.910)	(3.230)	(2.572)	(2.486)
T	1.029***	0.925***	0.929***	0.846***	0.741***	0.741***
	(0.207)	(0.192)	(0.192)	(0.248)	(0.229)	(0.229)
Firm Size	72.120***	72.497***	72.494***	75.166***	75.686***	75.770***
	(2.152)	(2.190)	(2.201)	(2.747)	(2.786)	(2.796)
ROA	49.052	51.844*	53.827*	81.225*	85.059*	89.308**
	(30.385)	(29.778)	(29.638)	(44.368)	(43.979)	(43.801)
Executive Directors	-25.704***	-25.566***	-25.519***	-26.691***	-26.428***	-26.398***
	(5.240)	(5.241)	(5.242)	(6.944)	(6.935)	(6.936)
Leverage	68.128***	67.203***	67.562***	82.997***	81.403***	81.546***
	(20.228)	(20.290)	(20.281)	(26.726)	(26.893)	(26.883)
CapExp-to-Assets	-380.745***	-382.091***	-382.123***	-370.829***	-373.956***	-373.415***
	(84.221)	(84.235)	(84.283)	(112.392)	(112.688)	(112.690)
Constant	-53.59	-53.535	-52.376	-45.496	-45.145	-42.317
	(50.213)	(49.953)	(49.974)	(73.282)	(73.170)	(73.412)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.35	0.35	0.34	0.34	0.34	0.34
Number of observations	4752	4752	4752	3176	3176	3176

Panel B. Winsorized Pay Spread as Dependent Variable

Dependent variable: Wonsorized *SalarySpread*	Model (1) Theta - Variation 0w	Model (2) Theta - Variation 1w	Model (3) Theta - Variation 2w	Model (4) Theta - Variation 3w	Model (5) Theta - Variation 4w	Model (6) Theta – Variation 5w
ln(θ)	-4.900**	-4.476**	-4.142**	-6.185**	-5.260**	-4.583**
	(1.903)	(1.774)	(1.737)	(2.460)	(2.311)	(2.235)
T	0.856***	0.772***	0.778***	0.680***	0.593***	0.594***
	(0.152)	(0.144)	(0.144)	(0.186)	(0.177)	(0.177)
Firm Size	69.590***	69.765***	69.741***	72.034***	72.311***	72.357***
	(1.794)	(1.797)	(1.802)	(2.243)	(2.245)	(2.248)
ROA	59.469**	57.363**	59.016**	85.821**	83.238**	86.708**
	(27.474)	(27.590)	(27.511)	(39.414)	(39.559)	(39.409)
Executive Directors	-30.433***	-30.316***	-30.262***	-31.662***	-31.423***	-31.385***
	(3.662)	(3.658)	(3.658)	(4.705)	(4.687)	(4.687)
Leverage	63.094***	62.276***	62.689***	74.437***	73.068***	73.268***
	(16.252)	(16.263)	(16.255)	(20.240)	(20.271)	(20.264)
CapExp-to-Assets	-358.596***	-361.416***	-361.683***	-335.605***	-340.419***	-340.330***
	(65.573)	(65.792)	(65.825)	(85.167)	(85.534)	(85.568)
Constant	-44.552	-48.271	-47.459	-47.382	-51.443	-49.233
	(40.440)	(40.551)	(40.567)	(56.177)	(56.266)	(56.439)
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.41	0.41	0.41	0.41	0.41	0.41
Number of observations	4752	4752	4752	3176	3176	3176

Table A.2. Relationship Between Pay Spread and the Importance of Luck (by Terciles of Firm Size)

This table provides a summary results of sensitivity analysis using different measures of θ that are discussed in section 7. It is analogous to Table 5 but uses different measures of θ from the extended stage-1 specification summarized in Table 9. The dependent variable, *SalarySpread*, is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). The main variable of interests, ln(θ), is reported as a summary. Control variables (including *T*, Firm Size, ROA, Executive Directors, Leverage, CapExp-to-Assets) and industry dummies are included in the estimation but they not reported here. Samples are partitioned by terciles of firm size (total assets). Variables are defined in Table 1's Panel A. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Theta - Variation 1

	Model (1)	Model (2)	Model (3)
Dependent variable:	Top	Middle	Bottom
SalarySpread	*FirmSize* tercile	*FirmSize* tercile	*FirmSize* tercile
ln(θ)	-6.365	-5.138*	-0.322
	(4.348)	(2.884)	(2.590)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.22	0.15	0.19
Number of observations	1615	1568	1569

