4-2018

Industry Tournament Incentives

Zhichuan Li

Industry Tournament Incentives

Jeffrey L. Coles
David Eccles School of Business, University of Utah

Zhichuan (Frank) Li
Richard Ivey School of Business, University of Western Ontario

Albert Y. Wang
Raymond J. Harbert College of Business, Auburn University

We empirically assess industry tournament incentives for CEOs, as measured by the compensation gap between a CEO at one firm and the highest-paid CEO among similar (industry, size) firms. We find that firm performance, firm risk, and the riskiness of firm investment and financial policies are positively associated with the external industry pay gap. The industry tournament effects are stronger when industry, firm, and executive characteristics indicate high CEO mobility and a higher probability of the aspirant executive winning. (*JEL* G31, G32, G34, J31, J33, L25)

Received October 21, 2012; editorial decision March 26, 2017 by Editor Laura Starks.

Prior empirical work has indicated that tournament incentives, specifically the size of the tournament prize, affect the performance of professional golfers (Ehrenberg and Bognanno 1990, Brown 2011), race-car drivers (Becker and Huselid 1992), and football coaches (Fee, Hadlock, and Pierce 2006), and the risk-taking behavior of mutual fund managers (Brown, Harlow, and Starks 1996; Chen, Hughson, and Stoughton 2011). Further, internal tournament

We are grateful to Warren Bailey, Brad Barber, Joseph Chen, Yael Hochberg, Christopher Hrdlicka, Simi Kedia, Yao Lu, Anil Makhija, Bill Maxwell, Nagpurnanand Prabhala, Ned Prescott, Rahgu Rau, Rik Sen, and Konari Uchida and seminar participants at the 2013 Meeting of the American Finance Association, Arizona State University, Boston College, Chinese University of Hong Kong, Federal Reserve Bank of Richmond, the 2012 FMA-UC Davis Napa Conference, Kansas State University, Kyushu University, Rice University, Rutgers University, Southern Methodist University, the U.S. SEC, University of Alabama, University of Alberta, University of California at Riverside, University of Colorado at Denver, University of Maryland, University of Oklahoma, University of Tennessee, and the University of Western Ontario for helpful comments. We thank Dirk Jenter and Florian Peters for the use of their CEO forced turnover data. We have significantly benefitted from the insight and time of Laura Starks, the editor, and two constructive referees. We thank Jaclyn Einstein and Cindy Gross for careful document preparation. Supplementary data can be found on The Review of Financial Studies web site. Send correspondence to Jeff Coles, 1655 Campus Center Dr., University of Utah, Salt Lake City, UT 84112; telephone: (801) 587-9093. E-mail: jeff.coles@eccles.utah.edu.

doi:10.1093/rfs/hhx064 Advance Access publication July 27, 2017

incentives appear to provide senior executives in a firm with the incentive to increase firm performance and risk (Kale, Reis, and Venkateswaran 2009; Kini and Williams 2012; Burns, Minnick, and Starks 2017).[1]

We apply the primary elements of the logic on tournament incentives for executives inside companies in a novel fashion, specifically to the tournament incentives arising outside the firm in the external labor market for managers. We measure external tournament incentives by the pay differential between one firm's CEO and the highest-paid CEOs within a group of similar firms that operate in the same product market(s). Our main hypothesis is that high pay and/or other desirable characteristics of the CEO position at other companies in the same or related industries will provide incentives to CEOs at their own companies. If a CEO leads a company that delivers outstanding performance, through high quantity or quality of managerial input or perhaps from taking risk on behalf of shareholders, then that CEO is more likely to be a strong candidate for the industry prize, specifically a more desirable position leading another company. Such a position can be attractive because of high compensation, enhanced span of control, high visibility, and status as CEO of a leading company in the industry. Precisely along these lines, based on 401 survey responses from CEOs of U.S. companies, Graham, Harvey, and Rajgopal (2005) report that over 75% of CEOs assert that upward mobility in the labor market is more important than the compensation scheme at the CEO's own firm in influencing their own managerial decisions.

In terms of mobility and the tournament prize, there are formal mechanisms, such as the formation of peer groups for benchmarking executive pay, that provide information to top executives on compensation at other firms (e.g., Bizjak, Lemmon, and Nguyen 2011). Of course, peer group comparisons are intended to set pay at the CEO's own firm rather than induce movement to greener pastures. But executives do move, particularly when they perform well. Fee and Hadlock (2003) find that executives who jump to CEO positions at new employers come from firms that exhibit above average stock price performance. They find that this relation is more pronounced for more senior executives and that no such relation exists for jumps to non-CEO positions. Focusing on CEOs with prior CEO experience in another firm, Gudell (2010) shows that they earn a higher level of total compensation than those with no prior CEO experience, future compensation is positively related to prior performance, and with each move compensation almost doubles.

[1] In a tournament setting, multiple agents compete for a fixed number of ordered slots. In golf and auto racing, this means winning the match or race and the associated monetary and other prizes. In a company, the mechanism can be a "horse race" for promotion, and the winning executive receives a prize, such as higher pay, perquisites, and status in the new position (Vancil 1987; Lorsch and Khurana 1999; Naveen 2006). Moreover, given the option-like character of tournaments, some competitors in the tournament will have an incentive to select actions that increase risk, thereby increasing the probability of winning the tournament (e.g., Chen, Hughson, and Stoughton 2011).

Notwithstanding the above, there are some grounds for skepticism regarding our central hypothesis. Aggarwal, Knoeber, and Tsoulouhas (2006) argue that internal candidates for a vacant CEO position tend to be favored over external candidates. They find this effect in the data after controlling for candidate qualifications (skill, talent, and experience). Indeed, a large proportion of CEO hires come from inside the firm (68% according to Cremers and Grinstein 2011). This could suggest that when the external labor market is not very active, external tournament incentives are small or absent and have little power to explain firm performance and risk. On the other hand, executives could obtain part of the external tournament prize, at least the portion that appears in the form of an increase in compensation, even without switching firms. The potential external opportunity would put pressure on the current firm's board to increase the compensation of the sitting CEO, in which case the CEO need not move to extract benefits from the external opportunity. Mechanisms for this extraction include peer benchmarking (Bizjak, Lemmon, and Nguyen 2011) and the board's counter offer to an actual or anticipated external offer to the CEO. Thus, the external pay gap would provide tournament incentives that would affect firm performance and risk even if the CEO does not depart.

These arguments frame our empirical question. To what extent do industry tournament incentives matter? Focusing on internal tournament incentives, Kale, Reis, and Venkateswaran (2009) examine performance and Kini and Williams (2012) study risk-taking. In a similar manner, we test the hypotheses that firm performance and risk-taking positively depend on the extent to which CEOs face significant industry tournament incentives in the labor market for managers.

We construct two measures of industry tournament incentives, both based on the gap between CEO compensation at the firm of interest and maximal or near-maximal CEO compensation potentially available among firms that are similar based on product market and firm size. Based on a GMM specification with instrumental variables, we find that firm performance, as measured by Tobin's q, is significantly positively related to both measures of industry tournament incentives. For a one-standard-deviation increase in the CEO external pay gap, q of the CEO's own firm increases by an average of 0.34, as compared to the sample mean q of 2.23.

Likewise, firm risk, as measured by the variance of daily stock returns, is significantly positively related to instrumented industry tournament incentives. For a one-standard-deviation increase in the external pay gap, the variance of the firm's daily stock returns in the following year increases by 0.004, as compared to the sample mean of 0.030. For evidence on the mechanisms by which CEOs increase risk, we examine investment decisions and financial policy. R&D intensity, firm focus, and leverage all increase in the external industry pay gap, while capital expenditure decreases in the industry pay gap.

Several empirical matters are noteworthy. First, the CEO's board of directors is unlikely to have much control over the external pay gap, which makes it more

likely that our analyses are not contaminated by endogeneity problems and that our finding that industry tournament incentives (ITI) are important for firm performance, risk, and policy is valid. Second, and nonetheless, in addition to including a wide variety of control variables, CEO-firm fixed effects, and lags, we further attempt to address endogeneity concerns by employing instrumental variables and applying GMM in estimation. The two instruments for the CEO external pay gap are (1) the average compensation of geographically close CEOs and (2) aggregate CEO pay in the industry. The latter is most strongly related to the maximal or near maximal end of the pay gap, while the first is relevant for the pay gap primarily through the specific CEO's compensation. Third, our results hold when we control for the internal pay gap, the standard performance and risk-taking incentives arising from executive compensation (delta and vega), an analogously defined industry size gap, the CEO pay slice, and different industry definitions. Finally, we find that the industry pay gap tends to have a stronger effect on firm performance and risk when industry and executive characteristics indicate high CEO mobility, in which case the probability of the CEO capturing some or all of the tournament prize is higher.

Our analysis contributes to the literature in several respects. First, we apply the logic of promotion-based tournaments to propose the notion of industry tournament incentives for CEOs. Elements of this logic appear in Aggarwal, Knoeber, and Tsoulouhas (2006), Kale, Reis, and Venkateswaran (2009), Kini and Williams (2012), and Burns, Minnick, and Starks (2017), though none pursue the notion. In terms of risk-taking, the idea is explicit in the literature on mutual funds (Brown, Harlow, and Starks 1996; Chen, Hughson, and Stoughton 2011), but the focus therein has been on that particular form of financial intermediation. Thus, our primary contribution is to fashion the idea of industry tournament incentives for corporate CEOs and empirically test the implications for firm performance, risk, and policy. Second, our analysis builds on the large prior literature on managerial incentives. Our design considers together standard compensation-related incentives of the CEO (delta and vega), the recently examined internal promotion-based tournament incentives, and external tournament incentives to provide an empirical assessment of the relative economic importance of the external industry tournament. Third, our results evoke the importance of the external labor market for managerial incentives that affect firm performance and risk. This is particularly relevant for those interested in the ability of shareholders to assemble in concert the full spectrum of incentive and monitoring devices to maximize firm value. Fourth, and finally, our results relate to the public controversy over CEO pay. The industry tournament for CEOs, with the significant pay prize at stake, is a potential mechanism for upward pressure on CEO pay (Jensen, Murphy, and Wruck 2004; Bebchuk and Fried 2001; Bebchuk and Grinstein 2005) and for at least some portion of the volatility of firm stock and accounting returns and of the riskiness of firm policy.

1. Hypotheses and Data

1.1 Hypotheses

In this section we develop our hypotheses. In the two-player tournament setup of Lazear and Rosen (1981), effort is the only choice variable and it positively depends on the size of the prize to the winner. Hvide (2002) introduces risk-taking into that model and shows that both competitors have the incentive to choose infinite risk.[2] Our approach alters Lazear and Rosen (1981) and Hvide (2002) in two ways. First, we allow one CEO (the incumbent) to start the contest with a lead, perhaps in performance or perceived ability, relative to the CEO who aspires to move up the industry hierarchy. This allows us to place our model in a managerial labor market with some frictions (see below) and also to evaluate the effects of tournament incentives as a function of the probability of winning, as represented by the size of the initial lead. Second, we impose discreteness on the choice of the risk strategy so as to avoid difficulties in concavity of the decision problem and unboundedness of the choice of risk. The tournament prize in the model, the pay gap external to the firm, is the difference between compensation of the highest-paid (leader) CEO and the pay of the aspirant CEO. The aspirant earns the prize if the aspirant unseats the leader. Otherwise the leader retains their position and wins the prize.

Three model implications are most pertinent for our empirical analysis. First, an increase in the size of the prize, the external pay gap, increases the aspirant's effort and expected performance. Second, in any equilibrium the aspirant prefers and, if feasible, chooses more volatility in the outcome, while the leader prefers and chooses less. Moreover, the preference for higher risk by the aspirant is stronger when the prize is larger. Third, increasing the probability an aspirant can overtake a leader (decreasing the initial lead), all else equal, amplifies the effect of the tournament prize on the aspirant's incentive to perform well. A previous version of this paper supplied a formal model to convey more precisely the intuition behind our specific hypotheses. For the interested reader, Coles, Li, and Wang (2017) presents the model.

Two traditional approaches to the managerial labor market potentially can serve as the setting for industry tournament effects. One tradition argues that external career concerns and "ex post settling up" in the managerial labor market reduce agency problems between managers and shareholders. Managers with superior performance obtain high-wage, external offers, and perhaps board

[2] An alternative to the classic tournament of Lazear and Rosen (1981) is a line of research that focuses on employee promotion as a signal of ability. This work is based on the work of Waldman (1984), with subsequent contributions that include Gibbs (1995), Chan (1996), and DeVaro and Waldman (2012). While the classic and signaling tournament models have differences, such as the role of commitment in setting the structure of the tournament, in many respects the empirical predictions are similar (see Waldman 2013). For simplicity in illustrating the incentive effects that are the focus of our empirical design, we employ the traditional approach of Lazear and Rosen (1981) as adapted by Hvide (2002). At the same time, it is likely that the promotion-signaling approach also would be an appropriate way to model the external tournament.

seats, while managers with poor performance are dismissed and generate low-wage offers or no outside offers. These external labor market effects help discipline managers to work in the interests of shareholders (Fama, 1980).[3]

A second approach focuses on the matching of managers, who differ in talent, to firms that vary in ways that affect the productivity and value of talent, such as the size or nature of the asset base. When firm and manager characteristics are specialized or difficult to duplicate, executives are sorted or "assigned" to CEO positions based on matching their capabilities and human capital to the asset base (e.g., Rosen 1982; Tervio 2008). Suppose reassignment costs are zero; all parties know, without error, the abilities of the CEOs and the nature and productivity of the asset base to which CEOs are assigned; executive capabilities (e.g., through learning) and the character of the firm's asset base do not change through time; and the level and contractual form of pay are unaffected by other considerations (such as moral hazard or intra-firm equity concerns). Then firms and executives would be perfectly matched every time, and, depending on bargaining power, CEOs potentially would be paid something like the value of their marginal revenue product.[4] Executives, who are correctly assigned and paid, would never move. There would be an external pay gap, but it would be irrelevant for executive incentives. In contrast, it is more realistic that executive and firm characteristics are not perfectly known and matching is imperfect. Then firms would learn about the talent of potential CEOs through observing their performance in the job slots they currently occupy. Furthermore, matching can be a dynamic process. Through time executives can learn by doing and firms can require different skills as the firm's strategy and asset base adjust to market conditions. In any case, if the benefits of rearranging exceed the costs of reassignment, CEOs in the industry tournament would then be reallocated to firms, based on the updated assessment of their ability, whenever the home firm does not respond with enough pay and the benefits of capturing the external pay gap exceed the costs of reassignment.[5]

We hypothesize that these tournament incentive effects appear in data from the managerial labor market. In the time series, the effects of variation in the size of the tournament prize on effort and observable firm performance should

[3] Macauley (1963) and Fama and Jensen (1983) also emphasize the incentive and compliance effects of reputation in markets. One focus of tests of reputation in the labor market for directors and managers has been on retention and turnover of top executives. Numerous empirical studies provide evidence on turnover of the top management team when firm performance is poor (e.g., Coughlan and Schmidt 1985; Warner, Watts, and Wruck 1988) or when the firm faces financial distress (e.g., Gilson 1989; Cannella, Fraser, and Lee 1995). Other studies broaden the question to consider board seats; these studies include Gilson 1989, 1990) on bankruptcy; Kaplan and Reishus (1990) on dividend cuts; Coles and Hoi (2003) on takeover protection; and Brickley, Coles, and Linck (1999) on stock and accounting performance.

[4] Of course, when the ability to run a company is a specialized asset and if the CEO has significant bargaining power, even small differences in ability can generate large differences in pay (Rosen 1981; Gabaix and Landier 2008; Pan 2017) and large industry pay gaps.