Panel B. Theta - Variation 2

	Model (1)	Model (2)	Model (3)
Dependent variable:	Top	Middle	Bottom
SalarySpread	*FirmSize* tercile	*FirmSize* tercile	*FirmSize* tercile
ln(θ)	-4.870	-4.936*	-0.669
	(4.229)	(2.796)	(2.608)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.22	0.15	0.19
Number of observations	1615	1568	1569

Panel C. Theta - Variation 3

	Model (1)	Model (2)	Model (3)
Dependent variable:	Top	Middle	Bottom
SalarySpread	*FirmSize* tercile	*FirmSize* tercile	*FirmSize* tercile
ln(θ)	-8.310	-7.006	-5.752
	(6.982)	(4.569)	(4.190)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.25	0.11	0.22
Number of observations	1100	1070	1006

Panel D. Theta - Variation 4

	Model (1)	Model (2)	Model (3)
Dependent variable:	Top	Middle	Bottom
SalarySpread	*FirmSize* tercile	*FirmSize* tercile	*FirmSize* tercile
ln(θ)	-4.347	-6.423*	-2.421
	(5.723)	(3.647)	(3.373)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.24	0.11	0.21
Number of observations	1100	1070	1006

Panel E. Theta - Variation 5

	Model (1)	Model (2)	Model (3)
Dependent variable:	Top	Middle	Bottom
SalarySpread	*FirmSize* tercile	*FirmSize* tercile	*FirmSize* tercile
ln(θ)	-3.490	-5.451	-2.165
	(5.462)	(3.560)	(3.261)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.24	0.11	0.21
Number of observations	1100	1070	1006

Panel F. Theta - Variation 0w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Top *FirmSize* tercile	Middle *FirmSize* tercile	Bottom *FirmSize* tercile
ln(θ)	-8.210**	-6.579**	-1.693
	(3.874)	(3.083)	(2.727)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.27	0.18	0.20
Number of observations	1615	1568	1569

Panel G. Theta - Variation 1w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Top *FirmSize* tercile	Middle *FirmSize* tercile	Bottom *FirmSize* tercile
ln(θ)	-7.412**	-5.699**	0.133
	(3.725)	(2.773)	(2.446)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.27	0.18	0.20
Number of observations	1615	1568	1569

Panel H. Theta - Variation 2w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Top *FirmSize* tercile	Middle *FirmSize* tercile	Bottom *FirmSize* tercile
ln(θ)	-6.159*	-5.545**	-0.228
	(3.588)	(2.709)	(2.411)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.27	0.18	0.20
Number of observations	1615	1568	1569

Panel I. Theta - Variation 3w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Top *FirmSize* tercile	Middle *FirmSize* tercile	Bottom *FirmSize* tercile
ln(θ)	-5.843	-8.203**	-4.708
	(5.001)	(4.037)	(3.667)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.29	0.15	0.22
Number of observations	1100	1070	1006

Panel J. Theta - Variation 4w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Top *FirmSize* tercile	Middle *FirmSize* tercile	Bottom *FirmSize* tercile
ln(θ)	-5.992	-6.845*	-1.883
	(5.057)	(3.511)	(3.198)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.29	0.15	0.22
Number of observations	1100	1070	1006

Panel K. Theta - Variation 5w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Top *FirmSize* tercile	Middle *FirmSize* tercile	Bottom *FirmSize* tercile
ln(θ)	-5.315	-6.089*	-1.651
	(4.840)	(3.421)	(3.097)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.29	0.15	0.22
Number of observations	1100	1070	1006

Table A.3. Relationship Between Pay Spread and the Importance of Luck (Interactive Specification with Firm Size)

This table provides a summary results of sensitivity analysis using different measures of θ that are discussed in section 7. It is analogous to Table 6 but uses different measures of θ from the extended stage-1 specification summarized in Table 9. The dependent variable, *SalarySpread*, is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). The main variables of interests, ln(θ), and the interaction effects with firm size are reported as a summary. Control variables (including *T*, Firm Size, ROA, Executive Directors, Leverage, and CapExp-to-Assets) and industry dummies are included in the estimation but they not reported here. Samples are partitioned by terciles of firm size (total assets). Variables are defined in Table 1's Panel A. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Theta - Variation 1

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	5.399	63.984**
	(8.491)	(26.479)
ln(θ) × Firm Size	-1.204	-16.898**
	(1.153)	(7.264)
ln(θ) × Firm Size × Firm Size		1.000**
		(0.489)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.35	0.35
N	4752	4752

Panel B. Theta - Variation 2

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	1.084	69.591***
	(8.397)	(25.394)
ln(θ) × Firm Size	-0.597	-18.892***
	(1.139)	(7.001)
ln(θ) × Firm Size × Firm Size		1.161**
		(0.474)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.34	0.35
N	4752	4752

Panel C. Theta - Variation 3

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	13.758	72.106*
	(13.968)	(36.793)
ln(θ) × Firm Size	-2.587	-18.424*
	(1.867)	(10.087)
ln(θ) × Firm Size × Firm Size		1.031
		(0.683)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.34	0.34
N	3176	3176

Panel D. Theta - Variation 4

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	4.868	73.515**
	(11.630)	(35.018)
ln(θ) × Firm Size	-1.205	-20.187**
	(1.580)	(9.577)
ln(θ) × Firm Size × Firm Size		1.248*
		(0.647)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.34	0.34
N	3176	3176

Panel E. Theta - Variation 5

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	4.435	73.954**
	(11.258)	(33.970)
ln(θ) × Firm Size	-1.041	-20.245**
	(1.527)	(9.303)
ln(θ) × Firm Size × Firm Size		1.261**
		(0.629)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.34	0.34
N	3176	3176

Panel F. Theta - Variation 0w

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	8.849	88.286***
	(8.380)	(26.240)
ln(θ) × Firm Size	-1.747	-22.526***
	(1.101)	(7.052)
ln(θ) × Firm Size × Firm Size		1.298***
		(0.465)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	4752	4752

Panel G. Theta - Variation 1w

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	6.717	59.361**
	(7.593)	(23.637)
ln(θ) × Firm Size	-1.434	-15.276**
	(1.018)	(6.416)
ln(θ) × Firm Size × Firm Size		0.867**
		(0.427)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	4752	4752

Panel H. Theta - Variation 2w

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	3.036	63.695***
	(7.438)	(22.547)
ln(θ) × Firm Size	-0.916	-16.839***
	(0.998)	(6.131)
ln(θ) × Firm Size × Firm Size		0.995**
		(0.409)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	4752	4752

Panel I. Theta - Variation 3w

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	9.095	86.333**
	(11.198)	(33.662)
ln(θ) × Firm Size	-1.922	-22.282**
	(1.457)	(9.127)
ln(θ) × Firm Size × Firm Size		1.288**
		(0.607)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	3176	3176

Panel J. Theta - Variation 4w

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	5.973	69.458**
	(10.427)	(32.280)
ln(θ) × Firm Size	-1.439	-18.575**
	(1.406)	(8.762)
ln(θ) × Firm Size × Firm Size		1.103*
		(0.586)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	3176	3176

Panel K. Theta - Variation 5w

Dependent variable: *SalarySpread*	Model (1) Size Interaction	Model (2) Size Interaction with Quadratic Term
ln(θ)	6.096	68.493**
	(10.199)	(31.251)
ln(θ) × Firm Size	-1.364	-18.170**
	(1.372)	(8.491)
ln(θ) × Firm Size × Firm Size		1.080*
		(0.569)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	3176	3176

Table A.4. Relationship Between Pay Spread and the Importance of Luck (by Market Structure)

This table provides a summary results of sensitivity analysis using different measures of θ that are discussed in section 7. It is analogous to Table 7 but uses different measures of θ from the extended stage-1 specification summarized in Table A.2. See also Table 9 for summary of the variations of the main analysis. The dependent variable, *SalarySpread*, is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). The main variable of interests, ln(θ), is reported as a summary. Samples are partitioned by market structure. Competitive markets (column 1) correspond to a Herfindahl-Hirschman Index (HHI) less than 0.15. Moderately concentrated markets (column 2) correspond to a HHI between 0.15 and 0.25. Highly concentrated markets (column 3) correspond to an HHI greater than 0.25. Control variables (including *T*, Firm Size, ROA, Executive Directors, Leverage, CapExp-to-Assets) and industry dummies are included in the estimation but they not reported here. Variables are defined in Table 1's Panel A. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Theta - Variation 1