[5] Based on a structural model, Nickerson (2013) finds evidence of a considerable cost, approximately 4.8% of firm value for the median Execucomp firm, associated with the inability of firms and managers to be optimally matched in the cross-section.

apply to the aspirant CEO. Moreover, through time the CEO should employ a risky (less risky) strategy if the CEO is the aspirant (leader). In terms of the cross-section, comparing CEO tournaments that vary only in the size of the prize, a larger pay gap, using the CEO with maximal pay as the reference point, will be associated with higher effort from the aspirant CEO and better expected performance from that firm. Furthermore, the larger the pay gap the stronger will be the preference of the aspirant CEO for risk and, supposing the aspirant CEO has some discretion over the choice of risk, the higher aspirant firm risk will be. In addition, the effects of the tournament prize on firm performance and risk will be stronger when the probability of the aspirant overtaking the incumbent and capturing the prize is larger.

The primary hypotheses are as follows.

Hypothesis 1. Firm performance increases in the size of the industry tournament prize, as measured by the external pay gap.

Hypothesis 2. To the extent that the trailing CEO can affect risk, then the stock return volatility and riskiness of investment and financial policies of the aspirant's firm increase in the size of the prize.

Hypothesis 3. A higher probability of the aspirant winning the tournament and capturing the gain increases the incentive effect of the tournament on the performance, risk, and policy of the aspirant's firm.

1.2 Data sources

We obtain CEO compensation data from the Standard and Poor's (S&P) ExecuComp database, which covers more than 1,500 firms each year including those that are in the S&P 500, S&P mid-cap 400, and S&P small-cap 600 indices. The sample period is 1992-2005.[6] We obtain stock return data from the Center for Research in Security Prices (CRSP) and firm characteristics from the Compustat Industrial and Segment files. The sample, excluding financial and utility firms, aggregates to 17,702 firm-year observations arising from 2,265 unique firms and 4,136 unique CEOs.

ExecuComp provides data on salary, bonus, stock awards, option grants, and total compensation for named executive officers (NEOs). For total compensation, we use TDC1, which for 2005 and prior eschews using option

[6] Our sample ends in 2005 to avoid data complications associated with the 2006 change in executive compensation reporting requirements (see Coles, Daniel, and Naveen 2013), to allow direct comparison to the results of Kale, Reis, and Venkateswaran (2009), Kini and Williams (2012), and Cremers and Grinstein (2011), and to avoid potential mismeasurement of CEO compensation arising from the recent adoption of complex, performance-contingent vesting provisions (Bettis et al. 2010, 2016). We include all firmyears that have an identifiable CEO (using CEOANN).

grant values reported by the companies in favor of using Black-Scholes. Thus, using TDC1 for 1992-2005 means we can use the same valuation approach for options across all firms.[7]

1.3 Measures of the CEO industry tournament prize

To group firms based on the product market, we apply the Fama-French 30 industry classification (FF30).[8] The discussion above suggests that every CEO in the industry has the incentive to compete for the CEO position in the same industry with the highest pay and perhaps with other desirable attributes, such as increased span of control, perquisites, and visibility. An obvious approach is to define the industry tournament incentive as the compensation gap between the CEO in question and the highest-paid CEO in the same industry. One difficulty is that extreme compensation within an industry in a particular year may be due to an unusual, transitory event, in which case maximal industry CEO compensation is not likely to approximate what the executive would receive if were to win the tournament.[9] To remove at least some potential outliers, we use the second-highest CEO pay rather than maximal pay.[10] Our first measure of industry tournament incentives, *Indgap1*, is defined as the compensation gap between the CEO under consideration and the second-highest-paid CEO in the same industry.

Selecting peer groups to form performance percentile benchmarks for CEO pay is a common industry practice. Moreover, peer groups tend to be comprised of firms with similar revenue from the same industry (Bizjak, Lemmon, and Naveen 2008; Faulkender and Yang 2010; Bizjak, Lemmon, and Nguyen 2011). Accordingly, we use net sales to control for firm size. In each year for each industry, we divide firms into two groups based on whether annual sales (net of returns, discounts, rebates, and allowances) is above or below the industry median.[11] Based on this sample partition, our second measure of industry tournament incentive, *Indgap2*, is the compensation gap between the

---

[7] TDC1 in ExecuComp has some missing values, in which case we use the individual components reported in ExecuComp to calculate TDC1. This adds 171 firm-year observations.

[8] The details are available from http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/ftp/Siccodes30.zip.

[9] For example, Charles Wang, the CEO of Computer Associates, received a large stock grant in 1998 that brought his total compensation to $655.45 million. The second-highest CEO pay within the same industry in 1998 was $43.23 million (Siebel Systems). The lowest CEO compensation in that industry in 1998 was at J. D. Edwards, a computer software company, with total CEO compensation equal to $140,227. Also, executives often accumulate unexercised options. For example, former Walt Disney Chairman Michael Eisner, on December 3, 1997, exercised stock options at a profit of about $565 million, for an abnormally lucrative payday. The exercised options, on 7.3 million shares of stock, had been awarded to Mr. Eisner in contract negotiations in January 1989.

[10] Hall and Liebman (1998) find that regression results with CEO compensation as the dependent variable are sensitive to outliers. Nonetheless, our results are robust to using maximal CEO pay rather than second-highest CEO pay.

[11] As in all calculations herein that partition a sample into subsamples based on the median of a variable, if the sample contains an odd number of observations, we assign the median firm to the subsample comprised of observations above the median. If multiple observations tie at the median, we randomly order the tied firms and assign them in alternating fashion to the above- and below-median groups, starting with the former.

Table 1
Summary statistics

Variable	N	Mean	Median	SD	10th pctl	90th pctl
A. Incentives						
Indgap1 ($000)	17,282	24,501.27	14,296.71	30,036.52	3,470.38	51,431.32
Indgap2 ($000)	16,862	14,891.01	6,955.97	23,676.79	1,219.67	31,384.01
Firm gap ($000)	16,408	3,387.85	1,298.98	12,692.41	232.42	7,143.43
CEO delta (per $1)	17,702	0.039	0.014	0.071	0.001	0.105
CEO vega ($000)	17,702	65.363	32.504	202.055	0	148.577
CEO total compensation ($000)	17,702	4,256.6	1,966.91	11,333.31	524.678	8,906.13
B. CEO characteristics						
CEO tenure (years)	17,702	7.391	7	3.985	3	13
CEO age (years)	16,490	55.405	55	7.822	45	65
New CEO	17,702	0.103	0	0.304	0	0
Retire CEO	16,490	0.219	0	0.414	0	1
C. Industry characteristics						
Ind # CEOs	17,702	91.813	63	64.921	25	204
Ind stock return vol	17,702	0.016	0.009	0.048	0.002	0.040
Industry homogeneity	17,702	0.160	0.150	0.071	0.092	0.237
Industry mobility	17,702	0.153	0.11	0.129	0.06	0.39
Industry talent	17,702	0.723	0.722	0.203	0.5	1
Ind CEO comp ($000,000)	17,702	370.241	206.828	376.771	56.234	869.606
D. Firm characteristics						
q	17,304	2.233	1.647	2.607	1.036	3.778
ROE (%)	17,161	7.229	11.458	27.726	−9.626	25.086
Stock return vol	17,218	0.030	0.025	0.021	0.015	0.049
EBITDA vol	15,729	0.012	0.007	0.020	0.002	0.026
R&D	17,682	0.037	0.002	0.101	0	0.113
CAPEX	17,682	0.064	0.048	0.061	0.014	0.131
# segments	9,547	4.559	3	4.344	1	12
H-index	9,547	0.540	0.422	0.328	0.166	1
Total assets ($000,000)	17,682	4,787.35	963.978	20,173.19	172.597	9,819.99
Sales ($000,000)	17,676	4,228.33	1021	13,215.28	159.231	2,975.60
Book leverage	17,624	0.191	0.166	0.186	0	0.410
Stock return (1 yr)	17,317	0.182	0.102	0.536	−0.360	0.739
Sales growth	17,626	0.177	0.091	0.817	−0.106	0.440
Capital investment	17,642	0.302	0.247	0.218	0.064	0.637
CEO pay slice	17,586	0.372	0.367	0.129	0.220	0.526
FCF	17,612	0.028	0.047	0.149	−0.057	0.114

This table presents summary statistics for ExecuComp firms, excluding financials and utility firms, from 1992 to 2005. We provide incentive measures in panel A, CEO characteristics in panel B, industry characteristics in panel C, and firm characteristics in panel D. See Table A1 (the appendix) for variable definitions. The industry tournament incentive measures and industry instruments are based on the Fama-French 30 industries classification. All calculations, including those in panel C, are based on firm-year observations. All variables related to firm characteristics are winsorized at 1% and 99%.

CEO and the second-highest paid CEO in the same size-industry group.[12] For both measures, the notion is that the tournament incentive is larger when the "promotion" prize is bigger and the gap is wider.

Panel A in Table 1 provides descriptive statistics. The industry pay gap measures accord with the substantial level and dispersion of compensation

[12] For both *Indgap1* and *Indgap2*, we exclude CEOs with a negative pay gap, meaning the highest-paid CEO in each industry or in each sized-based half industry. Our results are almost identical if, instead, we define the pay gap as zero for those highest-paid CEOs and include those observations.

awards to CEOs over the sample period. The median (mean) of our first measure of industry pay gap, *Indgap1*, using second-highest CEO pay within an industry as the benchmark is $14.3 million ($24.5 million). As expected, the industry pay gap conditional on the same size group, *Indgap2*, is substantially smaller than *Indgap1*. Both measures of the industry tournament prize substantially exceed the median (mean) CEO pay of $1.97 million ($4.26 million).[13]

1.4 Dependent variables: Performance, risk, and policy

To measure firm performance (or value) we employ Tobin's q, defined here as the ratio of the sum of market value of equity and book value of debt to total assets. The sample mean and median for q are 2.23 and 1.65. As for firm risk, we define *Stock return vol* as the variance of one year of daily stock returns. Mean and median *Stock return vol* are 0.030 and 0.025, respectively.

Indicators of the riskiness of firm investment policy include: *R&D*, defined as R&D expenditures divided by total assets; *CAPEX*, capital expenditures divided by total assets; *# segments*, the number of operating segments (Compustat segment database); *H-index*, the sum of the square of segment sales divided by the square of firm sales (the Herfindahl index in firm sales); and *Book leverage*, which is book value of interest-bearing debt divided by total assets.

1.5 Internal tournament incentives, delta, vega, and other control variables

Prior studies using U.S. data have documented the empirical effects of within-firm tournament incentives for firm value (Kale, Reis, and Venkateswaran 2009) and risk (Kini and Williams 2012). Burns, Minnick, and Starks (2017) find a positive relation between firm value and the internal pay gap for non-U.S. firms.[14] We follow these studies to calculate *Firm gap* as the difference between CEO total compensation and median VP total compensation.[15] Vice presidents (VPs) are the group of (up to) four named executive officers who are not CEO. This variable captures the increase in a median VP's compensation if she wins the internal promotion tournament. As panel A of Table 1 indicates, the median (mean) within-firm pay gap for our sample is $1.30 million ($3.39 million), which is similar to that reported by Kale, Reis, and Venkateswaran (2009) and Kini and Williams (2012). Note that the internal pay gap is dwarfed by the prize in the external tournament.

---

[13] Gillan et al. forthcoming find that backfill bias in the Execucomp data causes overrepresentation of high-growth companies that experienced high, low-risk returns. Moreover, managers whose data are backfilled tend to have lower salaries, lower total compensation, and higher ownership. It is possible that any biases in CEO pay and maximal CEO pay offset each other in construction of our measures of the pay gap. On the other hand, to the extent that our measures of the external pay gap are affected by such biases, our results should be interpreted with care.

[14] Burns, Minnick, and Starks (2017) also find that the tournament structure itself varies across firms based on country characteristics, including cultural variables, as well as on firm characteristics.

[15] Like Kale, Reis, and Venkateswaran (2009) and Kini and Williams (2012), we eliminate cases with negative *Firm gap*. The regression results are almost identical if, instead, we assign a value of zero and include the observations.

Also note that there is a mechanical relation between the external and internal tournament incentive measures. Holding all else constant, for each dollar that CEO pay rises, the external (internal) pay gap falls (rises) by a dollar. Nonetheless, the correlations among the internal and two external tournament incentive measures are positive in the cross-section, which suggests that some of the economic forces that determine each are distinct.

We control for other incentive variables previously established to be empirically relevant. For managerial incentives arising from CEO compensation structure, we calculate CEO delta and vega. In computing these measures, we include direct stock ownership, restricted stock, and existing and newly granted stock options, all based on accumulated grants net of dispositions. CEO delta represents the sensitivity of CEO wealth to firm performance. Per Aggarwal and Samwick (2003), we define *CEO delta* to be the change in executive wealth per $1 change in shareholder wealth. *CEO vega* is the change in the value of the CEO's wealth for a 0.01 change in the annualized standard deviation of stock returns.[16]

In most specifications, we employ control variables pertaining to CEO attributes (*CEO tenure* and *CEO age*), firm attributes (*Stock return 1 yr*, *Sales growth*, *Book leverage*, *R&D*, *Capital investment*, and *FCF*), and industry attributes (*Industry stock return vol*). See Table A1 (the appendix) for detailed definitions.

2. Instruments and Other Variables Related to the Industry Tournament Prize

We argue that the industry pay gap provides tournament-based incentives for managers to improve firm performance and to increase risk. In performance-on-structure and structure-on-structure regression specifications, however, omitted variables, measurement error, and simultaneity or reverse causation are general concerns (e.g., Coles, Lemmon, and Wang 2011) that are likely to be relevant for our specific empirical questions. One potential line of attack is to supplement a comprehensive set of control variables and fixed effects with instruments. Thus, we estimate a first stage using instrumental variables, control variables, and fixed effects to predict the industry pay gap for each CEO in each year. The

[16] For direct stock ownership and restricted stock, we compute the number of shares of stock held by the executive divided by the number of shares outstanding. For stock options, we follow Yermack (1995) to compute the option delta from the Black-Scholes option-pricing model (the change in the value of the stock option for a one dollar change in the stock price) multiplied by the ratio of the number of options held to total shares outstanding. Following Core and Guay (1999), we separately compute option deltas for new option grants and existing options. For newly granted options, we assume a maturity of seven years because executive stock options are generally exercised early (Carpenter 1998; Huddart and Lang 1996; Bizjak, Bettis, and Lemmon 2003). For existing options, we assume that unexercisable options (those that are not vested) have a maturity of six years and that exercisable (vested) options have a maturity of four years. The dividend yields and volatility estimates for each firm year are given in ExecuComp. The risk-free rate is from the U.S. Federal Reserve Bank website. See Coles, Daniel, and Naveen 2006, 2013) on calculating pay level, delta, and vega using ExecuComp.

second stage regresses measures of firm performance and risk on the predicted industry pay gap, controls (excluding the instruments), and fixed effects.

2.1 Endogeneity concerns

There are several specific endogeneity concerns. First, the industry pay gap potentially is influenced by firm performance and risk. TDC1 (Execucomp) is comprised of salary, annual bonus, other annual pay (including perquisites and benefits), total value of restricted stock granted, total value of stock options granted, long-term incentive payouts (LTIP), and all other pay (such as tax reimbursements and signing bonuses). While salary tends to be set based on performance over the prior year, some of the other components of pay can be affected by contemporaneous performance and risk.

For example, the annual cash bonus schedule often is based explicitly on market or accounting performance in that year (Murphy 1999). Furthermore, long-term incentive cash payouts are based on a performance period longer than one year, so if the executive is in the last year of that period, then performance in that year can affect the LTIP payout. Thus, high performance in that same year is likely to cause an increase in CEO cash compensation. This would lead to a reduction of the gap between maximum pay in the industry and the pay of the CEO and, therefore, would spuriously reduce the estimated relation between performance or value and the industry tournament incentive (ITI).[17]

Second, and likewise, to the extent that the payout schedule for an annual bonus scheme or expiring LTIP award is convex in performance, an increase in contemporaneous risk will increase the expected payout in that year, thereby reducing on average the industry pay gap. Some annual bonus schemes and LTIP award schedules are convex for at least some of the performance domain (Murphy 1999). If executives are immediately able to change policy and increase risk in response to ITI, and if the annual bonus and expiring LTIP are significant components of pay, then estimates of the effect of the external pay gap on firm risk can suffer from a spurious negative relation between risk and the industry pay gap.

One approach to reverse causation is to employ lags. In the specifications explaining firm risk, we lag the industry pay gap measure by one year. This addresses the causation problem associated with the annual bonus and expiring LTIPs. Because Tobin's q is forward looking, insofar as it contains the present value of anticipated future performance, for the models explaining firm performance, we use contemporaneous values of q and the ITI. Nonetheless, q also can depend on current performance, so some concern about reverse causation remains.

[17] While the annual cash bonus and the LTIP typically are a relatively small portion of CEO pay, they are large for some firms (Murphy 1999). By way of illustration, for 2004 pay to CEOs of large US companies of $6.5 million, on average (in year 2000 dollars), the LTIP and the annual bonus payouts represented 27%, grant date value of stock and options comprised 51%, salary was 17%, and other (including pension and benefits) represented 5%. See Frydman and Jenter (2010).

Third, in terms of omitted variables, it is likely that growth opportunities affect both of the dependent variables, firm performance and risk, and our primary explanatory variable, the external pay gap, through CEO compensation. For example, firms with extraordinary growth opportunities are likely to demand extraordinary talent and skill on the executive team and to pay accordingly. Further, the position of CEO at a firm with high growth opportunities is likely to be demanding and require higher pay. Including a common proxy for growth opportunities, Tobin's q, does no good because we use it as a key outcome variable. Lagged q is unsuitable because investment opportunities (and q and the need for talent) are persistent. Fortunately, other proxies for growth opportunities and the need for talent are available. We use R&D intensity, investment in hard assets, and sales growth, as well as CEO-firm fixed effects, to capture growth opportunities.

2.2 Instruments for the industry pay gap

We utilize two instruments for the external pay gap. First, for each CEO-firm-year we calculate the average compensation of geographically close CEOs. Per Bouwman (2011), we expect the average compensation of geographically close CEOs to be positively associated with the total compensation of aspirant CEOs.[18] To the extent that pay in one location is associated with general conditions in the market for executives, this measure also should be associated with maximal or second-highest CEO pay in the industry. If the former effect dominates, the instrument will be negatively related to the industry pay gap. We follow Bouwman (2011) to construct *Geo CEO mean* as average total compensation received by all other CEOs of firms headquartered within a 250-km radius of the firm.[19]

In terms of the exclusion condition, we do not expect the average level of pay for geographically close CEOs to affect firm performance or risk, except through industry tournament incentives. Submitting this assertion to further inspection, one concern is that production technology or investment opportunities might be correlated with geographic location for some types of firms, such as mining firms that colocate near mineral deposits or high-tech firms spawned from top universities nearby. On the other hand, with

[18] Bouwman (2011) finds that CEO pay is related to the pay of geographically proximate CEOs in their reference group. Likewise, Kedia and Rajgopal (2009) argue competition for employees causes firms to grant more stock options to rank-and-file workers when a higher percentage of geographically close firms grant more options. Also see John, Knyazeva, and Knyazeva (2011) on the impact of geography on agency costs and payout policy.

[19] We obtain the location (city) of the headquarters of every firm in the sample from Compustat and latitude and longitude data from the Census 2000 U.S. Gazetteer. We exclude the 33 firms with headquarters outside the United States. Since Compustat assigns the latest headquarters location to all years, we verify the headquarters location for every firm over the entire sample period using 10Ks (and other financial documents, if needed) and correct the location if necessary. We also confirm that city names correspond with the names found in the Gazetteer "places" files and correct the name when needed. When we do not find a city name in the Gazetteer file (90 instances), we check the location of the city on maps.google.com and assign the observation to the nearest place on the Gazetteer file within a 15-km radius of the original location. We estimate the actual distance between cities with the Haversine formula, which gives great-circle distances between two points on a sphere.

modern communication and transportation (distribution) technologies, many firms have broad geographic span and operate and compete on a national or global basis. Thus, there should be at most a weak link between the location of a firm's headquarters and investment opportunities. We further address the concern through the following means. First, in formulating the instrument, when calculating average compensation of geographically close CEOs, we exclude all CEOs in the same industry (FF30). Second, in the GMM IV models we control for growth opportunities. Third, we employ CEO-firm fixed effects in both regression stages. These and other controls should increase the likelihood that this instrument and the other instrument described below satisfy the exclusion condition. The correlation between *Geo CEO mean* and *Indgap1* (*Indgap2*) is −0.28 (−0.23).

The second instrument we consider for the pay gap is a modification of total CEO pay in the industry. Our measure extends the notion that "fair" wages for employees depend on a firm's ability to pay (Kahneman, Knetsch, and Thaler 1986), so that total industry CEO compensation reflects the ability of an industry to pay. This is consistent with each CEO being paid more if the industry ability to pay is higher, which accords with the empirical observation that when maximal CEO pay is relatively high in an industry other CEOs in that same industry tend to be highly paid (Dickens and Katz 1986).

To avoid a mechanical relation between industry total compensation and our industry pay gap measures, when we calculate industry aggregate pay we exclude both components of the external pay gap, pay of the aspirant CEO at the firm in question and the "brass ring" (specifically maximal and second-highest pay in the industry or size-based half-industry). The omissions in construction mean the instrument varies in the industry across firms. While the proposed instrument never contains the pay of the CEO in question, common factors shaping the labor market are likely to cause pay of all CEOs in the industry to covary with each other and with omitted CEO pay. In terms of the pay gap, however, it is unclear whether the pay gap would be positively or negatively related to total industry pay, though we expect the former if near-maximal pay is more strongly related to total industry pay than is aspirant pay.[20] The correlation between *Ind CEO comp* and *Indgap1* (*Indgap2*) is 0.52 (0.49). To control for the possibility that average or aggregate CEO talent in the industry drives both total pay to CEOs in the industry and firm performance, in the GMM IV models

[20] If modified industry CEO pay indeed is a strong predictor of each CEO's pay, the contemporaneous mechanism is likely to be common factors in the labor market, rather than causal effect from one CEO's pay to the pay of another CEO (whether maximal or nonmaximal). The most direct connection from one CEO's pay to the pay of another likely would be the peer benchmarking process, as administered by the HR director and board compensation committee, often with the assistance of a compensation consultant. Through this process, the pay of industry peers from the prior year, not the current year, with a growth or inflation factor applied (e.g., 5%), translates lagged peers' pay into benchmarks used to set pay in the current year. See Bizjak, Lemmon, and Nguyen (2011), Faulkender and Yang (2010), and Murphy (1999). Rather, our measure of the industry ability to pay is meant to capture the contemporaneous correlation of pay and to exclude any causal effect from lagged peer pay and performance to the current pay of the CEO.

we control for individual CEO experience and firm/CEO performance. Again, we also include CEO-firm fixed effects in both stages.[21]

The diagnostics below indicate that both instruments are sufficiently correlated with one or both of the components of the endogenous regressor, the external pay gap, after controlling for the exogenous regressors (relevance). While we argue that both instruments affect firm performance and risk mainly through their effect on the industry pay gap, we fully acknowledge the difficulties in identifying proper instruments that satisfy exclusion.[22] Readers should apply appropriate caution in interpreting the results.

2.3 Other factors that affect the industry tournament prize

We follow prior research (Graham, Li, and Qiu 2011; Coles, Daniel, and Naveen 2006) in selecting the observable firm and manager characteristics that determine the level of CEO compensation. Variables include firm size, performance, and sales growth, industry volatility, and CEO tenure and age. At the industry level, we control for the volatility of industry performance and the number of CEOs (firms) in the industry comparison group.

2.4 CEO mobility and the industry prize

If executives are mobile and the firm wishes to retain the CEO, the firm will set pay higher to prevent departure and the external pay gap will be lower, all else equal. In contrast, if CEO immobility makes preemptive raises or equilibrating pay adjustments unnecessary, firms can set CEO pay so as to be less than fully responsive to growth in peer firm pay benchmarks, so the external pay gap potentially would be larger

We employ two CEO-level proxies for CEO mobility. First, the probability of turnover for a new CEO should be lower. Second, when a CEO is close to retirement, the likelihood of an immediate promotion to another firm in the same industry is also lower. *New CEO* equals 1 in the CEO's first year of

[21] In terms of *Ind CEO comp* satisfying exclusion, a potential concern arises if executives view the market as providing multiple upside and downside tournaments. If so, then the top end of the pay gap for one or more of the nonmaximal upside tournament gaps is a component of the proposed instrument. For downside gaps, the instrument can contain compensation figures representing the potential loss if the executive were to be displaced downward. On the other hand, in both the upside and downside instances, the ends of the wage gap all enter the measure as positive numbers, rather than in a way that represents the tournament pay gaps. Thus, while the instrument is related to a collection of tournaments, it is unclear as to whether the aggregation of the ends of the wage gaps weakens the argument that the second instrument satisfies exclusion. Moreover, CEO-firm and year fixed effects should account to some extent for variation of CEO position in the industry hierarchy and the number of upside and downside tournaments for the CEO. We empirically assess multiple upside and downside tournaments in the Internet Appendix.

[22] We also consider product market demand or competitiveness as a potential candidate for an instrument. In unreported regressions, we use the Herfindahl index of sales in the industry as a proxy for product market competitiveness and find it is not strongly related to the industry pay gap. Moreover, Giroud and Mueller (2011) show that firms in noncompetitive industries have lower equity returns, worse operating performance, and lower firm value. Thus, product market competitiveness seems unlikely to satisfy exclusion and surely does not satisfy relevance.

service as CEO (0 otherwise). *Retire CEO* equals 1 if the CEO is older than 65 (0 otherwise).

At the industry level, frictions, such as information costs and the fixed costs of repeatedly but imperfectly solving the assortative matching problem, for example, should reduce executive mobility in the industry (Nickerson, 2013). Restated, lower frictions should imply an active and competitive labor market for CEOs and higher CEO turnover rates, all else equal. To measure industry mobility in the CEO labor market, we calculate the annual unconditional probability of CEO turnover in each industry (*Industry Mobility*). We define a turnover event if a CEO in one year is not the same person in the next year. In addition, Cremers and Grinstein (2011) argue that firms that require more firm-specific human capital will promote from within, implying that CEOs in such industries are less likely to be replaced by outsiders. This limits the potential outside options of the CEO, which likely diminishes the incentive effect of the industry tournament prize. Following Cremers and Grinstein (2011), we measure the firm-specific talent in each industry by the percentage of insider CEOs in each industry per year (*Industry talent*). Along the same lines, the likelihood of hiring an outsider as CEO is higher when firms operate in homogeneous industries (Parrino 1997). We follow Parrino (1997) to construct *Industry homogeneity*, which measures the similarity among firms within an industry after isolating market effects.[23]

The number of firms (and corresponding CEO positions) in an industry potentially reflects the degree of competition for those slots. Competition among more candidates for more positions is likely to compress the variation in CEO pay, the gap in pay between the maximum and minimum and, more generally, the gap between the industry maximum and pay at a given firm. On the other hand, more CEOs in the same industry could be associated with larger variation in pay, perhaps due to randomness in performance and thus pay, in which case the typical pay gap need not shrink as the number of firms increases. Whether the former effect dominates the latter, so as to compress the external pay gap, is an empirical question.

2.5 Findings on the determinants of the industry tournament prize

Table 2 presents our findings on the "determinants" of the industry pay gap. All regressions in the table are pooled time-series, cross-sectional regressions with instruments, CEO-firm and year fixed effects, and observable firm, CEO, and industry characteristics. Columns 1 and 2 report results for the baseline specifications. Columns 3 and 4 include additional controls for CEO mobility.

[23] First, we assign firms in the CRSP monthly returns file to their respective Fama-French 30 industries classification code and then regress each firm's prior 60 monthly returns on an equally weighted monthly industry index and the market return. For each firm in each year, we then compute the partial correlation coefficient between the firm's returns and the industry index while holding market returns constant. *Industry homogeneity* is the average partial correlation coefficient for all firms within an industry. We use a 5-year rolling estimation period for each year in the sample.

Table 2
Determinants of the industry tournament prize

	Dependent variable			
Explanatory variables	ln(*Indgap1*)	ln(*Indgap2*)	ln(*Indgap1*)	ln(*Indgap2*)
CEO delta	−0.567**	−0.229*	−0.625*	−0.559*
	(0.245)	(0.122)	(0.356)	(0.310)
ln(*Firm gap*)	−0.127***	−0.220***	−0.127***	−0.214***
	(0.012)	(0.018)	(0.012)	(0.018)
ln(*Total assets*)	−0.222***	−0.040	−0.209***	0.007
	(0.053)	(0.075)	(0.051)	(0.074)
Stock return (1YR)	−0.066**	−0.106**	−0.062**	−0.100**
	(0.028)	(0.044)	(0.028)	(0.045)
Sales growth	−0.012	0.022	−0.013	0.017
	(0.011)	(0.018)	(0.011)	(0.018)
ln(*CEO tenure*)	0.103	−0.062	0.127**	−0.153
	(0.069)	(0.096)	(0.076)	(0.114)
ln(*CEO age*)	−1.013	−2.548	−1.407	−3.668
	(1.963)	(2.401)	(2.076)	(2.561)
Industry stock return vol	0.163	−0.675	0.050	−0.353
	(0.680)	(0.898)	(0.658)	(0.873)
ln(*Ind # CEOs*)	−1.271***	−0.819***	−1.279***	−0.768***
	(0.160)	(0.211)	(0.177)	(0.229)
New CEO			−0.047	−0.223**
			(0.072)	(0.104)
Retire CEO			−0.046	−0.172
			(0.083)	(0.129)
Industry homogeneity			0.872	1.505
			(0.723)	(1.089)
Industry mobility			0.008***	0.003
			(0.003)	(0.004)
Industry talent			0.036	0.047
			(0.084)	(0.134)
ln(*Ind CEO comp*) (IV)	2.200***	1.874***	2.121***	1.729***
	(0.090)	(0.144)	(0.092)	(0.143)
ln(*Geo CEO mean*) (IV)	−0.054**	−0.100**	−0.109**	−0.112**
	(0.019)	(0.045)	(0.052)	(0.055)
Year fixed effects	Yes	Yes	Yes	Yes
CEO-firm fixed effects	Yes	Yes	Yes	Yes
Observations	15,264	14,804	14,732	14,315
Adj. R-squared	0.144	0.092	0.141	0.080

This table presents multivariate models of the determinants of industry tournament incentives using data on ExecuComp firms, excluding financials and utility firms, from 1992 to 2005. The dependent variables are the natural logarithm of *Indgap1*(*Indgap2*) in Columns 1 (2) and 3 (4). *Indgap1* is the pay gap between the second-highest-paid CEO's total compensation within the same Fama-French 30 industries classification and the CEO's total compensation. *Indgap2* is the pay gap between the second-highest-paid CEO's total compensation in the same industry (FF30) and size group and the CEO's total compensation. Table A1 (the appendix) defines all other incentive variables and control variables. We include year and CEO-firm fixed effects in all specifications. Firm-clustered and Newey-West-corrected (up to four lags) standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

For the baseline results in Columns 1 and 2, the negative coefficients on *CEO delta* and the internal pay gap suggest that firms factor in the industry tournament when designing the pay structure of their own CEOs. Perhaps a higher external tournament incentive makes internal incentives less necessary. An alternative explanation is that implementing higher CEO delta requires larger stock and option grants and, thus, higher pay and a lower external gap. Also note that the CEO's pay defines the lower and upper edges of the external and internal pay gaps, respectively, so there is a mechanical negative relation

between the two gaps. CEO pay increases in firm size (Murphy 1999), so it is natural to find that *Indgap1* decreases in firm size. In contrast, *Indgap2* is constructed conditional on firm size. Variation across half-industries drives the association between size and ln(*Indgap2*). Better firm stock performance is contemporaneously associated with a lower external pay gap. Neither CEO age nor CEO tenure is related to the industry pay gap. The industry pay gap is not related to industry stock return volatility.