	Model (1)	Model (2)	Model (3)
Dependent variable: *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	-4.151	-3.195	-4.134*
	(5.288)	(4.449)	(2.273)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.28	0.32	0.39
Number of observations	1106	944	2702

Panel B. Theta - Variation 2

	Model (1)	Model (2)	Model (3)
Dependent variable: *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	-1.73	-1.034	-4.887**
	(5.001)	(4.192)	(2.327)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.28	0.32	0.39
Number of observations	1106	944	2702

Panel C. Theta - Variation 3

	Model (1)	Model (2)	Model (3)
Dependent variable: *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	1.807	-15.553*	-6.880**
	(8.691)	(8.236)	(3.216)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.29	0.34	0.39
Number of observations	768	597	1811

Panel D. Theta - Variation 4

	Model (1)	Model (2)	Model (3)
Dependent variable: *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	-2.252	-3.000	-5.860**
	(7.015)	(6.515)	(2.827)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.29	0.34	0.39
Number of observations	768	597	1811

Panel E. Theta - Variation 5

	Model (1)	Model (2)	Model (3)
Dependent variable: *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	0.574	0.218	-6.313**
	(6.825)	(6.209)	(2.775)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.29	0.34	0.39
Number of observations	768	597	1811

Panel F. Theta - Variation 0w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	-4.797	-3.849	-5.249**
	(4.427)	(4.579)	(2.297)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.39	0.36	0.43
Number of observations	1106	944	2702

Panel G. Theta - Variation 1w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	-4.831	-3.767	-4.267**
	(4.282)	(4.210)	(2.113)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.39	0.36	0.43
Number of observations	1106	944	2702

Panel H. Theta - Variation 2w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	-3.166	-1.788	-4.854**
	(4.096)	(4.018)	(2.103)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.39	0.36	0.43
Number of observations	1106	944	2702

Panel I. Theta - Variation 3w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	-2.708	-8.271	-6.485**
	(5.784)	(6.023)	(2.936)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.39	0.38	0.43
Number of observations	768	597	1811

Panel J. Theta - Variation 4w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	-3.686	-4.101	-5.738**
	(5.549)	(5.980)	(2.672)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.39	0.38	0.43
Number of observations	768	597	1811

Panel K. Theta - Variation 5w

	Model (1)	Model (2)	Model (3)
Dependent variable: Winsorized *SalarySpread*	Competitive markets	Moderately concentrated markets	Highly concentrated markets
ln(θ)	-1.703	-1.085	-6.146**
	(5.407)	(5.702)	(2.613)
Control Variables, Industry Dummies	Yes	Yes	Yes
R-squared	0.39	0.38	0.43
Number of observations	768	597	1811

Table A.5. Relationship Between Pay Spread and the Importance of Luck (Interactive Specification with Industry Concentration)

This table provides a summary results of sensitivity analysis using different measures of θ that are discussed in section 7. It is analogous to Table 8 but uses different measures of θ from the extended stage-1 specification summarized in Table 9. The dependent variable, *SalarySpread*, is the difference between CEO pay (in base salary) and the average pay (in base salary) of the firm's non-CEO executives (in thousands of US $). The main variables of interests, ln(θ), and the interaction effects with Herfindahl-Hirschman Index (HHI) are reported as a summary. Control variables (including *T*, Firm Size, ROA, Executive Directors, Leverage, CapExp-to-Assets, and HHI) and industry dummies are included in the estimation but they not reported here. Variables are defined in Table 1's Panel A. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Theta - Variation 1

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-2.107	-1.984
	(2.883)	(3.775)
ln(θ) × HHI	-9.891	-10.086
	(14.629)	(36.758)
ln(θ) × HHI × HHI		-1.628
		(59.700)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.35	0.35
N	4752	4752

Panel B. Theta - Variation 2

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-3.304	-2.702
	(2.733)	(3.545)
ln(θ) × HHI	-0.832	-6.851
	(13.011)	(32.338)
ln(θ) × HHI × HHI		7.460
		(49.103)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.35	0.35
N	4752	4752

Panel C. Theta - Variation 3

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-8.697**	-8.009
	(3.802)	(5.319)
ln(θ) × HHI	11.650	9.167
	(16.074)	(51.884)
ln(θ) × HHI × HHI		-1.399
		(69.562)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.35	0.35
N	3176	3176