The estimated coefficient on the number of CEOs in the industry is significantly negative in all four models, consistent with competition among more candidates compressing variation CEO pay. In Columns 3 and 4, we find little association between the CEO and industry mobility measures and the industry pay gap. The exceptions are a significantly negative coefficient on whether the CEO is new for *Indgap2* and a significantly positive coefficient on *Industry mobility* for *Indgap1*.[24]

Turning to our chosen instruments, as expected, the coefficient estimate on ln(*Geo CEO mean*) is always negative and is significant at least at the 5% level in all four specifications. Likewise, the effect on the industry pay gap of industry "ability-to-pay" (industry total compensation, *Ind CEO comp*) is positive and significant at the 1% percent level in all models.

3. Industry Tournament Incentive Effects

3.1 Industry tournament incentives and firm performance

Hypothesis 1 suggests a positive relation between firm performance and external tournament incentives. Because of the endogeneity concerns delineated above, on the right-hand side we use the predicted industry pay gap. We use GMM IV because the null hypothesis that there is no heteroskedasticity based on plain vanilla 2SLS IV is rejected.[25] As the dependent variables are likely to be time-persistent, here and throughout we report firm-clustered and Newey-West-corrected (up to four lags) standard errors. In order to isolate the effects of external tournament incentives, we control for CEO delta arising from the managerial compensation contracts, NEO tournament incentives internal to the firm, growth opportunities, and other variables. In all regressions, we include year and CEO-firm fixed effects.

Table 3 reports estimates of the relation between industry tournament incentives and firm performance. The dependent variable is contemporaneous

[24] The results of Kale, Reis, and Venkateswaran (2009) and Kini and Williams (2012) suggest that firms set a higher internal promotion-based tournament prize when the probability of winning the tournament is lower. This direct connection appears to be more tenuous for the external industry pay gap. The likely reason is that the firm does not have the discretion to set the industry maximum CEO pay, firm CEO pay, and promotion probability in a coordinated way.

[25] We perform Pagan and Hall's (1983) test of heteroscedasticity. For both *Indgap1* and *Indgap2*, $p < 0.001$.

Table 3
Industry tournament incentives and firm performance

	Dependent variable and model type					
	OLS	GMM IV		OLS	GMM IV	
Explanatory variables	q	1st stage ln(*Indgap1*))	2nd stage q	q	1st stage ln(*Indgap2*))	2nd stage q
ln(*Indgap1*)	0.008					
	(0.005)					
Predicted ln(*Indgap1*)			0.237***			
			(0.027)			
ln(*Indgap2*)				0.005		
				(0.005)		
Predicted ln(*Indgap2*)						0.276***
						(0.035)
CEO delta	0.395	−0.555*	0.414	0.054***	0.421	0.097
	(0.769)	(0.346)	(0.682)	(0.010)	(0.538)	(0.676)
ln(*Firm gap*)	0.055***	−0.127***	0.083***	−0.332***	−0.216***	0.111***
	(0.010)	(0.011)	(0.011)	(0.092)	(0.019)	(0.013)
ln(*Total assets*)	−0.332***	−0.208***	−0.350***	−0.143***	0.013	−0.406***
	(0.093)	(0.050)	(0.079)	(0.052)	(0.068)	(0.082)
ln(*CEO tenure*)	−0.137***	0.103*	−0.150***	−0.832	−0.062	−0.110**
	(0.053)	(0.059)	(0.049)	(1.440)	(0.082)	(0.053)
ln(*CEO age*)	−0.546	0.826	−0.219	0.978***	−2.336	−0.040
	(1.414)	(1.613)	(1.172)	(0.063)	(2.001)	(1.235)
Stock return (1 yr)	0.966***	−0.065***	0.996***	0.073	−0.114***	1.028***
	(0.061)	(0.023)	(0.057)	(0.057)	(0.041)	(0.060)
Sales growth	0.079	−0.007	0.079	−0.001	0.015	0.069
	(0.060)	(0.008)	(0.056)	(0.622)	(0.013)	(0.055)
FCF	−0.133	0.064	−0.196	1.865***	0.153	−0.097
	(0.688)	(0.168)	(0.559)	(0.624)	(0.251)	(0.530)
R&D	1.765***	−0.119	1.703***	0.024	−0.024	1.747***
	(0.677)	(0.195)	(0.582)	(0.388)	(0.333)	(0.536)
Capital investment	0.004	−0.261	0.053	2.295	−0.213	0.086
	(0.392)	(0.279)	(0.363)	(2.145)	(0.429)	(0.370)
Industry stock return vol	2.539	0.106	1.062	0.059	−0.697	0.987
	(2.143)	(0.749)	(1.895)	(0.071)	(0.983)	(1.897)
ln(*Ind # CEOs*)	0.056	−1.301***	−0.202***	0.336	−0.848***	−0.267***
	(0.068)	(0.148)	(0.067)	(0.748)	(0.195)	(0.075)
ln(*Ind CEO comp*) (IV)		2.241***			1.901***	
		(0.082)			(0.126)	
ln(*Geo CEO mean*) (IV)		−0.017**			−0.084**	
		(0.008)			(0.037)	
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
CEO-firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,946	14,946	14,946	14,492	14,492	14,492
R-squared	0.214	0.146	0.145	0.217	0.092	0.121
Endogeneity, relevance, and overidentification						
Hansen J-test		2.180			1.871	
Hausman exogeneity test		42.42***			42.03***	
First-stage F-statistics		372.34***			115.74***	

This table presents multivariate regression models of firm performance on industry tournament incentives using ExecuComp firms, excluding financials and utility firms, from 1992 to 2005. The dependent variable is q, which is the ratio of the sum of market value of equity and the book value of debt to total assets. *Indgap1* is the pay gap between the second-highest-paid CEO's total compensation within the same Fama-French 30 industries classification and the CEO's total compensation. *Indgap2* is the pay gap between the second-highest-paid CEO's total compensation in the same industry (FF30) and size group and the CEO's total compensation. Table A1 (the appendix) defines all other incentive variables and control variables. We include year and CEO-firm fixed effects in all specifications. Firm-clustered and Newey-West-corrected (up to four lags) standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Tobin's q.[26] The first three columns present results using *Indgap1*. For ordinary least-squares (OLS) regressions (Column 1), included here and later as a basis for comparison, the coefficient on ln(*Indgap1*) is 0.008, which is statistically insignificant. Columns 2 and 3 contain results from the two-stage GMM IV estimation. In the second stage (Column 3), the coefficient on predicted ln(*Indgap1*) is 0.237 (p <.01). The Hausman exogeneity test rejects the null hypothesis that the OLS and GMM IV estimates on ln(*Indgap1*) are the same (p <.01). The difference in results is consistent with the notion that better firm performance and higher firm value shrink the external pay gap, so that the estimate on ln(*Indgap1*) is attenuated in the OLS specification through reverse causation. In contrast, the sign and the magnitude of the coefficient using GMM IV are consistent with a positive effect flowing from industry tournament incentives to firm performance. In terms of economic significance, a one-standard-deviation increase in *Indgap1*, acting through ln(*Indgap1*) and the estimated GMM IV coefficient, increases Tobin's q by 0.34, which is economically significant in comparison to the median (mean) Tobin's q of 1.65 (2.23) in our sample.[27] Based on median (mean) total assets of $964 million ($4.79 billion), this change in q is equivalent to a change in firm value of $327 million ($1.629 billion).

Columns 4-6 in Table 3 report confirmatory results for similar specifications based on *Indgap2*. Using GMM IV, the coefficient on ln(*Indgap1*) in Column 6 is 0.276 (p <0.01).[28] Again, the Hausman exogeneity test rejects the hypothesis (p <.01) that the OLS and IV estimates are the same. The first-stage F-statistics for both *Indgap1* (372.34) and *Indgap2* (115.74) indicate that our instruments

[26] If the capital markets are reasonably efficient, contemporaneous q should capture at least some of the valuation consequences of tournament incentives. Moreover, executives will have had to anticipate the industry pay gap, with the various components of pay to be fully realized at the end of the year, to understand and act upon the tournament incentive. Two mechanisms contribute to the ability of a CEO to anticipate the industry pay gap. One is via benchmark data provided by compensation consultants. The compensation consultants provide those data for the past year and then typically apply a growth factor (e.g., 5%) to construct the benchmarks. To the extent that pay has persistent components, via uniform time-based vesting schedules for stock and option and long-term cash, for example, then the benchmarking should give a window into what realized end-of-year pay will be. Second, public disclosures (10-K, DEF14A) contain information on total compensation, grants of stock and options and long-term cash, outstanding equity-based awards, options and stock vested, and options exercised. While prior to the 2006 change in disclosure requirements the reporting was not as reliable or comprehensive as it is now, we consider it likely that executives still would have had a pretty good idea of what realized pay would be for executives in their own industry and elsewhere. As an empirical matter, when we estimate forward q as a function of predicted industry pay gap we get similar results.

[27] We use the natural logarithm of the industry pay gap in most regressions. To calculate the economic significance, we first compute the level of industry pay gap 0.5 standard deviations above and below the mean. We then compute the difference between the natural logarithm of the high and low industry pay gap and apply the appropriate coefficient estimate.

[28] We repeat the analysis for annual return on equity (ROE) in year $t+1$ as the performance measure, with results similar in direction, significance, and inference to those reported in Table 3. The GMM IV coefficient on ln(*Indgap1*) is 0.012 (p <.01) as compared to the OLS estimate of −0.003. Hansen's J, Hausman, and F tests support using GMM IV. In terms of economic significance, a one-standard-deviation increase in *Indgap1* increases ROE in the next year by 0.021, which represents a sizeable increase in comparison to the median (mean) ROE in our sample of 0.115 (0.073). For brevity, we do not provide tabular results.

collectively satisfy the relevance condition, and neither J-statistic rejects the null.[29,30]

The coefficients on CEO delta (per Columns 3 and 6) tend to be insignificant when q is the dependent variable, which is consistent with Coles, Lemmon, and Meschke (2012). The coefficients on internal (VP) tournament incentives are positive and statistically significant, which provides support for the findings in Kale, Reis, and Venkateswaran (2009). The signs of the coefficients on the control variables generally are similar to those previously documented (e.g., Coles, Daniel, and Naveen 2006).

Overall, consistent with Hypothesis 1, the GMM IV results suggest that a strong positive relation exists between firm performance and our measures of the CEO industry tournament prize. It appears that the CEO industry pay gap provides executives the incentive to perform better.

3.2 Industry tournament incentives and firm risk

Hypothesis 2 posits that the possibility of being promoted to a "better" firm with higher compensation gives aspirant executives the incentive to increase firm risk. Increasing firm risk, through investment or financial policy, for example, can generate uncertain but potentially extreme performance that increases the likelihood an aspirant CEO is promoted over peer CEOs.[31] Goel and Thakor (2008) provide a model that addresses this connection between tournament incentives and corporate risk-taking. The idea also is familiar insofar as Kini and Williams (2012) find a relation between internal tournament incentives and firm risk and Brown, Harlow, and Starks (1996) and Chen, Hughson, and Stoughton (2011) apply the notion to competition among mutual fund managers.[32]

As the dependent variable, we employ *Vol*, defined in percentage terms as 100 x *Stock return vol* over calendar year $t+1$. Our primary explanatory variable is the predicted CEO industry pay gap. In determining firm risk CEOs

---

[29] IV estimation with weak instruments can perform poorly in absolute terms and in comparison to OLS (Stock, Wright, and Yogo 2002). Table 3 and the subsequent tables report the F test for relevance for the collection of instruments used in each of the first-stage regressions that support the second stage specifications. We form the F-statistic based on Kleibergen-Paap-Wald statistics and employ critical values from Stock and Yogo (2005).

[30] Given there are more instruments than endogenous regressors, we perform Hansen's J-test for overidentifying restrictions, which is the GMM extension of the Sargan test (2SLS). This tests whether all instruments are exogenous, assuming that at least one instrument is exogenous. In Table 3, neither of the J-statistics is significant at conventional levels, which suggests that it is unlikely that one instrument satisfies the exclusion condition while the other does not.

[31] Increasing risk in this way also increases the probability of the CEO being far out of the money in the competition for the tournament prize, but in a winner-take-all tournament losing is the same, regardless of whether it is a close or distant loss. That said, a CEO potentially can lose her job when performance is extremely poor. Thus, there is a trade-off between the cost from the increased likelihood of being fired and the benefit from increasing promotion probability and expected payoff. If the benefits exceed the costs, this trade-off suggests that the chosen risk level will increase with the magnitude of the prize (pay gap) in the industry tournament.

[32] There is a potential countervailing effect. In an industry with big pay gaps, high-paying firms will understand that low-paid CEOs have strong incentives to take risks. Therefore, when a low-paid CEO delivers strong performance the high-paying firms realize that this performance was more likely due to luck than skill and the firm will be less willing to hire the low-paid CEO.

face potential costs of reduced expected utility arising from exposure to risk through performance-contingent compensation. On the other hand, convexity in executive compensation can offset the risk exposure arising from CEO *delta* to possibly increase the incentive to take risk (Guay 1999; Coles, Daniel, and Naveen 2006). Thus, we control for CEO *delta* and *vega* arising from the compensation scheme, as well as for VP tournament incentives (per Kini and Williams 2012), to assess whether industry tournament incentives affect firm risk.

Based on prior literature (Servaes 1994; Bhagat and Welch 1995; Opler et al. 1999; Nam, Ottoo, and Thornton 2003; Coles, Daniel, and Naveen 2006), we also control for firm size, Tobin's q, book leverage, the growth rate of sales, stock return, and CEO age and tenure. Unobserved variables, such as CEO risk aversion, are likely to affect both the dependent variable (firm risk) and independent variable (the industry tournament incentive). For instance, a risk-tolerant CEO will take more risks and earn more through increased option value, which leads to a lower industry pay gap. These omitted variable problems work against finding a positive link between firm risk and industry pay gap. We seek to mitigate the bias through year and CEO-firm fixed effects and instrumental variable estimation. Table 4 reports the results. The first (last) three columns show the results for *Indgap1* (*Indgap2*).

GMM IV (Column 3) gives a significantly positive coefficient of 0.176 on ln(*Indgap1*) ($p < 0.01$) that is more than 12 times the OLS estimate in Column 1. The Hausman test rejects the null hypothesis that the OLS and GMM IV estimates on *Indgap1* are the same.[33] A one-standard-deviation increase in *Indgap1* implies a 0.004 increase in stock return volatility, as compared to a median (mean) of 0.025 (0.030).[34]

Columns 4-6 repeat the analysis of the industry pay gap using *Indgap2*. The OLS coefficient on *Indgap2* is slightly positive and marginally significant ($p < .10$), while the GMM IV coefficient is a significantly positive 0.219 ($p < .01$), which is more than 30 times the OLS estimate. Again, the Hausman test rejects the hypothesis that the OLS and GMM IV estimates are equal. The first-stage F-statistics for the two industry pay gap measures exceed 90 and are highly significant ($p < .01$) and neither J-statistic is significant at conventional levels.