Panel D. Theta - Variation 4

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-4.847	-0.342
	(3.356)	(4.581)
ln(θ) × HHI	3.238	-44.778
	(15.384)	(40.669)
ln(θ) × HHI × HHI		65.581
		(53.065)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.34	0.35
N	3176	3176

Panel E. Theta - Variation 5

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-5.301	-1.731
	(3.225)	(4.409)
ln(θ) × HHI	10.373	-27.371
	(14.745)	(38.948)
ln(θ) × HHI × HHI		50.591
		(51.176)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.34	0.35
N	3176	3176

Panel F. Theta - Variation 0w

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-4.435*	-5.583
	(2.648)	(3.431)
ln(θ) × HHI	-1.781	13.743
	(11.734)	(31.659)
ln(θ) × HHI × HHI		-26.71
		(49.788)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	4752	4752

Panel G. Theta - Variation 1w

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-3.442	-1.955
	(2.451)	(3.157)
ln(θ) × HHI	-5.148	-20.729
	(11.233)	(28.311)
ln(θ) × HHI × HHI		21.756
		(41.770)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	4752	4752

Panel H. Theta - Variation 2w

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-4.178*	-2.785
	(2.392)	(3.077)
ln(θ) × HHI	0.866	-14.067
	(10.647)	(26.721)
ln(θ) × HHI × HHI		21.031
		(38.301)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	4752	4752

Panel I. Theta - Variation 3w

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-6.672**	-6.656
	(3.258)	(4.283)
ln(θ) × HHI	3.672	7.904
	(13.520)	(37.053)
ln(θ) × HHI × HHI		-10.686
		(51.040)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	3176	3176

Panel J. Theta - Variation 4w

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-5.378*	-0.948
	(3.056)	(4.001)
ln(θ) × HHI	1.907	-45.731
	(13.556)	(35.315)
ln(θ) × HHI × HHI		65.815
		(47.492)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	3176	3176

Panel K. Theta - Variation 5w

Dependent variable: *SalarySpread*	Model (1) HHI Interaction	Model (2) HHI Interaction with Quadratic Term
ln(θ)	-5.651*	-2.169
	(2.959)	(3.893)
ln(θ) × HHI	7.218	-29.948
	(13.112)	(34.144)
ln(θ) × HHI × HHI		50.569
		(45.978)
Control Variables, Industry Dummies	Yes	Yes
R-squared	0.41	0.41
N	3176	3176

Table A.6. Relationship Between Pay Spread and the Importance of Luck (by alternative measure of executive pay spread)

Regression results using other measures of the pay spread as dependent variables. In Model (1), *Bonus Spread* is the difference between the CEO's bonus and the average bonus of the firm's non-CEO executives (in thousands of US $). In Model (2), *Stock Spread* is the difference between the CEO's stock and options and the average stock and options of the firm's non-CEO executives (in thousands of US $). In Model (3), *Total Compensation Spread* is the difference between CEO total pay and the average total pay of the firm's non-CEO executives (in thousands of US $). The sample is the full sample of tournaments defined in section 4.2. Variables are defined in Table 1's Panel A. The importance of luck (θ) is estimated using the stage-1 specification summarized in Table 2. Bootstrapped standard errors are reported in parentheses. ***, **, * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Model (1) Dependent variable: *Bonus Spread*	Model (2) Dependent variable: *Stock Spread*	Model (3) Dependent variable: *Total Compensation Spread*
θ	16.196	421.359**	390.248***
	(9.983)	(188.269)	(135.523)
T	0.933	-0.354	6.355
	(1.022)	(4.910)	(4.962)
Firm Size	76.874***	1268.231***	1639.633***
	(8.682)	(91.513)	(76.266)
ROA	-31.578	2275.831**	2844.958***
	(93.181)	(988.457)	(875.149)
Executive Directors	76.275***	-480.686***	-525.720***
	(15.188)	(91.884)	(95.681)
Leverage	-163.583***	1201.796***	1287.910***
	(59.202)	(466.503)	(411.410)
CapExp-to-Assets	627.959	-1575.648	-3825.380**
	(454.381)	(1232.547)	(1510.792)
Constant	-226.377	-4351.804***	-5687.325***
	(163.673)	(718.061)	(857.415)
Industry dummies	Yes	Yes	Yes
R-squared	0.06	0.07	0.17
Number of observations	4752	4752	4752

Table A.7. Trend in Within-Firm Executive Pay Disparity

Trend in within-firm executive pay disparity from fiscal years 1992 to 2023. Panel A corresponds to Figure 3 and reports the total compensation spread. Panel B corresponds to Figure 4 and reports the salary spread. Both are in thousands of US $. Variables are defined in Table 1's Panel A.