---

[33] This difference in coefficients is consistent with the omitted variable problem leading to a downward-biased OLS parameter estimate on the industry pay gap.

[34] We repeat the analysis for two alternative measures of firm risk. Accounting volatility is the standard deviation of abnormal (seasonally adjusted) quarterly EBITDA divided by total assets for the 20 quarters from year t through year $t+4$. The OLS coefficient on ln(*Indgap1*) is not different from zero, while the GMM IV coefficient is positive and significant ($p < .03$) and the Hausman test rejects the null ($p < .01$). Based on GMM IV, a one-standard-deviation increase in *Indgap1* implies an increase of cash flow volatility of 0.002, versus median (mean) cash flow volatility of 0.007 (0.012). The second alternative risk measure is idiosyncratic firm risk, measured by the standard deviation of the residuals from a one-factor, three-factor, or four-factor model using daily stock returns in the prior 12-month period. The results are qualitatively similar to those based on total firm risk.

Table 4
Industry tournament incentives and firm risk

	Dependent variable and model type					
	OLS	GMM IV		OLS	GMM IV	
Explanatory variables	*Vol*	1st stage ln(*Indgap1*))	2nd stage *Vol*	*Vol*	1st stage ln(*Indgap2*))	2nd stage *Vol*
ln(*Indgap1*)	0.014***					
	(0.004)					
Predicted ln(*Indgap1*)			0.176***			
			(0.021)			
ln(*Indgap2*)				0.007*		
				(0.004)		
Predicted ln(*Indgap2*)						0.219***
						(0.028)
CEO delta	0.559*	−0.698*	0.627**	0.557*	0.321	0.465**
	(0.328)	(0.407)	(0.259)	(0.332)	(0.619)	(0.189)
CEO vega	0.008**	−0.035*	0.012**	0.008**	−0.028	0.011*
	(0.004)	(0.021)	(0.006)	(0.003)	(0.021)	(0.006)
ln(*Firm gap*)	−0.007	−0.129***	0.014**	−0.008	−0.213***	0.037***
	(0.006)	(0.012)	(0.006)	(0.006)	(0.015)	(0.009)
ln(*Total assets*)	−0.051	−0.245***	−0.028	−0.058	−0.028	−0.075*
	(0.046)	(0.057)	(0.035)	(0.047)	(0.073)	(0.038)
ln(*CEO tenure*)	0.002	0.156**	−0.010	0.003	−0.059	0.033
	(0.038)	(0.075)	(0.033)	(0.039)	(0.097)	(0.038)
ln(*CEO age*)	−0.800	−0.547	−0.632	−0.580	−3.249	0.212
	(1.192)	(1.545)	(1.119)	(1.185)	(2.125)	(1.069)
Stock return (1YR)	−0.013	−0.009	−0.007	−0.010	−0.012	−0.004
	(0.018)	(0.009)	(0.017)	(0.019)	(0.021)	(0.018)
Sales growth	0.001	−0.007	0.002	0.000	−0.017	−0.003
	(0.020)	(0.012)	(0.023)	(0.020)	(0.015)	(0.023)
q	0.007***	0.001	0.007***	0.007***	−0.009	0.008***
	(0.003)	(0.001)	(0.002)	(0.003)	(0.005)	(0.002)
Book leverage	0.437***	0.571***	0.343***	0.468***	0.211	0.416***
	(0.153)	(0.147)	(0.127)	(0.155)	(0.236)	(0.139)
Industry stock return vol	3.159***	0.048	2.452***	3.090***	−0.879	2.504***
	(0.632)	(0.789)	(0.634)	(0.632)	(1.037)	(0.656)
ln(*Ind # CEOs*)	−0.135***	−1.254***	−0.337***	−0.130**	−0.788***	−0.404***
	(0.051)	(0.168)	(0.051)	0.557*	(0.217)	(0.061)
ln(*Ind CEO comp*) (IV)		2.244***			1.881***	
		(0.096)			(0.140)	
ln(*Geo CEO mean*) (IV)		−0.274***			−0.587***	
		(0.055)			(0.075)	
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
CEO-firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,946	12,946	12,946	12,557	12,557	12,557
R-squared	0.397	0.148	0.320	0.299	0.195	0.323
Endogeneity, relevance, and overidentification						
Hansen *J*-test		2.128			1.875	
Hausman exogeneity test		44.61***			47.14***	
First-stage *F*-statistics		272.79***			91.67***	

This table presents multivariate regression models of firm risk on industry tournament incentives using ExecuComp firms, excluding financials and utility firms, from 1992 to 2005. The dependent variable is *Vol* =100 x *Stock return vol*, where *Stock return vol* is the standard deviation of one year of daily stock returns in year t+ 1. *Indgap1* is the pay gap between the second-highest-paid CEO's total compensation within the same Fama-French 30 industries classification and the CEO's total compensation. *Indgap2* is the pay gap between second-highest-paid CEO's total compensation in the same industry (FF30) and size group and the CEO's total compensation. Table A1 (the appendix) defines all other incentive variables and control variables. We include year and CEO-firm fixed effects in all specifications. Firm-clustered and Newey-West-corrected (up to four lags) standard errors are in parentheses ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

The effects of *delta* and *vega* on firm risk are positive and mostly significant. The results on *vega* are consistent with Coles, Daniel, and Naveen (2006). Like in Kini and Williams (2012), the coefficients on the internal pay gap are significantly positive. Coefficients on growth opportunities, as measured by Tobin's q, are positive and significant.[35] The signs of the coefficients on the remaining control variables are generally similar to those documented in prior literature.

In summary, using GMM IV with controls, CEO-firm and year fixed effects, and two different measures of the CEO industry pay gap, industry tournament incentives have a positive effect on firm risk that is economically and statistically significant.[36] These results are consistent with Hypothesis 2 and support the contention that a greater industry tournament incentive leads to higher risk-taking by aspirant CEOs.[37]

3.3 Alternative explanations

First, higher CEO ability would cause better firm performance, higher CEO pay, and a higher internal pay gap, but also a lower external pay gap, in which case we would observe a positive (negative) relation between performance and the internal (external) pay gap. The significantly positive coefficients on the external pay gap in Table 3 are inconsistent with CEO ability as an omitted variable that drives the results. Second, CEO entrenchment is likely to be associated with lower firm performance, higher CEO pay, a lower external pay gap, and also a higher internal pay gap. Thus, we should observe a positive (negative) relation between performance and the external (internal) pay gap. The results in Tables 3 and 4 indicate a positive relation in both cases. Moreover, controlling for the CEO pay slice as CEO entrenchment (Bebchuk, Cremers, and Peyer 2011), the estimated effects of the external tournament incentive on firm performance and risk-taking remain positive and significant.

---

[35] We estimate the models in Table 4, excluding q and also replacing q with R&D expenditure scaled by total assets, an alternative measure of growth opportunities, and obtain similar results. Since we are using future firm risk (or lagged q), we are not as concerned as we would be otherwise with firm risk affecting q. Moreover, q has become a standard measure of growth opportunities, so using q allows us and the reader to connect our empirical models and estimates to those in the prior literature.

[36] When we use industry fixed effects rather than CEO-firm fixed effects, for both firm performance and risk the GMM IV coefficients on the primary explanatory variables, our measures of the industry pay gap, almost always are larger (in absolute value) and have lower p-values. Moreover, the OLS estimates tend to differ somewhat. For example, in the OLS specifications in Tables 3 and 4 the OLS estimates on the pay gap are negative and significant. In comparing the OLS results based on industry versus CEO-firm fixed effects, we interpret these results to indicate that the endogeneity problem that implies spurious negative coefficient estimates on the industry pay gap is meaningful and that CEO-firm fixed effects, as one would expect, improve on industry fixed effects to provide a partial solution.

[37] It is possible that the industry pay gap implies incentives for risk-taking that exceed those that are suitable to implement optimal investment and financial policy. In no way, however, does our analysis allow us to assess whether or not the spectrum of incentive devices, including the internal pay gap, external pay gap, and performance-contingent pay, implement suboptimal risk-taking.

Third, both pay and other aspects of employment that comprise the industry tournament incentive are likely to be associated with firm size differences. Working for a larger firm likely confers on top executives a broader span of control over economic assets, more perquisites, and higher status. We decompose the predicted external pay gap into the portion that arises solely from differentials in firm size and the remaining that is orthogonal to the size gap. We find that the component of the instrumented external pay gap that is unrelated to the size gap has significant explanatory power for firm performance and firm risk. The above-mentioned results on the CEO pay slice and relative firm size appear in Tables OA1 and OA2, respectively (see the Internet Appendix).

3.4 The probability of winning and the strength of tournament incentives

We argued in Section 1.1 that the likelihood of the aspirant displacing an incumbent affects the industry tournament incentive. Hypothesis 3 asserts that a higher probability of winning increases the incentive effect of a given external pay gap. Lower labor market frictions, higher industry mobility, and executive and firm characteristics that permit job switching are likely to be associated with a higher likelihood, all else equal, of the aspirant being able to displace an incumbent.

3.4.1 CEO characteristics that affect CEO mobility and the external promotion probability. Our proxies for the probability the CEO can capture externally the gains from a favorable update in perceived ability include whether the CEO is new (*New CEO*) and whether the CEO is near retirement (*Retire*). In addition, we consider whether the CEO is a founder, the idea being that founders are less likely to abandon the firm they started.[38] Following Bebchuk, Cremers, and Peyer (2011), the CEO is designated as a founder (*Founder* =1, 0 otherwise) if the CEO's tenure reported in ExecuComp indicates that the CEO held that position prior to the firm's first listing on CRSP, which is assumed to be the IPO year. In each year for each measure, we assign CEOs to one of the two subgroups. For each proxy subgroup, we separately estimate the second stage GMM IV models for firm performance (per Column 3 in Table 3) and risk-taking (per Column 3 in Table 4).[39]

Table 5 shows the results for the three CEO-related proxies for probability of winning the tournament prize. Panel A (B) considers Tobin's q (*Vol*) as

[38] An alternative is that founders have low pay and a large gap and also, for various reasons, such as equity ownership or family considerations, have the incentive to perform well and take risk. This suggests, in contrast to our hypothesis, that the relation between performance and risk and the gap would be stronger if the CEO is a founder or member of the founding family.

[39] An alternative approach would be to regress firm performance and risk on the external pay gap and the pay gap interacted with the indicator for each subgroup. We have not taken this alternative approach because we have not generated suitable instruments for the interaction terms. Thus, so that we continue to benefit from using instruments to predict the external pay gap, we estimate performance and risk as a function of the instrumented pay gap for each partition (subgroup) of the data.

Table 5
Industry tournament incentives conditional on the probability of winning as measured by CEO characteristics

A. Firm performance	Dependent variable and data partition					
	q		*q*		*q*	
Explanatory variables	*New CEO*=0	*New CEO*=1	*Retire*=0	*Retire*=1	*Founder*=0	*Founder*=1
Predicted ln(*Indgap1*)	0.240***	0.034	0.281***	0.033	0.161***	0.132
	(0.029)	(0.067)	(0.036)	(0.036)	(0.022)	(0.095)
CEO delta	0.487	−0.051	1.344**	0.083	−0.303	1.342***
	(0.421)	(0.823)	(0.593)	(0.235)	(0.373)	(0.511)
ln(*Firm gap*)	0.101***	0.065***	0.112***	−0.004	0.075***	0.011
	(0.009)	(0.017)	(0.010)	(0.009)	(0.007)	(0.018)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
CEO-firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12,793	1,574	10,564	3,803	10,443	3,371
R-squared	0.228	0.184	0.229	0.258	0.226	0.241
Wald $\chi 2$ test for predicted ln(*Indgap1*)		0.00***		0.00***		0.08*
B. Firm risk	Dependent variable and data partition					
	Vol		*Vol*		*Vol*	
Explanatory variables	*New CEO*=0	*New CEO*=1	*Retire*=0	*Retire*=1	*Founder*=0	*Founder*=1
Predicted ln(*Indgap1*)	0.152***	0.037	0.223***	0.027	0.132***	0.054
	(0.018)	(0.077)	(0.021)	(0.027)	(0.018)	(0.051)
CEO delta	0.521**	0.835	0.806**	0.308	0.574*	−0.722***
	(0.264)	(0.893)	(0.350)	(0.367)	(0.293)	(0.250)
CEO vega	0.004	0.418***	0.016*	0.014	0.006	0.064***
	(0.005)	(0.068)	(0.010)	(0.011)	(0.005)	(0.019)
ln(*Firm gap*)	0.011**	0.020	0.021***	0.001	0.010*	−0.004
	(0.006)	(0.019)	(0.006)	(0.009)	(0.006)	(0.012)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
CEO-firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,967	1,349	9,010	3,306	9,167	3,014
R-squared	0.402	0.354	0.415	0.366	0.404	0.399
Wald $\chi 2$ test for predicted ln(*Indgap1*)		0.00***		0.00***		0.04**

This table presents GMM IV regressions (second stage only) of firm performance and risk on industry tournament incentives for subgroups based on CEO characteristics that affect the probability of winning the tournament. The sample covers all ExecuComp firms, excluding financials and utility firms, from 1992 to 2005. The dependent variables are *q* (panel A) and *Vol* (panel B), *Vol* =100 x *Stock return vol*, where *Stock return vol* is the standard deviation of one year of daily stock returns in year *t*+ 1. *Indgap1* is the pay gap between the second-highest-paid CEO's total compensation within the same Fama-French 30 industries classification and the CEO's total compensation. *New CEO* is a dummy variable equal to 1 in the CEO's first year of service in the new firm, and 0 otherwise. *Retire* is a dummy variable equal to 1 if the CEO's age is more than 65 years, and 0 otherwise. *Founder* is a dummy variable equal to 1 if the CEO held that position prior to appearing on CRSP, and 0 otherwise. In each year, we assign firms into one of the two subgroups based on whether the dummy variable for each proxy is 1 or 0. Table A1 (the appendix) defines all other incentive variables and control variables. We include year and CEO-firm fixed effects in all specifications. Firm-clustered and Newey-West-corrected (up to four lags) standard errors are in parentheses ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

the dependent variable. The proxies for probability of winning the industry tournament perform fully as predicted. For firm performance, for example, the coefficient on instrumented ln(*Indgap1*) is positive but insignificant when the CEO has recently assumed office, but positive, twice as large, and significant when the CEO is not new. The Wald chi-square test rejects the equality of the coefficients across the two subgroups. Likewise, the coefficient on the

tournament incentives measure is significantly larger when the CEO is not in the impending retirement group and when the CEO is not a founder. Similarly, for firm risk-taking, we find stronger tournament effects for firms with CEOs who are not brand new, CEOs not of retirement age, and CEOs who are not the founder.

Potential interfirm mobility of top executives is an important ingredient in the industry tournament. To frame and provide additional support for our analysis of external tournament incentives, we characterize the attributes of CEOs newly hired from other S&P 1500 firms in the period 1992 to 2005.[40] Out of 575 outside new CEOs, 249 of them were CEO at a previous employer. The other 326 (56.7%) new CEOs served in at least one senior management position at their prior company.

We argue that part of the prize in the industry tournament is the pay increase an executive receives by moving. Of the 249 new CEOs who were CEO at one or more previous employers (serial CEOs), 184 (or 74%) benefit from an increase in total compensation, with an average dollar increase of $11.8 million. By way of comparison, a CEO hired from inside the firm receives an average increase in pay of $0.90 million.[41] For the remaining 65 outside new serial CEOs who do not receive increased pay, we find that 43 (66%) did not leave the prior company voluntarily. For the other 22 voluntary turnovers in which the new CEOs did not receive a pay increase, 12 (55%) moved to a larger firm. These calculations, combined with evidence from Gudell (2010), suggest that there exists a substantial financial reward for new CEOs with prior CEO experience.[42,43]

3.4.2 Industry characteristics that affect CEO mobility and the external promotion probability. To further assess Hypothesis 3, we now consider whether industry characteristics associated with the probability of capturing externally the gains from a favorable update in perceived ability shape the incentives arising from the industry pay gap. We partition the sample based on

[40] ExecuComp identifies the executive who is the CEO (variable CEOANN) and the year in which the CEO was appointed (variable BECAMECEO). For firms with missing data on one or more of BECAMECEO and CEOANN, we inspect the proxy statement in that year and the previous year to ascertain whether the CEO is new. The percentage of new CEOs that come from outside the firm is similar to that documented by Denis and Denis (1995) and Huson, Parrino and Starks (2001).

[41] This figure for internally promoted CEOs will be biased downward if the insider already received the pay increase prior to the promotion or has additional benefits beyond pay after taking the job (e.g., the new CEO is a member of the founding family).

[42] Gudell (2010) argues that the incidence of serial CEOs is increasing and also suggests that significant implicit incentives, through career concerns of the sort associated with external industry tournament incentives, apply with particular force to serial CEOs.

[43] Other potential elements of the prize are the increase in span of control and enhanced status associated with working for a larger firm. Of the 249 new CEOs who served as CEO for the prior employer, 186 (74.6%) move to a larger firm with an average increase in assets of 4.13% ($26.45 million).

the industry measures constructed in Section 3.4. Our first proxy is *Industry mobility*. Holding pay at the firm constant, the industry tournament should have no effects on incentives if managers cannot move. For example, the industry tournament will be irrelevant if new CEOs come exclusively from inside the firm. We use *Industry talent* to measure the likelihood that CEO successors are insiders. By a similar logic, we also use *Industry homogeneity*, because the likelihood of hiring an outsider as CEO is higher in homogeneous industries (Parrino 1997) in which firm-specific human capital is less material and general human capital is most relevant for firm performance. Finally, we consider the number of CEOs, or identically the number of firms, in each industry (*Ind #CEO*). One possibility, holding constant the probability that any given CEO vacates their position, is that more potential CEO slots implies more vacancies in expectation, so that the executive is in more tournaments and the incentive effects of external pay gap(s) will be stronger. On the other hand, more CEOs also implies more competitors for each slot, so the net effect becomes an empirical question. To summarize, the effect of the industry tournament incentive should be stronger in industries with higher *Industry mobility*, lower *Industry talent*, higher *Industry homogeneity*, and possibly larger *Ind #CEO*.

To test these predictions, in each year, we split the industries into two subgroups based on whether each of the four proxies is above or below the sample median and then separately estimate the second stage of GMM IV regressions in Table 3 (for performance) and Table 4 (for risk-taking) across the two subgroups. Panel A (B) of Table 6 reports the results with q (*Vol*) as the dependent variable. The evidence supports Hypothesis 3. For example, in industries where *Industry mobility* is low and CEOs move less frequently, the tournament has little effect on either q or *Vol*, whereas the estimated effects are large and significant when executives are more mobile. Likewise, we find weaker results in industries with more inside CEOs, a lower degree of homogeneity, and fewer CEO positions in the industry.

3.5 Industry tournament incentives and manager decisions

We now assess the potential avenues through which the CEO industry pay gap is associated with firm risk by exploring the relation between industry tournament incentives and the riskiness of investment and financial policy. We hypothesize that aspects of financial and investment policy that increase firm risk, such as R&D intensity, firm focus, and book leverage, will increase in the industry pay gap, while the relation will be negative for investment in hard assets. We use two measures for firm focus, the Herfindahl index for firm sales by industry and the number of operating segments.

Table 7 reports the GMM IV results. In all five specifications the estimated coefficient on *Indgap1* has the predicted sign and three estimates are significant at least at 5%. R&D intensity, firm focus, and leverage increase in industry

Table 6
Industry tournament incentives conditional on probability of winning as measured by industry characteristics

A. Firm performance	Dependent variable and data partition							
	q *Ind. homo.*		*q* *Mobility*		*q* *Talent*		*q* *#CEO*	
Explanatory variables	Low	High	Low	High	Low	High	Low	High
Predicted ln(*Indgap1*)	0.102*	0.337***	0.067	0.205***	0.371***	0.041	0.080***	0.495***
	(0.057)	(0.047)	(0.040)	(0.039)	(0.045)	(0.036)	(0.014)	(0.098)
CEO delta	0.276	0.654	0.072	0.655	0.436	0.832	0.582**	0.279
	(0.292)	(0.617)	(0.259)	(0.565)	(0.295)	(0.568)	(0.257)	(0.756)
ln(*Firm gap*)	0.040***	0.052***	0.048***	0.094***	0.050***	0.119***	0.048***	0.140***
	(0.006)	(0.015)	(0.006)	(0.011)	(0.007)	(0.012)	(0.005)	(0.018)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CEO-firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,814	8,553	4,545	9,822	8,943	5,424	8,443	5,922
R-squared	0.256	0.252	0.241	0.244	0.316	0.253	0.357	0.290
Wald $\chi 2$ test for predicted ln(*Indgap1*)		0.06*		0.02**		0.00***		0.03*

B. Firm risk	Dependent variable and data partition							
	Vol *Homo.*		*Vol* *Mobility*		*Vol* *Talent*		*Vol* *#CEO*	
Explanatory variables	Low	High	Low	High	Low	High	Low	High
Predicted ln(*Indgap1*)	−0.014	0.287***	−0.025	0.115***	0.264***	−0.093***	0.018	0.362***
	(0.026)	(0.034)	(0.037)	(0.028)	(0.033)	(0.026)	(0.019)	(0.047)
CEO delta	0.375*	−0.173	−0.003	0.054	0.251	−0.021	0.685*	0.505
	(0.195)	(0.194)	(0.197)	(0.186)	(0.198)	(0.187)	(0.365)	(0.364)
CEO vega	0.083***	0.012**	−0.005	0.084***	−0.006	0.090***	−0.002	0.035**
	(0.020)	(0.005)	(0.004)	(0.012)	(0.004)	(0.013)	(0.005)	(0.016)
ln(*Firm gap*)	0.023***	0.015**	0.033***	−0.001	0.054***	0.025***	−0.010	0.037***
	(0.008)	(0.007)	(0.010)	(0.007)	(0.009)	(0.007)	(0.007)	(0.009)
Other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CEO-firm fixed effects (FF30)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,035	7,281	3,976	8,340	7,593	4,723	7,355	5,103
R-squared	0.352	0.417	0.333	0.416	0.336	0.422	0.321	0.519
Wald $\chi 2$ test for predicted ln(*Indgap1*)		0.00***		0.00***		0.00***		0.01***

This table presents GMM IV regressions (second stage only) of firm performance and risk on industry tournament incentives for subgroups based on industry characteristics that affect the probability of winning the tournament. The sample covers all ExecuComp firms, excluding financials and utility firms, from 1992 to 2005. The dependent variables are *q* (panel A) and *Vol* (panel B). *Vol* =100 x *Stock return vol*, where *Stock return vol* is the standard deviation of one year of daily stock returns in year $t+1$. *Indgap1* is the pay gap between the second-highest-paid CEO's total compensation within the same Fama-French 30 industries classification and the CEO's total compensation. *Ind. homo.*, *Industry homogeneity*; *Mobility*, *Industry mobility*; *Talent*, *Industry talent*; and #CEO, *Ind #CEO*. For each of the four proxies, in each year, we split the sample into two subgroups based on whether the industry in which the firm operates is below (low) or above (high) the sample median. Table A1 (the appendix) defines all other incentive variables and control variables. We include year and CEO-firm fixed effects in all specifications. Firm-clustered and Newey-West-corrected (up to four lags) standard errors are in parentheses ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

tournament incentives, while capital expenditures and segments decrease.[44] The results for all five models are similar using *Indgap2*. In terms of economic

[44] Compustat does not report segment data for many firms prior to 2002, so we have fewer observations when using *H-index* or the number of segments as the dependent variable. If a firm does not report R&D expenditures or capital expenditures, we assume the value to be zero (per Bizjak, Brickley, and Coles 1993). One reason for failure to report is that the company does not spend a "material" amount on R&D. As a check, we have conducted

Table 7
Industry tournament incentives and investment and financial policy

	Dependent variable				
Explanatory variables	*R&D*	*CAPEX*	*ln(# segments)*	*H-index*	*Book leverage*
Predicted ln(*Indgap1*)	0.456∗∗	−0.372∗∗∗	−0.024∗	0.017∗∗∗	0.002∗
	(0.223)	(0.086)	(0.012)	(0.005)	(0.001)
CEO delta	−1.043	3.522∗∗∗	−0.531∗∗∗	0.161∗∗	0.097∗∗∗
	(1.696)	(1.224)	(0.154)	(0.071)	(0.033)
CEO vega	0.006	0.061∗∗	0.004∗∗	0.002∗	−0.001
	(0.013)	(0.031)	(0.002)	(0.001)	(0.001)
ln(*Firm gap*)	0.088∗∗	0.137∗∗∗	0.002	0.001	−0.001
	(0.042)	(0.024)	(0.003)	(0.001)	(0.001)
Other control variables	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
CEO-firm fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	12,946	12,946	8,233	8,233	12,946
R-squared	0.025	0.060	0.446	0.459	0.027
Endogeneity, relevance, and overidentification					
Hansen J-test	0.035	0.478	1.171	0.791	1.6574
Hausman exogeneity test	12.12∗∗∗	9.92∗∗∗	12.69∗∗∗	13.23∗∗∗	8.21∗∗∗
First-stage F-statistics	283.18∗∗∗	238.19∗∗∗	267.66∗∗∗	238.78∗∗∗	54.11∗∗∗

This table presents GMM IV regressions (second stage) of firm investment and financial policy on industry tournament incentives using ExecuComp firms, excluding financials and utility firms, from 1992 to 2005. The dependent variables are *R&D*, *CAPEX*, ln(*# segments*), *H-index*, and *Book leverage*. All dependent variables are measured in year $t+1$ *R&D* is R&D expenditures divided by total assets (in percentage). *CAPEX* is capital expenditures divided by total assets (in percentage). ln(*# segments)* is the natural logarithm of the number of operating segments as reported in the Compustat segment database. *H-index* is the sum of the square of segment sales divided by the square of firm sales. *Book leverage* is interest-bearing debt divided by total assets. *Indgap1* is the pay gap between the second-highest-paid CEO's total compensation within the same Fama-French 30 industries classification and the CEO's total compensation. Table A1 (the appendix) defines all other incentive variables and control variables. We include year and CEO-firm fixed effects in all specifications. Firm-clustered and Newey-West-corrected (up to four lags) standard errors are in parentheses ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

significance, a one-standard-deviation increase in *Indgap1* implies an increase in R&D intensity of 0.006, compared with average *R&D* of 0.037, and a decrease in *CAPEX* by 0.003, compared with the average of 0.064. The same increase in *Indgap1* implies a decrease of the number of segments by 1.03 (versus the mean of 4.56) and an increase of the industry Herfindahl index of firm sales by 0.026 (mean *H-index* is 0.543).

4. Additional Analyses, Robustness Checks, and Discussion

4.1 Time-series variation in the level and effects of industry tournament incentives

To accommodate time-series variation we include year fixed effects and various time-varying control variables in the regression models. Variation through time in labor market conditions for executives, as indicated by trends in executive pay (Gabaix and Landier 2008), external mobility (Ryan and Wang 2012), hiring of CEOs from outside the firm (Murphy and Zábojník 2007; Cremers

the analysis omitting all missing R&D values (unless it is coded as "too small to report," in which case we again use a zero value). The results are similar.

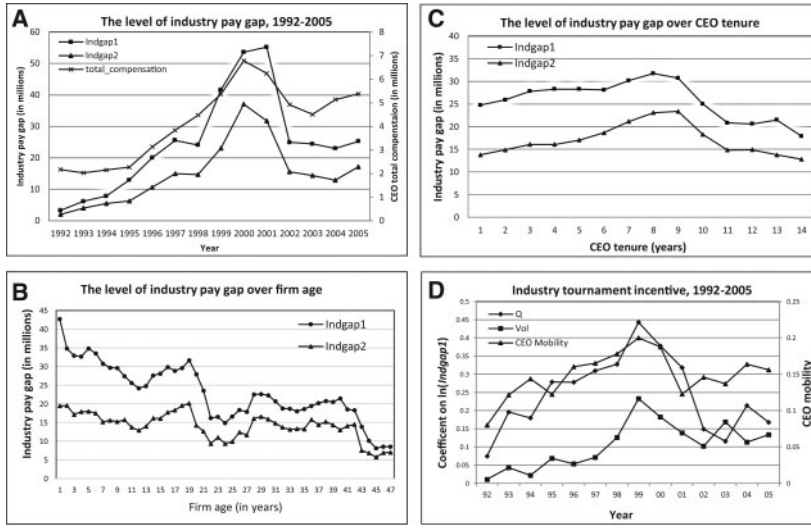

Figure 1
Time-series analysis of industry tournament incentives
This figure presents the time-series pattern for industry pay gap and industry tournament incentive effects for ExecuComp firms from 1992 to 2005, excluding financials and utility firms. *Indgap1* is the pay gap between the second highest CEO's total compensation within the Fama-French 30 industries classification and CEO's total compensation. *Indgap2* is pay gap between the second highest CEO's total compensation in the industry and size group and CEO's total compensation. *Vol* =100 x *Stock return vol*, where *Stock return vol* is the standard deviation of one year of daily stock returns in year $t+1$. *Indgap1*, *Indgap2*, and CEO total compensation are averaged across all firms in each year (*A*). The horizontal axis represents firm age, which is measured by the number of years since the firm was added to the CRSP database (*B*). *Indgap1* and *Indgap2* are then averaged among firms with the same age. The horizontal axis represents CEO tenure, which is measured by the number of years as firm's CEO (*C*). *Indgap1* and *Indgap2* are then averaged among CEOs with the same tenure. The vertical axis on the left side is the coefficient of the industry pay gap (*Indgap1*) based on the GMM IV regressions in Table 3 (*q*) and Table 4 (*Vol*) (*D*). To obtain the coefficients over time, we interact the industry pay gap with year dummies (using 1992 as the benchmark). The coefficient of industry pay gap in each year, except for 1992, is the sum of the coefficient of industry pay gap and the interaction term with the matched year dummy. The vertical axis on the right side of (*D*) is CEO mobility, which is defined as the annual CEO turnover rate.

and Grinstein 2011), and CEO turnover rate (Kaplan and Minton 2012), invites further examination of how the industry pay gap has evolved. As Figure 1A indicates, the averages of both *Indgap1* and *Indgap2* climb steadily from 1992 to 2000, followed by a large drop in 2001 and 2002. Figure 1A also shows that the average industry pay gap is correlated through time with average CEO compensation.

The industry pay gap varies across firm age and CEO tenure. In Figure 1B, we depict the average industry pay gap among firms with the same age, which is measured by the number of years since the firm has been added to the CRSP database. The plot indicates that the industry pay gap in younger firms is larger than that in older firms and that, once the firm reaches the age of ten years, the industry pay gap starts to shrink. This is consistent with the fact that surviving firms tend to be larger and tend to pay more. Figure 1C tracks the industry pay gap in CEO tenure. The industry gap increases in tenure initially, but on

average starts to decline after a CEO has held the position for over nine years. This is consistent with the notion CEOs with long tenure have high ability and the firm increases their pay to retain their talent.