Panel A. Total Compensation Spread (in thousands of US $)

Year	Mean	Median	Std. Dev.	Min	Max
1992	1,429.87	951.36	1,754.58	43.50	14,339.62
1993	1,278.97	679.37	2,087.82	1.16	30,044.38
1994	1,420.37	695.70	2,447.87	0.65	32,527.98
1995	1,497.11	740.38	3,116.13	0.92	63,190.79
1996	2,208.79	931.87	7,087.22	2.78	199,523.70
1997	2,650.72	1,139.58	6,323.50	6.43	116,508.10
1998	3,251.82	1,185.05	15,919.66	2.36	566,253.80
1999	3,856.31	1,357.74	10,462.73	0.42	178,675.40
2000	5,084.58	1,557.26	20,337.59	1.00	593,497.60
2001	4,631.07	1,673.91	13,623.22	0.61	340,750.40
2002	3,494.71	1,665.59	6,160.28	0.06	92,464.95
2003	3,163.45	1,577.82	4,828.53	1.88	73,986.01
2004	3,616.00	1,905.55	5,881.99	8.79	114,136.50
2005	3,747.17	1,952.52	5,796.24	8.12	86,299.45
2006	3,820.19	1,972.47	6,289.96	0.26	122,919.20
2007	5,568.11	1,753.76	95,702.31	0.26	4,466,574.00
2008	3,408.83	1,700.07	6,113.78	0.58	112,524.20
2009	2,901.49	1,608.38	4,190.69	0.15	71,700.92
2010	3,413.75	2,070.22	4,712.97	0.13	80,963.63
2011	3,651.99	2,233.25	5,260.07	0.04	130,802.00
2012	3,673.53	2,322.66	5,235.97	6.61	97,197.64
2013	4,003.63	2,581.32	5,447.13	2.51	94,599.48
2014	4,149.80	2,730.70	5,668.05	1.29	150,463.30
2015	4,253.17	2,878.79	5,500.35	5.11	118,336.30
2016	4,371.20	3,090.14	5,036.24	1.78	83,726.04
2017	5,003.47	3,328.28	7,551.06	2.65	145,215.80
2018	5,373.90	3,687.98	8,553.76	3.85	245,056.40
2019	5,283.68	3,778.01	8,639.91	2.01	280,179.90
2020	5,671.13	3,905.09	9,822.41	5.66	204,406.80
2021	7,273.35	4,815.70	16,450.82	11.44	370,888.30
2022	6,585.49	4,740.28	10,085.35	14.32	195,215.50
2023	6,190.81	4,182.95	9,571.71	2.50	179,814.00

Panel B. Salary Spread (in thousands of US $)

Year	Mean	Median	Std. Dev.	Min	Max
1992	343.21	312.10	219.12	8.95	1,852.98
1993	290.63	257.74	200.44	0.22	2,148.91
1994	277.19	237.88	199.88	2.50	2,281.21
1995	285.36	243.32	213.85	2.35	2,787.96
1996	296.14	256.11	221.22	0.17	3,051.86
1997	303.22	269.57	219.05	0.57	2,989.80
1998	313.50	276.85	214.63	3.12	2,392.05
1999	312.46	275.58	219.33	1.25	2,376.74
2000	327.19	287.32	235.74	3.75	3,262.81
2001	350.18	306.41	249.34	1.01	3,613.31
2002	360.17	326.21	244.14	2.86	3,497.07
2003	365.33	337.34	237.74	2.03	2,583.23
2004	367.51	336.40	239.56	0.54	2,599.23
2005	371.94	334.34	288.95	1.27	5,241.74
2006	383.12	342.50	256.66	1.06	3,901.73
2007	362.49	314.59	259.59	2.98	4,000.75
2008	375.70	334.56	249.18	3.28	3,637.76
2009	375.05	330.00	258.38	0.00	3,324.75
2010	387.56	344.56	278.64	0.00	3,313.40
2011	395.78	358.90	282.63	1.24	4,919.25
2012	401.89	362.74	274.60	0.44	4,869.25
2013	407.32	369.83	267.78	2.15	4,874.06
2014	415.64	379.18	266.13	4.17	4,087.50
2015	421.57	393.67	248.21	1.21	2,582.69
2016	424.65	399.81	255.13	4.06	3,236.20
2017	428.50	402.43	254.61	0.34	3,170.00
2018	437.66	415.25	253.54	1.06	3,170.00
2019	444.17	424.33	255.37	0.36	3,581.03
2020	427.24	407.21	250.38	0.15	2,983.85
2021	466.93	432.85	424.88	9.90	14,375.00
2022	471.22	445.52	392.97	3.60	12,970.00
2023	480.11	458.81	258.01	1.33	3,199.86