We also assess whether the effects of industry tournament incentives change over time. To gauge effects through time, we re-estimate the GMM-IV models for performance (Column 3 in Table 3) and risk-taking (Column 3 in Table 4) but include predicted ln(*Indgap1*) interacted with year dummies (using 1992 as the benchmark). In Figure 1D, we depict the coefficient on instrumented ln(*Indgap1*) in each year from 1992 to 2005, which is calculated as the sum of the coefficient on predicted ln(*Indgap1*) and the interaction term with the matched year dummy (except 1992). In the same plot, we also include CEO mobility, which is defined as the annual CEO turnover rate. Figure 1D indicates that there is time series variation for the annual coefficients and the effect of industry tournament incentive varies in tandem with CEO mobility. For example, in 1999, both the coefficients and CEO turnover rate spiked. One explanation is that executive mobility was very high at the time, which amplified the incentive effect of the external pay gap.[45]

4.2 Cross-industry variation in the effects of industry tournament incentives

Parrino (1997) documents a large variation in firm homogeneity across industries. Cremers and Grinstein (2011) indicate that the CEO talent pool (measured by the percentage of internal CEOs hires) varies across industries. We now explore cross-industry variation in the incentive effects of the industry pay gap.

To measure the industry tournament incentive in each industry, we re-estimate the second stage of the GMM-IV regression models for firm performance and risk-taking for each Fama-French 30 industries classification, including Utilities and Financials.[46] Table 8 reports the coefficients and economic magnitude for predicted ln(*Indgap1*) in Columns 1 and 2 (for performance) and Columns 3 and 4 (for risk-taking). Industries that reflect the strongest effects of the external tournament incentive on firm performance include Retail, Transportation, Business Equipment, Health care, and Clothing. Industries with the strongest effects on firm risk-taking include Financials, Food, Retail, and Oil, Petroleum, and Natural Gas. Overall, there seems to be substantial variation in the effect of industry tournament incentives across industries. For both performance and risk, the F-test rejects the hypothesis that the coefficients across industries (FF30) are the same ($p < .01$).

[45] The CEO annual turnover rate for 1999 was 21.5%, which is 35% higher than the sample average. Nevertheless, when we exclude 1999 from the data, for q, firm risk, and policy, we obtain similar results for the effect of the external pay gap

[46] Due to a small number of firms in some industries, we merge firms in Food Products, Beer and Liquor, and Tobacco Products together. We combine firms in Mines and Coal for the same reason.

Table 8
Industry tournament incentives across FF30 industries

	q on ln(*Indgap1*)		*Vol* on ln(*Indgap1*)			
FF30 industry	*Coefficient*	*Magnitude*	*Coefficient*	*Magnitude*	*q*	*Vol*
Food Products, Beer and Liquor, and Tobacco	0.109*	0.028	0.435**	0.110	2.257	0.019
Games & Recreation	0.022	0.005	0.143	0.033	1.849	0.033
Books, Printing and Publishing	0.296***	0.077	0.398**	0.103	1.957	0.021
Household Consumer Goods	0.046	0.012	−0.053	−0.014	2.095	0.024
Clothing and Accessories	0.429**	0.116	0.117	0.032	1.840	0.028
Healthcare, Medical Equip. & Pharmaceuticals	0.642***	0.121	0.234*	0.044	3.197	0.033
Chemicals	0.275	0.060	0.049	0.011	1.729	0.023
Textiles	0.079	0.048	0.010	0.006	1.324	0.029
Construction and Construction Materials	0.358**	0.111	0.277**	0.086	1.569	0.025
Steel Works	−0.391	−0.138	−0.169	−0.059	1.355	0.028
Fabricated Products and Machinery	0.195***	0.051	0.375**	0.099	1.828	0.027
Electrical Equipment	−0.153	−0.037	0.011	0.003	2.262	0.026
Automobiles	0.137***	0.027	0.136	0.026	1.599	0.025
Aircraft, Ships and Railroad Equipment	0.259**	0.078	0.287**	0.086	1.542	0.021
Mines & Coal	0.192	0.095	0.030	0.015	1.940	0.030
Oil, Petroleum and Natural Gas	0.168***	0.062	0.077	0.028	1.620	0.024
Utilities	0.098	0.035	0.097	0.035	1.221	0.017
Telecommunications	0.139**	0.082	0.984***	0.583	1.899	0.029
Personal and Business Services	0.715***	0.255	0.483**	0.172	3.292	0.035
Business Equipment	0.646***	0.217	0.056	0.019	2.754	0.040
Paper and Business Supplies	0.624	0.170	0.169	0.046	1.575	0.023
Transportation	0.141**	0.030	0.855***	0.184	1.644	0.028
Wholesale	0.112***	0.025	0.369**	0.082	1.538	0.027
Retail	1.179***	0.294	0.547***	0.137	2.074	0.031
Meals, Restaurants and Hotels	0.366*	0.091	0.285*	0.071	1.908	0.030
Financials, Banking, Insurance and Real Estate	0.628**	0.140	1.026***	0.229	1.403	0.023
Others	0.085	0.098	−0.105	−0.121	1.590	0.025

This table reports the coefficient on predicted ln(*Indgap1)* from GMM IV regressions (second stage) of firm performance and risk on industry tournament incentives using ExecuComp firms, excluding financials and utility firms, from 1992 to 2005. The dependent variables are *q* and *Vol*. *Vol* =100 x *Stock return vol*, where *Stock return vol* is the standard deviation of one year of daily stock returns in year $t+1$. *Indgap1* is the pay gap between the second-highest-paid CEO's total compensation within the same Fama-French 30 industries classification and the CEO's total compensation. *Magnitude* is measured by the change in *q* or *Vol* for a one-standard-deviation increase in *Indgap1* in each industry ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. The average *q* and *Vol* in each Fama-French 30 industries classification are reported in the last two columns.

4.3 Robustness to industry definition

We perform the analysis of firm performance and risk using Fama-French 17 (FF17) and 48 (FF48) industry classifications. One possibility is that general human capital is a primary factor defining the span of the tournament. This would suggest that FF30 is too narrow and that it is cross-industry differences that drive differences in the effect of the pay spread on firm performance and risk. Then moving to the coarser FF17 will attribute variation previously accommodated by CEO-firm or industry fixed effects to variation in the industry pay gap. On the other hand, if human capital specific to industries more narrowly defined than FF30 determines the span of the tournament, moving instead to FF48 should make the estimated effects stronger as the boundaries

of the tournament are narrowed to encompass only the most relevant CEO positions. Table 9 presents the results. For both firm performance and risk-taking, the coefficient on predicted ln(*Indgap1*) using narrower industries (FF48) is approximately the same as the coefficient using broader industries (FF17). We interpret the results as consistent with the notion that both industry-specific and general human capital are relevant for defining the boundaries of the managerial labor market for external tournament incentives.

4.4 Are the internal and external tournaments symbiotic?

In an internal rank-order tournament among executives for the CEO position, the potential for promotion provides managers with an incentive to provide more productive input. One difficulty, however, with the internal horse-race model is that it need not be time-consistent. Once a well-qualified, effective executive has assumed the CEO position, absent outside options the likelihood that one of the other NEOs will become CEO in the near or medium term is substantially reduced. There would be no immediate reason for the company to dislodge the winner of the horse race, in which case any internal tournament incentives going forward would be significantly diminished. Our conjecture is that it is precisely because of the presence of the external tournament that internal tournament incentives have power. While the firm would want to retain an effective, high-ability CEO, such a CEO is likely to depart when offered a significantly better outside opportunity, in which case the internal horse race is still on, thereby providing significant internal tournament incentives. Accordingly, we surmise that the internal and external tournaments are "supermodular," insofar as they reinforce the incentive properties of one another.[47]

5. Conclusions

Empiricists have focused on executive wealth-performance sensitivity since the early 1990s (Jensen and Murphy 1990, Bizjak, Brickley, and Coles 1993), on executive risk-taking incentives starting 10 years later (Guay 1999; Rogers 2002; Coles Daniel, and Naveen 2006), and, more recently, on internal tournament incentives for executives (Kale, Reis, and Venkateswaran 2009; Kini and Williams 2012; Burns, Minnick, and Starks 2017). In this paper, we have conceptually and empirically extended the literature on executive incentives to assess industry tournament incentives external to the firm.

Consistent with the predictions of tournament theory (Lazear and Rosen 1981), empirical measures of CEO industry tournament incentives have substantial power to explain firm performance, risk, investment policy, and financial policy. The estimated incentive effects of the CEO external pay gap on

[47] We are grateful to Nagpurnanand Prabhala for discussions that elucidated this idea. See Fee, Hadlock, and Pierce (2006) for a related discussion based on internal and external labor markets for football coaches.

Table 9
Industry tournament incentives based on FF17 versus FF48

	Dependent variable and industry definition			
	q		*Vol*	
Explanatory variables	FF17	FF48	FF17	FF48
Predicted ln(*Indgap1*)	0.189***	0.178***	0.150***	0.164***
	(0.026)	(0.023)	(0.021)	(0.018)
CEO delta	0.226**	0.185**	0.486*	0.485*
	(0.108)	(0.088)	(0.252)	(0.255)
CEO vega			0.007*	0.002
			(0.004)	(0.006)
ln(*Firm gap*)	0.070***	0.074***	0.003	0.010
	(0.010)	(0.010)	(0.006)	(0.006)
ln(*Total assets*)	−0.379***	−0.342***	−0.053	−0.025
	(0.076)	(0.071)	(0.034)	(0.035)
ln(*CEO tenure*)	−0.150***	−0.150***	−0.795	−0.713
	(0.047)	(0.044)	(1.107)	(1.119)
ln(*CEO age*)	−0.406	−0.429	−0.015	−0.006
	(1.116)	(1.124)	(0.016)	(0.017)
Stock return (1 yr)	0.985***	0.955***	0.002	0.001
	(0.056)	(0.055)	(0.023)	(0.023)
Sales growth	0.080	0.078	0.150***	0.134***
	(0.056)	(0.056)	(0.021)	(0.018)
FCF	−0.243	−0.094		
	(0.551)	(0.546)		
R&D	1.627***	1.756***		
	(0.573)	(0.556)		
Capital investment	0.047	0.091		
	(0.354)	(0.355)		
q			0.007***	0.007***
			(0.002)	(0.002)
Book leverage			0.379***	0.350***
			(0.126)	(0.126)
Industry stock return vol	1.685	1.049	2.474***	2.388***
	(1.832)	(1.661)	(0.619)	(0.620)
ln(*Ind # CEOs*)	−0.108**	−0.101*	−0.193***	−0.180***
	(0.044)	(0.052)	(0.036)	(0.044)
Year dummy	Yes	Yes	Yes	Yes
CEO-firm fixed effects	Yes	Yes	Yes	Yes
Observations	15,128	14,694	13,128	12,694
R-squared	0.190	0.154	0.366	0.338
Endogeneity, relevance, and overidentification				
Hansen *J*-test	1.973	1.627	1.902	1.628
Hausman exogeneity test	30.05***	34.37***	33.55***	36.44***
First-stage *F*-statistics	369.36***	372.63***	287.89***	278.77***

This table presents GMM IV regressions (second stage only) of firm performance and risk on industry tournament incentives using alternative industry classifications. The sample covers all ExecuComp firms, excluding financials and utility firms, from 1992 to 2005. Columns 1 and 3 are based on Fama French's 17 industries classifications (FF17) Columns 2 and 4 are based on Fama French's 48 industries classifications (FF48). The dependent variables are *q* and *Vol*. *Vol* =100 x *Stock return vol*, where *Stock return vol* is the standard deviation of one year of daily stock returns in year $t+1$. *Indgap1* is the pay gap between the second-highest-paid CEO's total compensation within the same Fama-French 30 industries classification and the CEO's total compensation. Table A1 (the appendix) defines all other incentive variables and control variables. We include year and CEO-firm fixed effects in all specifications. Firm-clustered and Newey-West-corrected (up to four lags) standard errors are in parentheses ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

q, firm risk, and policy choices are statistically and economically significant. Moreover, the incentive effects of the industry pay gap are larger when the aspiring executive has a higher probability of winning the tournament and obtaining the prize. We also have found that the magnitude of the effects of the industry pay gap varies across industries and through time. Our results are robust to using 2SLS IV rather than GMM IV, using different industry definitions and time fixed effects, and controlling for the industry size gap, CEO pay slice, and measures of CEO talent and entrenchment. The results are stronger when we use industry fixed effects, rather than CEO-firm fixed effects.

This study has deployed performance-on-structure and structure-on-structure regression analysis. Herein, structure has encompassed various aspects of the organization, including internal and external tournament incentives, CEO delta and vega, financial policy, and investment policy. We have found, among other results, that performance, measured by Tobin's q, increases in both internal and external tournament incentives. The logical question arises as to why all firms do not increase these incentives and, thereby, increase firm value and q. Of course, if firms had done so, then we would not have observed the data that give rise to the estimated positive relation in the first place.

At least two explanations for a relation between performance and structure are possible (e.g., Coles, Lemmon, and Wang 2011). One is that the observed positive relation represents equilibrium covariation driven by one or more omitted variables. We have taken considerable measures to eliminate this explanation, including the use of instruments, CEO-firm fixed effects, and numerous control variables. A second potential explanation is that transaction costs, including those arising from other organizational considerations, prevent frictionless adjustment by firms of executive pay. In this case, the empirical estimates reflect an upward-sloping segment of the relation between firm value and the external tournament prize. The argument is particularly plausible for the external pay gap, because a firm has little control over the compensation and perquisites offered at other companies, such as the firm that provides maximal or near-maximal pay. For pay of the CEO at one's own firm, the firm can be constrained by internal considerations, such as contract design for optimal delta incentives and ideal internal tournament incentives, as well as equity concerns among the executive team. Moreover, the costs of moving or reassignment can imply that a firm need not respond to external opportunities to retain the CEO.

The idea of industry tournament incentives likely extends beyond CEOs to other named executive officers. Just as CEOs appear to be motivated by the possibility of being promoted to another firm in the same industry with higher compensation, so would other executives who possess discretion and influence over firm assets. Indeed, in our sample, 56.7% of new CEOs were not CEO at their prior firm. Though the external industry pay gap is likely to underestimate the size of the tournament prize for non-CEO NEOs (which would be the sum of the external pay gap and the internal pay gap), it is plausible that some of the

substantial effects on firm performance and risk we estimate arise from external tournament incentives for those executives.

Appendix

Table A1
Data sources and definitions

Variable	Source	Definition
Incentives		
Indgap1 ($000)	ExecuComp	The pay gap between the second-highest-paid CEO's total compensation within the same Fama-French 30-industry classification and the CEO's total compensation
Indgap2 ($000)	ExecuComp	The pay gap between the second-highest-paid CEO's total compensation in the same industry (FF30) and size group and the CEO's total compensation
Firm gap ($000)	ExecuComp	The pay gap between CEO's total compensation and the median VP total compensation
CEO delta (per $1)	ExecuComp	(Shares owned at the beginning of the year + Average delta of prior option grants × No. of options)/Number of shares outstanding
CEO vega ($000)	ExecuComp	The dollar change in the CEO's wealth for a 0.01 change in standard deviation of stock returns
CEO total comp ($000)	ExecuComp	Salary + bonus + restricted stock grants + option grants + LTIP + other annual payments
CEO characteristics		
CEO tenure	ExecuComp	The number of years as the firm's CEO
CEO age	ExecuComp	The CEO's age in the sample year
New CEO	ExecuComp	A dummy variable = 1 in the CEO's first year of service as CEO, and 0 otherwise
Retire CEO	ExecuComp	A dummy variable = 1 if the CEO's age is more than 65 years, and 0 otherwise
Founder	ExecuComp	A dummy variable = 1 if the CEO is the founder, defined by if the CEO's tenure reported in ExecuComp indicates that the CEO held that position prior to the firm's first listing on CRSP, and 0 otherwise
Industry characteristics		
Ind # CEOs	ExecuComp	The number of CEOs (and firms) within the same industry in the sample year
Industry mobility	ExecuComp	The unconditional probability of CEO departure in each industry in the sample year
Industry talent	ExecuComp	The percentage of insider CEOs in the industry in the sample year
H-index Industry homogeneity	ExecuComp CRSP	The industry Herfindahl index of firm sales, the sum of the square of segment sales divided by the square of firm sales in the sample year Mean partial correlation between firm's returns and an equally weighted industry index for all firms with the same Fama-French 30 industry code holding market return constant with prior 60 monthly returns.
Industry stock return vol	CRSP	The average volatility of all firms within the same industry based on daily returns in the prior year

(*continued*)

Table A1
Continued

Variable	Source	Definition
Firm characteristics		
q	Compustat	The ratio of the sum of market value of equity and the book value of debt to total assets
ROE	Compustat	Return on equity per share, calculated as net income divided by shareholder equity
Stock return vol	CRSP	Variance of one year of daily stock returns
EBITDA vol	Compustat	Cash flow volatility is the seasonally adjusted standard deviation of quarterly EBITDA divided by total assets from year t through year $t+4$
R&D	Compustat	R&D expenditures divided by total assets, = 0 if "not material" or missing
CAPEX	Compustat	Capital expenditures divided by total assets
# segments	Compustat	The number of operating segments as reported in Compustat segment database
Total assets	Compustat	Total assets
Sales	Compustat	Sales (net of returns, discounts, rebates, and allowances for missing and damaged goods)
Book leverage	Compustat	Book leverage = interest-bearing debt divided by total assets
Stock return 1 yr	Compustat	One-year stock return
Sales growth	Compustat	The average sales growth over years $t-4$ through $t-1$
Capital investment	Compustat	Investment in property, plant, and equipment divided by total assets
FCF	Compustat	Free cash flow = (operating income before depreciation − interest expense − income taxes minus cash dividends − capital expenditure) / total assets
CEO pay slice	ExecuComp	Fraction of aggregate compensation of the top-five executives captured by CEO
Instrumental variables		
Geo CEO mean	ExecuComp Compustat	The average total compensation received by all other CEOs who work at firms in a different industry which are headquartered within a 250-km radius of the firm
Ind CEO comp ($000,000)	ExecuComp	The sum of total compensation of all other CEOs in each industry (or size-based half industry), except the highest-paid CEO

References

Aggarwal, R. K., and A. A. Samwick. 2003. Performance incentives within firms: The effect of managerial responsibility. *Journal of Finance* 58:1619–43.

Agrawal, A., C. Knoeber, and F. Tsoulouhas. 2006. Are Outsiders Handicapped in CEO Successions? *Journal of Corporate Finance* 12:619–644.

Bebchuk, L., and J. Fried. 2001. Managerial power and rent extraction in the design of executive compensation. *University of Chicago Law Review* 69:751–846.

Bebchuk, L., and Y. Grinstein. 2005. The growth of U.S. executive pay. *Oxford Review of Economic Policy* 21:283–303.

Bebchuk, L., M. Cremers, and U. Peyer. 2011. The CEO pay slice. *Journal of Financial Economics* 102:199–221.

Becker, B. E., and M. A. Huselid. 1992. The incentive effects of tournament compensation systems. *Administrative Science Quarterly* 37:336–50.

Bettis, C., J. Bizjak, J. L. Coles, and S. Kalpathy. 2010. Stock and option grants with performance-based vesting provisions. *Review of Financial Studies* 23:3849–88.

———. 2016. Performance-vesting provisions in executive compensation. Working Paper, Texas Christian University.

Bhagat, S., and I. Welch. 1995. Corporate research and development investments: International comparisons. *Journal of Accounting and Economics* 19:443–70.

Bizjak, J., J. Brickley, and J. Coles. 1993. Stock-based incentive compensation and inestment behavior. *Jounral of Accounting and Economics* 16:349–372.

Bizjak, J., C. Bettis, and M. Lemmon. 2003. An empirical examination of executive stock option exercises. Working Paper, University of Utah.

Bizjak, J., M. Lemmon, and L. Naveen. 2008. Does the use of peer groups contribute to higher pay and less efficient compensation? *Journal of Financial Economics* 90:152–68.

Bizjak, J., M. Lemmon, and T. Nguyen. 2011. Are all CEOs above average? An empirical analysis of compensation peer groups and pay design *Journal of Financial Economics* 100:538–55.

Bouwman, C. 2011. The geography of executive compensation. Working Paper, Case Western Reserve University.

Brickley, J. A., J. L. Coles, and G. Jarrell. 1997. Leadership structure: separating the CEO and chairman of the board. *Journal of Corporate Finance* 3:189–220.

Brickley, J. A., J. L. Coles, and J. Linck. 1999. What happens to CEOs after they retire? Evidence on career concerns and CEO incentives. *Journal of Financial Economics* 52:341–77.

Brown, J. 2011. Quitters never win: the (adverse) incentive effects of competing with superstars. *Journal of Political Economy* 119:982–1013.

Brown, K., W. Harlow, and L. Starks. 1996. Of tournaments and temptations: An analysis of managerial incentives in the mutual fund industry. *Journal of Finance* 51:85–110.

Burns, N., K. Minnick, and L. Starks. 2017. CEO tournaments: A cross-country analysis of causes, cultural influences and consequences. *Journal of Financial and Quantitative Analysis* 52:519–51.

Cannella, A. A., D. R. Fraser, D. S. Lee. 1995. Firm failure and managerial labor markets: evidence from Texas banking. *Journal of Financial Economics* 38(2): 185–210.

Carpenter, J. 1998. The exercise and valuation of executive stock options. *Journal of Financial Economics* 48:127–58.

Chan, W. 1996. External recruitment versus internal promotion. *Journal of Labor Economics* 14:555–70.

Chen, J., E. Hughson, and N. Stoughton. 2011. Strategic mutual fund tournaments. Working Paper, University of California, Davis.

Coles, J. L., N. D. Daniel, and L. Naveen. 2006. Executive compensation and managerial risk-taking. *Journal of Financial Economics* 79:431–68.

———. 2013. Calculation of compensation incentives and firm-related wealth using ExecuComp: Data, program, and explanation. Working Paper, Temple University.

Coles, J. L., and C. Hoi. 2003. New evidence on the market for directors: Board membership and Pennsylvania Senate Bill1310. *Journal of Finance* 58:197–230.

Coles, J. L., M. Lemmon, and J. F. Meschke. 2012. Structural models and endogeneity in corporate finance: The link between managerial ownership and corporate performance. *Journal of Financial Economics* 103:149–68.

Coles, J. L., M. Lemmon, and Y. Wang. 2011. The joint determinants of managerial ownership, board independence, and firm performance. Working Paper, University of Utah.

Coles, J., Z. F. Li, and A. Wang. 2017. A model of industry tournament incentives. Working Paper, University of Utah.

Core, J., and W. Guay. 1999. The use of equity grants to manage optimal equity incentive levels. *Journal of Accounting and Economics* 28:151–84.

Coughlan, A. T., and R. M. Schmidt. 1985. Executive compensation, management turnover, and firm performance: An empirical investigation. *Journal of Accounting and Economics* 7:43–66.

Cremers, M., and Y. Grinstein. 2011. The market for CEO talent: Implications for CEO compensation. Working Paper, Yale School of Management.

Denis, D., and D., Denis. 1995. Performance changes following top management dismissals. *Journal of Finance* 50:293–340.

DeVaro, J., and M. Waldman. 2012. The signaling role of promotions: Further theory and empirical evidence. *Journal of Labor Economics* 30:91–147.

Dickens, W., and L. Katz. 1986. Inter-industry wage differences and industry characteristics. In *Unemployment and the structure of labor markets*, eds. K. Lang and J. Leonard. New York: Blackwell.

Ehrenberg, R. G., and M. L. Bognanno. 1990. Do tournaments have incentive effects? *Journal of Political Economy* 98:1307–24.

Fama, E. 1980. Agency problems and the theory of the firm. *Journal of Political Economy* 88:288–307.

Fama, E., and M. Jensen. 1983. Separation of ownership and control. *Journal of Law and Economics* 26:301–25.

Faulkender, M., and J. Yang. 2010. Inside the black box: The role and composition of compensation peer groups. *Journal of Financial Economics* 96:257–70.

Fee, C. E., and C. J. Hadlock. 2003. Raids, rewards, and reputations in the market for managerial talent. *Review of Financial Studies* 16:1311–53.

Fee, C. E., C. J. Hadlock, and J. Pierce. 2006. Promotions in the internal and external labor market: Evidence from professional football coaching careers. *Journal of Business* 79:821–50.

Frydman, C., and D. Jenter. 2010. CEO compensation. *Annual Review of Financial Economics* 2:75–102.

Gabaix, X. and A. Landier. 2008. Why has CEO increased so much? *Quarterly Journal of Economics* 123: 49–100.

Gibbs, M. 1995. Incentive compensation in a corporate hierarchy. *Journal of Accounting and Economics* 19:247–77.

Gillan, S., J. Hartzell, A. Koch, and L. Starks. Forthcoming. Getting the incentives right: backfilling and biases in executive compensation data. *Review of Financial Studies*.

Gilson, S. 1989. Management turnover and financial distress. *Journal of Financial Economics* 25:241–62.

———. 1990. Bankruptcy, boards, banks, and blockholders. *Journal of Financial Economics* 27:355–87.

Giroud, X., and H., Mueller. 2011. Corporate governance, product market competition, and equity prices. *Journal of Finance* 66:563–600.

Goel, A., and A., Thakor. 2008. Overconfidence, CEO selection, and corporate governance. *Journal of Finance* 63:2737–84.

Graham, J., C., Harvey, and S., Rajgopal. 2005. The economic implications of corporate financial reporting. *Journal of Accounting and Economics* 40:3–73.

Graham, J., S. Li, and J. Qiu. 2011. Manager attributes and executive compensation. *Review of Financial Studies* 24:1944–79.

Guay, W. 1999. The sensitivity of CEO wealth to equity risk: An analysis of the magnitude and determinants. *Journal of Financial Economics* 53:43–71.

Gudell, S. M. 2010. Serial CEOs and their career concern. Working Paper, University of Rochester.

Hall, B. J. and J. B. Liebman. 1998. Are CEOs really paid like bureaucrats? Quarterly Journal of Economics 113:653–91.

Huddart, S. and M. Lang. 1996. Employee stock option exercises: an empirical analysis. *Journal of Accounting and Economics* 21:5–43.

Huson, M., R., R. Parrino, and L. Starks. 2001. Internal monitoring mechanisms and CEO turnover: A long-term perspective. *Journal of Finance* 56:2261–97.

Hvide, H. 2002. Tournament rewards and risk taking. *Journal of Labor Economics* 20:877–98.

Jensen, M. C. and K. J. Murphy. 1990. Performance pay and top-management incentives. *Journal of Political Economy* 98(2):225–264.

Jensen, M., K. Murphy, and E. Wruck. 2004. CEO pay . . . and how to fix it. Working Paper, Harvard Business School.

John, K., A. Knyazeva, and D. Knyazeva. 2011. Does geography matter? Firm location and corporate payout policy. *Journal of Financial Economics* 101:533–51.

Kahneman, D., J. L. Knetsch, and R. Thaler. 1986. Fairness as a constraint on profit seeking: entitlements in the market. *American Economic Review* 76:728–41.

Kale, J. R., E. Reis, and A. Venkateswaran. 2009. Rank-order tournaments and incentive alignment: The effect on firm performance. *Journal of Finance* 64:1479–512.

Kaplan, S., and B., Minton. 2012. How has CEO turnover changed? *International Review of Finance* 12:57–87.

Kaplan, S., and D. Reishus. 1990. Outside directorships and firm performance. *Journal of Financial Economics* 27:389–410.

Kedia, S., and S. Rajgopal. 2009. Neighborhood matters: The impact of location on broad based stock option plans. *Journal of Financial Economics* 92:109–27.

Kini, O., and R. Williams. 2012. Tournament incentives, firm risk, and corporate policies. *Journal of Financial Economics* 103:350–76.

Lazear, E.P., and S. Rosen. 1981. Rank-order tournaments as optimum labor contracts. *Journal of Political Economy* 89:841–64.

Lorsch, J. and R. Khurana. 1999. Changing leaders: The board's role in CEO succession. *Harvard Business Review* 77:96–105.

Macauley, S. 1963. Noncontractual relations in business. *American Sociological Review* 28:55–67.

Murphy, K. J. 1999. Executive compensation. In *Handbook of labor economics*, eds. O. Ashenfelter and D. Card, vol. 3. Amsterdam: North-Holland.

Murphy, K. J., and J. Zábojník. 2007. Managerial capital and the market for CEOs. Working Paper, University of Southern California.

Nam, J., R. Ottoo, and J. Thornton. 2003. The effect of managerial incentives to bear risk on corporate investment and R&D investment. *Financial Review* 38:77–101.

Naveen, L. 2006. Organizational complexity and succession planning. *Journal of Financial and Quantitative Analysis* 41:661–83.

Nickerson, J. 2013. Structural estimation of the cost of suboptimal matching in the CEO labor market. Working Paper, University of Texas.

Opler, T., R. Pinkowitz, R. Stulz, and R. Williamson. 1999. The determinants and implications of corporate cash holdings. *Journal of Financial Economics* 52:3–46.

Pagan, A. R., and A. D. Hall. 1983. Diagnostics tests as residual analysis. *Econometric Reviews* 2(2):159–218.

Pan, Y. 2017. The determinants and impact of executive-firm matches. *Management Science* 63:185–200.

Parrino, R. 1997. CEO turnover and outside succession: A cross-sectional analysis. *Journal of Financial Economics* 46:165–97.

Rogers, D. 2002. Does executive portfolio structure affect risk management? CEO risk-taking incentives and corporate derivatives usage. *Journal of Banking and Finance* 26:271–95.

Rosen, S. 1981. The economics of superstars. *American Economic Review* 71:845–58.

———. 1982. Authority, control, and the distribution of earnings. *Bell Journal of Economics* 13:311–23.

Ryan, H., and L. Wang. 2012. CEO mobility and the CEO-firm match: Evidence from CEO employment history. Working Paper, Georgia State University.

Servaes, H. 1994. Do takeover targets overinvest? *Review of Financial Studies* 7:253–77.

Stock, J. H., and M. Yogo. 2005. Testing for weak instruments in linear IV regression. In *Identification and inference for econometric models: Essays in honor for Thomas J. Rothenberg*, eds. J. H. Stock and D. W. K. Andrews, ch. 5. Cambridge: Cambridge University Press.

Stock, J. H., J. H. Wright, and M. Yogo. 2002. A survey of weak instruments and weak identification in generalized method of moments. *Journal of Business and Economic Statistics* 20:518–29.

Tervio, M. 2008. The difference that CEOs make: An assignment model approach. *American Economic Review* 98:642–68.

Vancil, R. 1987. *Passing the baton: Managing the process of CEO succession*. Boston, MA: Harvard Business School Press.

Waldman, M. 1984. Job assignments, signaling, and efficiency. *Rand Journal of Economics* 15:255–67.

———. 2013. Classic promotion tournaments versus market-based tournaments. *International Journal of Industrial Organization* 31:198–210.

Warner, J. B., R. L. Watts, and K. H. Wruck. 1988. Stock prices and top management changes. *Journal of Financial Economics* 20:461–92.

Yermack, D. 1995. Do corporations award CEO stock options effectively? *Journal of Financial Economics* 39:237–69.