Table A.8. Examples of Firms Exhibiting High (or Low) "Importance of Luck"

The importance of luck (θ) is estimated using the stage-1 specification summarized in Table 2. *SalarySpread* (in thousands of U.S. dollars) is defined in Table 1's Panel A. In Table A.8, Panel A provides examples of firms (obtained from the ExecuComp database) in the top decile of the estimated θ. Panel B provides examples of firms in the bottom decile of the estimated θ.

Panel A. Examples of Firms in Top Decile of the Estimated θ

Examples of Firms	**Number of Firm-CEO Tournament in Top-Decile of θ**	θ	***SalarySpread***
WENDY'S CO	1	0.830	397.628
ROYAL CARIBBEAN GROUP	1	0.723	369.377
DECKERS OUTDOOR CORP	2	0.676[1]	521.365[1]
DECKERS OUTDOOR CORP		0.203[2]	458.738[2]
SANDISK CORP	1	0.605	320.318
REGENERON PHARMACEUTICALS	1	0.574	414.639
KEURIG DR PEPPER INC	1	0.382	383.259
EBAY INC	1	0.321	203.903
TYSON FOODS INC	1	0.306	373.601
IROBOT CORP	1	0.290	282.897
INTUIT INC	3	0.269[1]	317.727[1]
INTUIT INC		0.262[2]	484.204[2]
INTUIT INC		0.197[3]	329.596[3]
BROADCOM INC	1	0.223	511.576
EXPEDIA GROUP INC	1	0.208	592.820
SIRIUS XM HOLDINGS INC	1	0.199	685.146
KB HOME	1	0.186	526.417
ELECTRONIC ARTS INC	1	0.176	185.991
SALESFORCE INC	1	0.174	414.587
PANERA BREAD CO	1	0.172	165.589

[1] indicates Firm-CEO tournament 1; [2] indicates Firm-CEO tournament 2; [3] indicates Firm-CEO tournament 3.

Panel B. Examples of Firms in Bottom Decile of the Estimated θ

Examples of Firms	Number of Firm-CEO Tournament in Bottom-Decile of θ	θ	*SalarySpread*
3M CO	3	0.001[1]	755.548[1]
3M CO		0.002[2]	518.740[2]
3M CO		0.003[3]	555.325[3]
ALPHABET INC	1	0.001	1181.666
JOHNSON & JOHNSON	2	0.001[1]	640.966[1]
JOHNSON & JOHNSON		0.005[2]	575.639[2]
CATERPILLAR INC	3	0.002[1]	534.256[1]
CATERPILLAR INC		0.003[2]	580.830[2]
CATERPILLAR INC		0.005[3]	791.013[3]
WALGREENS BOOTS ALLIANCE INC	3	0.002[1]	639.962[1]
WALGREENS BOOTS ALLIANCE INC		0.002[2]	534.386[2]
WALGREENS BOOTS ALLIANCE INC		0.004[3]	440.847[3]
JOHNSON & JOHNSON	1	0.003	809.045
UNITED AIRLINES HOLDINGS INC	1	0.003	278.888
FOOT LOCKER INC	1	0.004	904.053
INTL BUSINESS MACHINES CORP	2	0.004[1]	1039.206[1]
INTL BUSINESS MACHINES CORP		0.004[2]	1300.078[2]
MICROSOFT CORP	1	0.004	1140.534
FORD MOTOR CO	1	0.005	1204.531
LOCKHEED MARTIN CORP	1	0.005	942.825

[1] indicates Firm-CEO tournament 1; [2] indicates Firm-CEO tournament 2; [3] indicates Firm-CEO tournament 3.